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Urban Policy (im)mobilities and Refractory Policy Lessons: Experimenting with the Sustainability Fix

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This paper bridges scholarship on policy mobilities and urban climate change experimentation to analyze the ways in which innovative low-carbon policies fail to diffuse. It argues that urban experiments become strategic learning tools that allow dominant actors in urban environmental politics to map pathways for a sustainability fix, test new low-carbon interventions, and gain knowledge of pathways for growth. Through a case-study of a solar district heating demonstration project in the Calgary metropolitan region, we suggest that these experiments allow powerful actors to mobilize 'perverse policy lessons' in order to construct 'policy failures' in cases that do not meet their requirements for a sustainability fix. Our analysis elucidates material and discursive strategies mobilised by dominant actors to selectively circulate knowledge that defines an urban experiment's success or failure. We highlight two takeaways for future scholarship on urban environmental governance and policy mobilities.

Keywords: policy learning, sustainability fix, urban experimentation, urban environmental governance, district heating systems

Urban Policy (im)mobilities and Refractory Policy Lessons: Experimenting with the Sustainability Fix

1. Introduction

This paper focuses on the Drake Landing Solar Community (DLSC), a solar district heating demonstration project, to understand the role of policy learning in the urban politics and governance of low-carbon transitions. The DLSC was completed in 2007 in the Town of Okotoks in the Calgary Metropolitan Region (CMR) of Alberta, Canada[1]. It was supported by Natural Resources Canada (NRCan), a department of the Canadian Federal Government, and leveraged partnerships with industry to demonstrate a model for low-carbon heating in Northern cities. Despite technical success, broad support, and intentions for widescale replication, the lessons gained in the DLSC have not been emulated in Alberta, nor has it spurred reproduction at a larger scale in Canada. Why would such a successful experiment for low-carbon urbanism fail to be emulated in communities throughout Canada as it was intended to do? Why didn't these policy lessons diffuse outside of the CMR? Our paper analyzes this inability to realize the "longer-term benefits" of replication and diffusion through the concepts of policy learning and the 'sustainability fix'. The sustainability fix refers to urban governance strategies that simultaneously meet profit-making and environmental goals without addressing structural inequalities. We suggest that 'perverse policy lessons' are mobilized by powerful interests to construct 'policy failures' in cases that do not meet their requirements for the sustainability fix. In this way, we see policy learning as relational and power-laden, not dualistic or apolitical.

The DLSC project was inspired from similar systems implemented in Scandinavian countries and was 'imported' to Alberta. It was rolled out as a turnkey project by NRCan and a coalition of local actors. The location of this low-carbon project is surprising for two reasons. First, the province's strong economic reliance on oil and gas and weak policies on climate change forecloses many political pathways for low-carbon transition (Diamanti, 2016)[2]. Alberta's petro-dominated economy and global position in fossil capitalism has made imagining and practicing low-carbon transitions particularly difficult (Adkin, 2016; Wilson, Carlson, & Szeman, 2017). Second, most Albertan municipalities who benefit from the growth and resource rents created by oil and gas industry are relatively passive in designing low-carbon urban policies. A survey conducted by the Albertan Municipal Climate Change Action Centre in 2014 indicates that only 40% of the respondents adopted a "formal or informal" community greenhouse gas emissions plan, about half of the respondents had no staff person responsible for climate change, and only one municipality had a full time designated person (Municipal Climate Change Action Centre, 2014). This highlights the important role of higher levels of government in urban low-carbon politics.

[1] While Okotoks is not officially included in the Calgary census metropolititan area (CMA), it is a suburb of Calgary and located within the Calgary Metropolitan Region (CMR) and participates in the newly formed Calgary Metropolitan Region Board (CMRB).

[2] In Canada, provinces and territories hold large competences and responsibilities related to energy and climate change.

Within this context, we examine how the successful DLSC experiment failed to produce broader changes in urban socio-material systems. We also analyze how the policy lessons and technical knowledge it generated have been mobilised by the actors involved in the project *against* broader low-carbon transitions. We situate our case study within the growing literature on policy mobilities and urban (climate change) experimentation, contributing to the formulation of a conceptual framework that advances analyses of the politics of urban experimentation. Policy mobilities scholars highlight the importance of understanding how policy models, practices, and expertise are selectively mobilized, allowing different urban actors and institutions to intervene in urban development, propose specific solutions, and gather the political support and legitimacy needed to carry out particular interventions (Mccann, 2011; Temenos & Mccann, 2012a, 2013). Similarly, scholars studying low-carbon transitions and the urban governance of climate change have suggested these interventions are often rolled out in strategic projects, or "experiments," that test particular sociotechnical and policy solutions, generate practical lessons and technical knowledge, and rework how urban (carbon) governance is enacted (Bulkeley & Castán Broto, 2012, 2014). We bring these literatures into conversation to analyze the construction of urban experiments, such as the DLSC, and the mobilization of policy learnings. We show that policy failures are an important element of urban experimentation, but also suggest that policy lessons aid in the production of a sustainability fix (While, Jonas, & Gibbs, 2004). Our central argument is that politics of urban experiments are deeply intertwined with the social and power-laden construction of success and failure (and who defines them as such), and that actors can mobilize lessons from experimentation to slow down or block sustainable transition.

In the next section, we expand on our theoretical approach, building from literature on policy mobilities, urban experimentation, and urban political economy. We outline how policy failures (and sociotechnical experiments) are increasingly important to the reconfiguration of urban climate governance, yet the material interests of urban regimes for capital accumulation often limit the bounds of acceptable sociotechnical transformation and forms of experimentation while also capturing policy learnings to direct future strategies for growth. We then describe the case study of the DLSC in detail, providing empirical richness to our argument. We follow an extended case-study method as deployed by scholars of urban policy (Peck & Theodore, 2012). Our abductive analysis is based on a recursive "conversation" between empirical materials from our case and theory and concepts in urban geography (especially related to experimentation and policy mobilities). We utilize content and discourse analysis of interviews conducted with various actors involved in the project, as well as of development plans, policy at the federal and local level, and local media articles collected between 2013 and 2017. These materials were collected as a part of a five-year project on the politics of low-carbon transitions in Canada and France, specifically focused on district heating systems. Secondary source materials were gathered from the Town of Okotoks, local media, Natural Resources Canada, international climate organizations, and developer plans and websites. We supplemented the secondary source materials with half a dozen in-depth interviews with key stakeholders, and participant observation at community meetings and conferences in Calgary.

Our analysis shows how the DLSC was set up as a model for reproduction but failed to diffuse because of the economic interests of an existing urban regime who saw the model as a challenge to their bottom line interests in profitable property development and energy sales. The learnings from this experiment, were used to rework the regimes pathways for growth, ultimately

undermining the low-carbon features, including the solar centralized heating system and green building models. We argue that the nature of urban experiments—as temporally limited, spatially bounded, and strategic interventions—provide opportunities for urban sociotechnical regimes to incorporate them into existing channels of growth. The power dynamics of sociotechnical regimes limits both the mobility of lessons and models generated/tested in urban experiments and the possibilities for more extensive low-carbon transition. We suggest that social and political production of successes and failures allows for experimentation with a 'sustainability fix', providing the means through which regimes of developers, government, and utility interests can test-out different sociotechnical configurations for low-carbon transitions and experiment their potential to activate (or not) new channels of growth. We conclude with a discussion of how policy learning can be progressively understood to enable more just and reproducible low-carbon transitions, which entails an alternative urban politics of experimentation based in a pragmatic incrementalism.

2. Urban experimentation, policy learning, and the sustainability fix

In order to understand the case of DLSC in the broader context Alberta's low-carbon transition and how it illuminates broader trends in urban politics and governance, we build on three interrelated literatures. First, we draw on the literature on urban experiments to understand their role in reconfiguring urban governance and urban politics around learning and carbon reduction. Second, we build on the notion of the sustainability fix to understand the motivations driving these forms of urban environmental governance. Lastly, we draw on policy mobilities and policy learning to understand the ways in which policy lessons are selectively mobilized. Drawing these literatures together helps us understand the ways in which 'refractory policy lessons' were generated in Okotoks, and the ways in which actors constructed the lessons to invalidate the efficacy of the DLSC model for replication or expansion. More broadly, our conceptual framework elucidates the politics of policy experimentation and mobility, especially related to green and sustainable urbanism, and thus is instructive for critical analyses of the successes and failures of urban sustainability policy.

2.1. The urban politics of experimentation

Bringing attention to the multitude of ways in which the urban intervenes in energy production, distribution, and consumption, Rutherford and Coutard (2013) argue cities have become key sites for the governance of energy transitions. Urban energy governance, as Rutherford and Jaglin (2015, p. 174) note, refers to the "multitude of ways in which urban actors engage with energy systems, flows, and infrastructures in order to meet particular collective goals and needs, framed or expressed in policymaking processes, but also in debates, contestations, and conflicts over policy orientations, resources, and outcomes." This definition suggests that urban energy governance does not only rest in official policy making procedures, but also in the various ways that urban actors interact with energy infrastructures. It also suggests that low-carbon politics are implicated in the reconfiguration of collective consumption, urban space, and provision of public services (Cohen, 2017; Jonas, Gibbs, & While, 2011).

This mirrors discussions of urban climate governance more generally, and the governance of low-carbon transitions (Bulkeley, 2010; Bulkeley, Castán Broto, & Edwards, 2014; Bulkeley, Castán Broto, Hodson, & Marvin, 2010). Bulkeley & Castán Broto (2012) document the

multitude of low-carbon projects and policies in cities globally, referring to them as "climate change experiments" that are central to urban climate governance. These experiments "are purposively designed to trial the social and technical experience of responding to climate change, put new materials, technologies and social actions to the test, or develop knowledge within the city to respond to climate change" (Castán Broto & Bulkeley, 2013). Experiments, however, are not only opportunities for learning or developing best practices. As Bulkeley and Castán Broto note (2012, p. 368), "rather than regarding experimentation as an open-ended process orchestrated by the dynamics of learning the city, or outside of the proper governance of climate change in the city, [...] experiments are critical sites of urban climate politics."

Scholarship on urban experimentation has engaged with various conceptions of urban politics, usually relating to climate, environment, or sustainability-related concerns. Evans (2011, p. 233) argues that the socio-ecological systems approach to urban adaptation, for example, has set out to create the city as a place for experimentation, opening up political possibility: "The central role afforded to experimentation in current manifestations of urban sustainability undoubtedly offers up a potential space for more playful or insurgent political engagements with urban infrastructure and material form. If sustainability comes down to letting 1000 experimental flowers bloom, then it matters who gets to experiment, and how." Similarly, the literature on urban laboratories has identified the promises and pitfalls of experimentation (Evans & Karvonen, 2014; Gopakumar, 2014; Karvonen & van Heur, 2014; Strebel & Jacobs, 2014). While experimentation may achieve new policy learnings or even radical changes on a small scale, the questions around who benefits and who loses out in experimentation is determined on a case by case basis. If urban experimentation is centrally about learning from real-world sociotechnical interventions, in a situated, change-oriented, and contingent manner (Karvonen & van Heur, 2014), then we must ask: who defines experiments, who controls the interventions, who shapes knowledge production and circulation processes, and what happens when the experiment ends? In short, urban experimentation has politics influenced by existing power relations in the city.

Recent scholarship on urban experimentation has grappled with these politics more closely asking who "gets to take part" in experimentation at both the institutional and practical levels (Evans, Karvonen, & Raven, 2016), especially considering that private companies and firms are heavily involved in this mode of urban governance (Bulkeley & Castán Broto, 2012; Evans & Karvonen, 2014). While experiments are often described as central to generating and governing urban low-carbon or sustainability transitions (Bulkeley et al., 2014; Moloney & Horne, 2015), the central question of power relations has brought concern about contestation and resistance from dominant regimes or the ability to manage such a widespread, power-laden process at all (Geels, 2014; Shove & Walker, 2007). Evans, Karvonen, & Raven (2016) discuss three aspects of power relations important to the politics of experimentation. First, power relations determining the *process* of urban experimentation: who participated in designing and framing the experiment, who's knowledge claims and discourse position is considered and how are socio-material transformations selected and shaped (Bulkeley & Castán Broto, 2014). Second, they argue the *outcomes* of experimentation are central to politics. How have urban experiments promoted a business-as-usual approach often resulting in the reproduction of inequalities? Central to the discussion of policy failures, *how are successes defined and measured*? Third, experiments can be a locus for radical change, a powerful political strategy for grassroots movements to challenge and disrupt the status-quo. Urban experiments can become "urban

politics by other means" to reclaim the democratic construction of the urban fabric and offer alternative socio-material pathways through social innovations and new practices.

2.2. Growth politics and the low-carbon fix

Scholars investigating the politics of urban development have shown how environmental policy considerations are being mainstreamed to enhance urban competitiveness and gain boarder political support (Jonas et al., 2011; Long, 2016; While et al., 2004; While, Jonas, & Gibbs, 2010). While et al. (2004) advance the concept of a 'sustainability fix' building on Harvey's (Harvey, 1981) concept of the spatial fix to analyze the ways discourses of sustainability are enrolled in an entrepreneurial approach of urban growth. Caught between growing pressure to adopt local policies on environmental issues on one hand, and inter-urban competition and state rescaling on the other, they argue that cities are deploying green differentiation strategies to attract investment capital. Urban regimes selectively develop environmental policies with the aim to reproduce or create new channels of growth:

> The historically contingent notion of a 'sustainability fix' is intended to capture some of the governance dilemmas, compromises and opportunities created by the current era of state restructuring and ecological modernization. […] sustainable development is itself interpreted as part of the search for a spatio-institutional fix to safeguard growth trajectories in the wake of industrial capitalism's long downturn, the global 'ecological crisis' and the rise of popular environmentalism. […] The notion of sustainability fix does not deny progress on ecological issues, but draws attention to the selective incorporation of ecological goals in the greening of urban governance." (While et al., 2004, p. 551)

The concept of sustainability fix entails a reconfiguration of the relationship between private and public actors, urban policies, and the built environment, and "in this sense the `sustainability fix', for both the public and private sector, is often as much about changes in political discourse as it is about material change in the ecological footprint of economic activity" (While et al., 2004). Expanding on the sustainability fix to analyze the broader relationship between ecological crisis and urban growth politics, Jonas et al. (Jonas et al., 2011) suggest carbon control is the central discourse, strategy and struggle around urban development in the "New Environmental Politics of Urban Development" (NEPUD). They explain that this entails a "retooling" of the urban growth regime, public-private partnerships, and urban fiscal incentives around carbon reductions throughout the urban fabric. Low-carbon transition here is thoroughly embedded not only in interurban competition as "the dominant mode of political calculation in urban governance", but also manifest in contestations between urban growth coalitions and a low-carbon polity in struggles around collective consumption, public services, public infrastructures, and environmental regulations that might conflict with or guide strategies of growth (Jonas et al., 2011, p. 2539). Thus, the NEPUD provides a conceptualization of the interface between policy flows and territorial interests that might influence policy mobilities (Chang, 2017; Temenos & Mccann, 2012a) and the shaping of urban experiments (Bulkeley & Castán Broto, 2014; Evans & Karvonen, 2014).

Recent scholarship on urban environmental governance has expanded on the sustainability fix and the NEPUD, arguing that "new urban environmental regimes" represent three dominant

trends: (1) development of an economic sector of green urbanism characterized by neo-managerial instruments of control and new modalities of competitiveness; (2) increasingly mobile, (trans-)locally produced and transformed policies aimed at building green urbanist reputations; and (3) broad movements towards sustainability post-politics that recreates exclusionary urban politics (Rosol, Béal, & Mössner, 2017, p. 1711). These new urban environmental regimes are defined by six features: they are growth-oriented, neo-managerial, best-practice driven, socio-spatially selective, city-centric, and post-democratic (Rosol et al., 2017). Centrally, these regimes promote sustainability in a largely symbolic way, to present cities as green while reproducing the status quo. This is evidenced by the urban environmental policies focused on growth-oriented strategies that are predominantly state-led and driven by public actors in government agencies.

In order to understand how the politics of urban experimentation and the sustainability fix influence the circulation of policy models and knowledge, we turn to the scholarship on policy mobilities and policy learning. These literatures help us understand the dialectics of policy failure and success, and the role of experimentation in testing pathways that simultaneously assure capital accumulation and assuage environmental concerns. In our specific case, a publicly-funded low-carbon urban experiment provides a learning site for dominant growth coalitions to test channels of economic growth in "green" urban socio-technical configurations.

2.3. Power and policy learning

Policy mobilities literatures brings consideration of the role of knowledge circulation from the site of experiment to the 'outside', and the constitution of networks that produce and circulate certain forms of knowledge (Mccann, 2011; Temenos & Mccann, 2013). The policy mobilities approach focuses on "following policies and 'studying through' the sites and situations of policy making" (McCann & Ward, 2012). Its methodological undertaking and inquiry (Cochrane & Ward, 2012; Peck & Theodore, 2012) critically investigates two intertwined processes in the construction and travel of urban policies. First, the *selective and power-laden process* of circulation of knowledge and policy through formation of transnational networks (or constellation) of actors. Scholars analyze why policy travels from place to place, how policies travel, and who makes policies mobile for whom and what (Mccann, 2008; Montero, 2017; Temenos & Mccann, 2012b; Wood, 2015a). Secondly, it focuses on how policies are constructed and how policies change as they circulate. Scholars examine how networks of actors transform and adopt elements of policy, as well as how place-specificities impact processes of mutation (Muller, 2014; Peck, 2012; Wood, 2015b).

These considerations are central to understanding the power relations behind the branding of "best practices" and the selective production and circulation of policy knowledge by different networks of actors (Baker & Temenos, 2015; Peck & Theodore, 2012; Temenos & Mccann, 2013). Critical attention to these power relations have pointed towards the importance of accounting for policy failures, and more centrally to deconstructing the dualisms of failure/success and immobility/mobility (Mccann & Ward, 2015). Similarly, Baker and Temenos (Baker & Temenos, 2015) argue that defining a policy as a success or failure are "power-laden" notions, resulting from the ways in which evaluations are socially and politically constructed.

An underlying assumption of the urban experimentation literature is that learnings and knowledge generated through a project might be mobilized by participants for replication and diffusion. Urban experiments aim to be replicated in "other locales" (Karvonen, Evans, & van Heur, 2014) or to be sustained and scaled up "to the entire, or at least a significant portion, of the urban landscape, through the transformation of urban planning practices" (Bulkeley & Castán Broto, 2014). This epistemology aims for "transformative learnings" – i.e. learning directed toward change and transformation – as opposed to learnings directed toward blockage and reproduction of the status-quo. Haughton and McManus (Haughton & Mcmanus, 2012) describe this as "perverse policy learning," building on Sites (2007) conceptualization of the ways in which cities become "social laboratories for the corporate and policy 'learning' that enhances neoliberal flexibility and governance."

Following McCann and Ward's (2015) emphasis on relational thinking against dualisms such as policy success and failure, we suggest this can also be applied to the concept of learning. Instead of positing that learning is positive or negative, we follow Mcfarlane's (2011, p. 362) conceptualization of learning as "crucial to how urbanism is produced and to how different constituencies respond to it." Learning in this regard is always potentially transformative, but also always power-laden. In support of powerful interests such as those involved in 'creative' or 'smart' city agendas, there is a tendency to focus on learning for knowledge-economies (Hollands, 2008; Krätke, 2012). Yet, as McFarlane (2011, p. 363) notes, this is "learning only in name and the purpose is to confirm what is already known, or to support existing politico-corporate agendas, while in other cases urban learning may be reduced to a direct or indirect process of imposition or instruction rather than dialogue and reflection."

Green urban experiments can thus be conceptualised as a strategy for dominant actors to test potential channels of growth associated with low-carbon transformations and to use these policy learnings for future growth-oriented agendas. In many cases, these urban experiments serve as a sustainability fix to simultaneous fuel growth and mitigate environmental impacts. If urban experiments are not profitable, they are often branded as a failure. Of course, in practice determining the success or failure of an urban experiment is more complex and power-laden. Constructing a narrative of failure or success centers around sorting out and selecting sociotechnical interventions and policy models that are the most 'promising' while putting aside those which are not profitable – or even threatening to economic interests. The construction of these narratives are tied to the broader development of a sustainability fix. This means analyses of urban experiments must take into account place-specific power relations and their role in the mobilization of policy learnings.

This scholarship on policy learning, urban environmental governance, and urban experimentation provides a conceptual framework for our analysis of the ways in which powerful actors selectively mobilize policy learnings associated with urban socio-material transformation. While urban experimentation offers opportunities for cities to progressively act on climate change or environmental issues, it also offers opportunities for business-as-usual approaches to construct a green image and test a particular sustainability fix. Our synergistic review of these literatures demonstrates that (1) urban experimentation is political and power-laden, and (2) policy success and failure is socially and politically constructed, coopting the radical potential of urban learning to serve the interests of profit-motivated developers and utilities. In the following sections, we

show the impetus for experimentation in Okotoks was driven by the potential for the DLSC pilot project to generate economic opportunities associated with a new low-carbon district heating system. We identify perverse policy learning by analyzing the knowledge and practices that are purposefully captured and immobilized by urban environmental regimes to prevent radical changes that could threaten their dominant position in the economic status quo.

3. The Drake Landing Solar Community experiment

In order to provide background on Alberta's urban energy and environmental politics, this section contextualizes Okotoks in the broader Calgary metro-politics. We provide a brief overview of previous local-level energy and environmental planning and policy. Then we provide background information about the DLSC and its potential for low-carbon heating in Northern cities.

3.1. Petro-state urban politics

The economic boom of the oil and gas industry have impacted urbanization in Alberta. This has brought jobs and population growth to the Edmonton and Calgary metro areas and put new pressures on urban governments to develop sustainably. Within the Calgary metropolitan region (CMR), the Town of Okotoks population has increased dramatically over the last two decades, from 8,528 in 1996, 17,150 in 2006, and to 28,881 in 2016. Most of this growth has been absorbed through low-density developments and extension of municipal borders through successive land annexation. Single-detached houses represent 77% of the dwelling stock in the town (Canada Census 2006, 2016).

Okotoks is characteristic of growing suburbs in the Canadian "in-between" often experiencing trouble meeting infrastructural needs and service demands (Filion & Keil, 2017; Young & Keil, 2010). In the late 1990s, the growth capacity of Okotoks was threatened by provincial water regulation and water quota management. To authorize its growth strategy, the municipality had to secure a minimum amount of water per capita. Okotoks had to cap its population growth to 30,000 inhabitants in its 1998 Municipal Development Plan. The same year, the Town of Okotoks adopted a sustainability strategy plan, mostly focused on water conservation. After significant investment in water savings programs, and the negotiation of an agreement with the City of Calgary, the municipality managed to cope with water requirements and increased its access to new water resources. In 2012, the town reviewed its municipal development plan and decided to "transition[n] from the finite growth model of the 1998 Legacy Plan to one of continued managed growth" to accommodate an expected increase of in population to over 80,000 over the next three decades (Town of Okotoks, 2016).

In Okotoks, the real estate sector, home-builders and developers represent a significant share of the local economy, and play a central role in politics and planning. Municipal policy in Calgary in the late 1990s and 2000s was largely focused on implementing new urbanist concepts and sustainability goals combined in a "smart growth" agenda (Grant, 2009). This strategy included a "sustainable suburbs" policy that was slow to be implemented in the late 2000s because of a push by developers against regulation. In periods of high growth during the tar sands boom, developers appeared to be more willing to support plan and policy changes for smart growth, such as dense and transit-oriented development, especially in privatized suburban developments

(Grant, 2009). In this push for working towards more sustainable suburbs, Okotoks had been positioned as a site for testing solar district heating technology in newly built residential developments.

3.2. Assembling the DLSC

The Drake Landing Solar Community (DLSC) is an innovative energy district heating system built in Okotoks in 2007. District heating systems (DHS) are decentralised heating infrastructure that supplies heat from one or several thermal plants to many buildings through an underground network of pipes. Heating plants can use various sources of energy: fossil fuels, low-carbon energy sources including waste heat recovery, biomass, geothermal and thermal solar. The flexibility of energy sources and the possibility to use renewable energy makes district heating a widely applicable tool for reducing greenhouse gas emissions in cities.

While DHS have been widely used in Europe and are often cited as a key sociotechnical intervention for urban low-carbon transitions with its own inherent organizational and implementation concerns (Gabillet, 2015; Hawkey, Webb, & Winskel, 2013; Webb, 2015), this infrastructure has not been widely implemented in residential applications in Canada (CIEEDAC, 2014). Over the past two decades, there has been a growing interest in DHS across Canadian cities. This interest has been bolstered by European experience and the advocacy of municipal network associations, such as the Federation of Canadian Municipalities. Even at the provincial level, there have only been three DHS pilots. The DLSC stands out because it showcases an innovative low-carbon heating technology, as opposed to natural gas; it was initiated by an individual working for a federal agency; and the pilot was built in a low-density suburban development.

The DLSC showcases a seasonal solar thermal storage technology (see Figure 1). The system connects 52 energy-efficient detached, single-family homes. Each dwelling has solar thermal arrays installed on the garage roof. Heat is captured and stored in the ground through an underground system of pipes and reservoirs during the summer. During winter, heat stored in the ground is released to heat the homes. The system avoids the emissions of 5 tonnes of carbon per house per year – including two tonnes due to the high energy performance of the houses.

[insert figure 1 here]

The DLSC project was initiated and managed by an engineer of a federal agency within the Canadian Ministry of Energy. The project manager's career in solar energy had given them experience and knowledge on solar thermal projects implemented in Scandinavian countries and Germany. In the late 1990s, "all the factors sort of laid down to help [the project] come about" (Project Manager, Interview, January 2015). This included growing concerns over climate change, increasing energy prices, and federal funding allocated to renewable heating projects in the residential sector.

With these drivers for implementation motivating the project, the main challenge was to find a place to anchor the demonstration project and to "assemble a team" consisting of a municipality, a developer, a home builder, and a utility. Through a process of networking amongst the project team, a low-density residential development was identified in Okotoks. The project was

approved because no homeowner or project team member would pay any additional cost for the solar DHS. As the project manager explained:

> We assembled that team. But the pitch that I made in order to bring these people together and agree to the proposal, was that we will find the funding to pay for the solar technologies and the storage technologies […] That's what brought them in. They saw they didn't have to come up with extra cash in order to pull this off. That they would rely on us to sort the funding for that. […] This is how we get them in initially, by removing this financial risk from them. (Project Manager, Interview, January 2015)

Beyond the local approval for this pilot project, technical expertise was required for modelling and designing the thermal storage system. A team of international experts was recruited to design the system in which they deployed a Swedish company's model that was successful in earlier energy storage projects. Construction started in 2005 and the project was completed in 2007.

3.3. Demonstrating solar district heating

The total cost of DLSC was CAD$7 million or approximately $134,000 per house. This cost included energy efficiency upgrades, but excluded the cost of land and homes construction which was the responsibility of the developer and homeowners. The "experimental" portion of the project was almost entirely funded by two major federal grants (a $2 million grant from the federal Technology Early Action Measures fund and a $2.5 million grant from the Federation of Canadian Municipalities). The provincial government also awarded the project a small grant.

According to the main page of the project website, the objectives of this urban pilot were twofold: to demonstrate the feasibility of seasonal solar thermal storage in Canada's cold climate; and to be replicated at a larger scale, in other Canadian cities (Drake Landing Solar Community, n.d.). From the start of operation, the DLSC has successfully demonstrated the technical feasibility of seasonal thermal storage technology in a cold climate. Over the past six years, the system provided over 90% of space heating needs, surpassing initial expectations. This success was recognized by several prestigious national and international energy prizes and awards, such as the Golden Energy Globe World Award from the Energy Globe Foundation in 2011, a first for a Canadian project. In 2013, the project won the International Energy Agency (IEA) Solar Heating and Cooling (SHC) Programme Solar Award, which "recognises not only the excellent results of the project, but also the pioneering spirit of the involved partners" (IEA Solar Heating Programme, 2013). Building on this publicity, in 2012, a Korean delegation visited the DLSC to learn from the project and to see if it could be replicated in developments for the 2018 Winter Olympics.

Despite this broad success and notoriety, ten years after its completion, the DLSC remains a North American first that failed to be replicated. Discussions were initiated with the municipality of Fort McMurray (Alberta) and a few municipalities in Nova Scotia, and feasibility studies were conducted in Whitehorse (Yukon) as well as in Okotoks for an additional 1000-unit system (Rodham, 2011). Yet, none of the municipalities followed up, mostly because of the high upfront costs of the system, and the absence of public funding available to replicate the project. The next section analyzes the role of power relations in the construction of this policy failure in the DLSC.

4. Solar trials and economic tribulations: Constructing policy failure

To understand how policy failures are constructed and how they influence urban environmental governance, we unpack the politics of experimentation through an analysis of the DLSC. We discuss three moments in the production and mobilization of policy learnings: (1) sociotechnical construction of the urban experiment, (2) shaping of policy failure, and (3) blockage of radical change.

4.1. Sociotechnical construction

The DLSC was inspired by seasonal solar thermal storage system developed in Scandinavian countries. Yet, when implemented in Okotoks, the pilot project underwent a series of significant socio-technical alterations that weakened its economic performance. Two key spatial features of district heating systems (DHS) were neglected during the transfer of knowledge: autonomy and self-sufficiency on one hand, and density on the other. DHS lays at the intersection between urban planning and energy systems, and like many infrastructure systems, they are place-specific and place-sensitive. Given DHS are capital-intensive infrastructures and rely on economies of scale to operate efficiently, their economic viability depends on the *energy density* of an area, i.e. heating load per kilometre of pipe network. The higher the building density, the more secure the heat load, and the easier to secure a reasonable return on investment.

In the case of DLSC, the system was poorly designed in regard to the principles of economy of scale. The system was designed and built in a low-density suburban development. Construction was made possible by the provision of public funding covering the upfront capital costs. The revenues generated by the fifty-two single-detached houses are barely sufficient to cover operations and maintenance costs, and there are not enough reserve funds to pay for major repair or replacement. In addition, the costs of the system were overrun due to infrastructural redundancy: the fifty-two homes are also connected to the conventional natural gas distribution system that provides for the remainder of space heating and hot water needs. This led to higher energy bills for connected households who pay fees for the DHS and a significant annual connection fee for the natural gas distribution system.

By contrast, energy efficient homes were not an initial component of the demonstration project. The official news release issued by NRCAN (NRCAN, 2005) does not mention energy efficiency measures. Energy efficiency became a central feature of the DLSC only when the modeling phase underscored the prohibitive costs of designing a system that would meet the heating needs of conventional homes. Based on the learnings from modeling, the project manager decided to make the project energy efficient. The only official thermal insulation standard at that time was the R-2000 certification. This certification developed by NRCAN required homes to consume thirty percent less energy than conventionally built homes, that was the equivalent of a reduction of energy consumption by thirty-seven Gigajoules per year.

The highly insulated homes decreased the necessary storage capacity of the system by forty-five percent. Energy savings also contributed to reduced carbon emissions by two tonnes per house per year. This is compared with the 5.6 tonnes avoided by the entire system (energy efficiency and solar storage). Energy efficient homes are a low-cost intervention compared to the rest of the

system, at only $6,400 (Howell-Mayhew Engineering, 2008). Energy efficiency contributed to thirty-five percent of the total carbon savings while representing only five percent of the initial capital costs of the project.

Energy efficient homes were an additional part of the urban experiment's sociotechnical construction. The R-2000 performance helped the project's technical success in the face of limited financial resources of the project by enabling the system designers to decrease the size, and the corresponding cost, of the storage system. As one engineering consultant noted, the experiment did not consider energy efficiency as a central feature, but focused on the demonstration of the solar thermal heating technology:

> In fact (…) I said to them [the other engineering consultants]: "Well, you are going to make it R-2000 energy efficient first, aren't you?" And he looked at me as if I was from Mars. He thought I was absolutely crazy to make a project that was energy efficient and he said: "No, no, we just want to make it solar". (**Engineering Consultant, Interview Oct 22, 2015)**

The sociotechnical construction of the DLSC was focused on "proving" the concept of solar thermal district heating. While common sense engineering knowledge would always recommend efficiency first, this was developed as an add-on to the DLSC's demonstration. Corresponding to much of the critical scholarship on urban experimentation (Halpern, LeCavalier, Calvillo, & Pietsch, 2013; McLean, Bulkeley, & Crang, 2015), the focus on demonstration and technological testing often blinds opportunities for more radical (and perhaps simpler and cheaper) solutions for responding to climate change. In this case, the DLSC's tunnel-vision view for implementing solar DHS nearly was only made possible by integrating basic forms of carbon reduction technology, well-insulated homes.

4.2. (Perverse) learnings: constructing failure

The DLSC experiment produced four policy lessons that were mobilized selectively in order to showcase the sustainability signature of Canada's first solar thermal DHS while also undermining its practical and economic viability:

1) Confirmation of the potential for a technological fix to reduce greenhouse gas emissions;
2) Demonstration of the exorbitant costs of the technological fix compared to its environmental benefits, in a province with low energy price and weak carbon policy;
3) Demonstration of financial unsustainability of the operation and maintenance of a DHS built in a low-density development;
4) Demonstration of cost-efficiency and carbon-efficiency of energy efficiency homes compared to the thermal solar technology.

These learnings are based on financial and material characteristics of the project. The mobilization and translation of these learnings by the participants vary in that the first two were expected by the participants but the second two were not. Correspondingly, the socio-material implications of these learnings are such that some aligned with developer and utility interests and others challenged them.

The selective ambitions to focus on a technological demonstration and not on the infrastructural aspect of DHS were well-understood before the implementation of the project by the home builder, the developer, the utility, and the Town of Okotoks. During the conception phase, the project manager organized a study tour in Sweden, the Netherlands, and Germany to educate the participants on seasonal solar thermal storage systems to "bring [them] up to speed" (Interview, DLSC Project Manager, January 2015). The participants had the opportunity to connect with stakeholders involved in the construction and operation of those systems. The project manager described the aim of the project:

> To be clear with what we were doing with the project, this project – the size of it being only 52 homes – was big enough to demonstrate the concept of seasonal storage […] but it is not the size in order to move towards commercialisation. You will really never build a project this size for it to be commercially viable. You have to go to a much, much larger project. (Interview, DLSC Project Manager, January 2015)

Study tours play an important role in policy knowledge production and exchange (Cook, n.d.; Cook, Ward, & Ward, 2015). In the DLSC, this enabled local actors to be aware of mutations from best practices" as demonstrated in Europe (e.g. technological focus and neglect of DHS, low-density development, infrastructural redundancy). They also knew the outcome of the project – an uneconomic technical demonstration. In other words, during the design and implementation of the project, dominant actors knew that the DLSC differed from the 'inspirational" European models in two ways. First, they understood that the low-density suburban development and associated urban planning practices would be left unchanged. Second, they learned that, given the cost of the demonstration, the intention was not to replace fossil-fuel based heating systems with solar energy in the short- or medium-term.

These "predetermined" lessons were central to manufacturing a policy failure. Actors engaged in the project to benefit from the environmental branding and sustainability discourse while at the same time reproducing existing low-density urban planning practices and demonstrating non-threatening technological systems with zero financial risk. The limited scope of the project would be a way to continue business-as-usual development and assuage environmental concerns (at least in the short-term).

By contrast, the addition of energy efficiency measures and long term maintenance of the system has produced a set of unexpected practical policy lessons. First, it highlighted the relative cost-efficiency of high energy efficiency standards in reducing greenhouse gas emissions in comparison to the solar storage system. Second, it underscored the financial infrastructural burden resulting from urban sprawl and low-density development. Both of these lessons had the potential to challenge existing environmental regimes, but were actively quieted in discourse on the DLSC experiment.

At that time of the DLSC experiment, the province of Alberta had one of the least efficient building code standards in Canada despite the harsh winters (Alberta Energy Efficiency Alliance, 2009). In the context of rapid population growth, energy efficient homes threatened home builders, developers, and energy utilities material interests, increasing the per unit costs and

decreasing profits. In addition, energy efficient homes require industry support that includes worker training, new building practices, and increased construction costs.

> The builder did not want to do anything what so ever out of the ordinary, even taking their homes from their base level of energy efficiency to R-2000. They did not want to do it. The mindset back then was just so stupid against anything new […] R-2000 at the time (2004-2005) was amazingly ambitious, it was a leading edge. But there was a lot of resistant from home builders. (Engineering Consultant #1, Interview Oct 22, 2015)

For natural gas utilities, higher energy efficiency standards would have translated into lower energy sales, and thereby a lower turnover. In addition, the growing cost of sprawl on municipal budget, especially the cost of operation and maintenance of urban infrastructures, started to challenge low-density residential development and land annexation. For example, the City of Calgary projected that "combined cumulative operating and capital revenue and funding deficiency … to be approximately $7 billion over the next 10 years" (City of Calgary, 2011). To resorb this deficit the City reviewed its Municipal Development Plan in 2009 to limit greenfield development, with the "endeavour to accommodate 50 % of Calgary's future population growth over the next 60 to 70 years within Developed Areas of the city" (City of Calgary, 2009).

4.3. Blockage of radical change?

Developers and utilities involved in the DLSC mobilized two strategies to shape policy learnings: selective circulation of policy knowledge and reproduction of a market solution narrative. The first strategy built upon the tension between the technological success of the experiment and its economic failure. On one hand, the awards and accolades received by the DLSC project from established organizations in the energy landscape provided credentials for the solar DHS. This credential permitted the technology to disrupt the dominant urban energy regime in principle, yet, the exorbitant costs for infrastructure and the low price of natural gas foreclosed pathways for market penetration in practice. This situation is well summarized by the home builder: "We've proved it can be done. Now we just have to prove it makes economic sense" (Rodham, 2011). By making visible the technological success of the project and its economic failure, the dominant actors were able to use the discourse of ecological modernization to suggest the DLSC was a failure and would only be feasible if the costs of solar heating technologies decrease and the scale of the systems could be increased. Second, they limited the focus on low-carbon interventions embedded in the project. The focus on seasonal thermal solar storage and the ecological modernization narrative diverted attention from energy efficiency features and the lessons for low-carbon urban form.

The discourse around the replication of the project has focused on the solar thermal heating technology, not about the more "common sense" lessons regarding energy efficient homes. As a result of this selective discussion of the experiment's success, the focus is on the non-threatening technology rather than on low-tech energy saving know-how. In addition, the discursive framing of the DLSC experiment does not challenge the unsustainable patterns of low-density suburban development in Alberta. As described by Sibbitt et al (2015, p. 36), the project was built to conform to existing patterns of development: "At first glance, the tidy two-story houses lining two streets in a Canadian suburb look much like thousands of other homes that surround them; but a district heating system that stores summer's abundant solar energy to heat the homes during

winter makes this community a global pioneer in heat storage technologies." This diverts the attention from the intrinsic economic and environmental unsustainability of greenfield, low-density and car-oriented development, and displaces alternative urban planning practices based on compact, mixed-used, and transit-oriented developments. The economic narrative disqualifying the solar technology because of its high cost also eliminates broader consideration of the political construction of energy prices, and the possibility for the Provincial Government to influence energy prices by introducing regulations effectively pricing carbon. In the context of Alberta's petro-politics, such radical changes would force consideration of alternative sociotechnical configurations.

To summarize, three policy lessons and their associated urban socio-material implications were marginalised by the coalition of local actors and government institutions involved in the DLSC project: energy efficient homes, compact development, and urban energy systems with higher fossil fuel prices. The impact was a "showcase" project that earned sustainability credentials for low-carbon experimentation, but undermined such pathways and reiterated the dominant position of a fossil-fuel based energy regime.

5. Conclusion: Mobilizing against transition

In this paper, we have argued that the selective mobilization of policy knowledge is central to the constitution of policy failure. Urban experimentation offers the potential for transformative learning and action, yet it is often deployed as a way to further the sustainability fix (Jonas et al., 2011; While et al., 2004). We suggested that "refractory" policy lessons are used to undermine low-carbon transitions, and that this is a growing feature of urban environmental governance not wholly captured by the idea of the sustainability fix, urban experimentation, or policy mobilities individually. Instead, we advocate for bringing these literatures together to analyze how dualisms of policy success/failure are weilded in support of, or against, urban low-carbon transitions. The case of the DLSC shows how analyses of urban environmental governance should be sensitive to policy learning and experimentation, but also to local, growth-oriented urban politics.

We highlight two key takeaways for future scholarship on urban environmental governance based on our analysis. First, analyses of the sustainability fix, or more broadly urban environmental politics, is increasingly tied to the global circulation of policy knowledge and to the broader trend of urban experimentation. Our case study suggests that urban experimentation can be part of a strategy for dominant regimes to test new channels of growth associated with ostensibly "green" sociotechnical interventions. Experiments offer one-off, contained projects, or what many transitions scholars call technological niches that offer opportunities for learning (Hess, 2015; Hommels, Peters, & Bijker, 2007). In new urban environmental regimes (Rosol et al., 2017), urban sustainability is often wielded to further the post-political, techno-managerial approaches to urban environmental governance. Local growth coalitions with convergent material interests are able to continue business as usual, with a flair of green credentials. In the case of DLSC, the energy utility, the developer, the home builder, and the municipality of Okotoks, had aligned material interests secured by a specific socio-material configuration entangling low-density residential development and a fossil-fuel based energy system.

Secondly, we argue for a need to go beyond identifying "perverse learning" that only bolsters existing, unsustainable development. Countering existing regimes means not only analyzing

these strategies but also charting alternatives. Our analysis is instructive in advocating for ways in which policy learning might be progressively understood to enable more just and reproducible low-carbon transitions, which entails an alternative urban politics of experimentation. To realize this, there is a pressing need to establish agendas for experiments that directly challenge urbanization as usual. Experiments are not simply about the pursuit of novelty but about fundamentally altering the way that urban development is done in a particular place. The transformative potential of experimentation does not lie in a series of one-off experiments where knowledge gleaned is fed into existing policy mechanisms, but in challenging the status quo and offering alternatives by re-orienting policy and planning around inclusive innovation and learning activities. If we begin to understand experiments in cities as urban politics by another means (Evans and Karvonen 2013), then the challenge of experimentation is to go beyond the existing constellation of actors and develop more participatory agendas that can imagine significantly different urban futures.

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Figure 1 Seasonal thermal solar technology mechanisms
Source: (Canmet Energy, 2009) Url:
https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/DrakesLanding(ENG).pdf
No need for permission request. See: https://www.canada.ca/en/transparency/terms.html