Harriet Bulkeley, Andrés Luque-Ayala, Jonathan Silver

Housing and the (re)configuration of energy provision in Cape Town and São Paulo: making space for a progressive urban climate politics?

Article (Published version)
(Refereed)

Housing and the (re)configuration of energy provision in Cape Town and São Paulo: Making space for a progressive urban climate politics?

Harriet Bulkeley [a,*], Andrés Luque-Ayala [a], Jonathan Silver [b]

[a] Department of Geography, Durham University, Durham DH1 3LE, UK
[b] LSE Cities, London School of Economics, London, UK

ABSTRACT

This paper takes as its starting point the argument that infrastructure networks cannot merely be thought of as the backdrop against which climate politics is played out in the city, but are instead fundamental to the ways in which this is conducted. Bringing infrastructure networks into view as a central tenet to the governing of climate change is not simply a matter of recognizing such spheres as critical sites for urban climate policy, but rather requires a conceptual approach that moves beyond a concern with the capacities of individual actors and institutions, and engages with the ways in which power operates and is constituted through the socio-materiality of the city. Drawing on theories of governmentality we develop such an approach and use it to examine the ways in which housing is providing a means through which experimentation with climate governance is taking place in Cape Town and São Paulo. Through this analysis we find that climate change is being mobilized both as a means to create new flows of carbon finance and as a means through which to advance calls for social inclusion and 'dignified' housing. Rather than being characterized by one dominant model, we suggest that the governing of climate change in cities in the global South is multiple, combining market and social logics in eclectic ways, where one is not predominant and both are in constant negotiation, dialogue and contestation.

Introduction

As responding to climate change takes root across multiple urban contexts, urban infrastructure networks — particularly those concerning the provision and consumption of energy services — are becoming critical to the workings of climate politics. For the most part, such networks have remained in the analytical background as researchers have sought to understand the ways in which municipal actors and their partners have responded to climate change (Bulkeley, 2010). In contrast, a growing body of work focuses explicitly on the ways in which infrastructure serves as the socio-technical backbone through which the urban condition is forged and its relation to other spheres of social, economic and political life (Gandy, 2004; Graham & Marvin, 2001, p. 479; Harvey, 1996; Heynen, Kaika, & Swyngedouw, 2003; Starr, 1999; Swyngedouw & Heynen, 2003). Working across these largely separate fields (Castán Broto & Bulkeley, 2013; Monstadt, 2009), this paper takes as its starting point the argument that infrastructure networks can not merely be thought of as the backdrop against which climate politics is played out in the city, but are instead fundamental to the ways in which this is conducted.

We argue that this is a politics that does not only take place in the formalities of urban planning and policy, but through experiments (e.g. pilot projects, novel technologies, various forms of social innovation and demonstration schemes) that emerge as urban actors seek to problematize and intervene in the city in relation to climate change (Bulkeley & Castán Broto, 2013; Castán Broto & Bulkeley, 2013; Evans, 2011). We suggest that the juncture between housing/energy infrastructure networks is a critical lens through which to understand these processes. Of particular significance has been the ways in which the social provision of housing has become a site for the demonstration of low carbon possibilities, often framed as delivering both carbon savings and social benefits (Castán Broto, 2012; Lovell, 2004). Through comparing low carbon interventions in publically built housing in Cape Town and São Paulo, we explore the ways in which energy infrastructures and housing are being mutually reconfigured through forms of experimental intervention. Examining the case of

* Corresponding author. Tel.: +44 (0)191 334 1940.
E-mail address: h.a.bulkeley@durham.ac.uk (H. Bulkeley).

insulated ceiling retrofit in Mamre, Cape Town, and the adoption of solar hot water technologies in São Paulo, we find that there are multiple drivers for such forms of urban experimentation, where market logics for the development of the carbon economy sit alongside articulations of low carbon energy interventions as a means through which to improve housing quality and provide for 'dignified' forms of housing and living. However, the cases illuminate the relative fragility of such a politics, and the constant work (and funding) required in delivering on this promise. Positioned as providing new markets and new forms of public benefit, we find that climate change acts at once to reconfigure urban possibilities and entrench existing interests.

Urban experiments, infrastructure and the social provision of housing

Over the past two decades, a growing debate has drawn attention to the significance of the urban as a site of response to climate change (Bulkeley, 2010). Such scholarship has tended to neglect the critical ways in which climate change is being realized through the reconfiguration of urban infrastructure networks and the critical projects of state restructuring and urban political economy involved (see Hodson & Marvin, 2010, p. 160; While, Jonas, & Gibbs, 2010). Bringing infrastructure networks into view as a central tenet to the governing of climate change is not simply a matter of recognizing such spheres as critical sites for urban climate policy, but rather requires a conceptual approach that engages with the ways in which power operates and is constituted through the socio-materiality of the city. In the rest of this section we develop such a perspective through an engagement with the concept of governmentality, before considering in more detail housing as a critical site of intervention in response to the urban climate change problem.

Governing climate change through urban experiments: a politics of improvement?

Rather than view governance as a set of capabilities or powers inhering in particular actors or institutions, a governmentality perspective suggests that what is central to the process of governing is "the will to improve: the attempt to direct conduct or intervene in social processes to produce desired outcomes and avert undesired ones" (Li, 2007a: 264). At stake is an understanding that governing proceeds through the development of particular mentalities and practices of rule in relation to particular objects or problematics, operating through subjectivities and in turn subject to forms of contestation and resistance (Dean, 1999, p. 231; Li, 2007b). Such problematics relate to "the condition of the population", and are invested with the purpose of the 'improvement' of such conditions relating to, for example wealth, longevity, and health (Foucault, 2009: 105). Seen from this perspective, the growing efforts to develop an urban response to climate change can be regarded as one amongst many urban 'problematics' that are regarded as requiring forms of intervention and improvement. Such a governmentality perspective is productive for it moves the focus of inquiry to dispersed forms of rule and the ways in which this is achieved through the social body. At the same time, as many of those working in other areas of climate politics have attested (e.g. Okereke, Bulkeley, & Schroeder, 2009; Paterson & Stripple, 2010), it enables analytic attention to be drawn not only to the question of why climate change has become problematized within any particular political domain, but also to how this has been conducted, and to the social and material work involved in the making of climate politics or what Li (2007a) terms the "practices of assemblage" involved in accomplishing governance. To this end, it

becomes critical to understand that "the things government must be concerned about … are men in their relationships, bonds and complex involvements with things like wealth, resources, means of subsistence, and, of course, the territory" (Foucault, 2009: 98). Foucault's conception of governmental power is therefore suggestive of the socio-material constitution of government and conduct, hinting at the importance of critically interrogating urban infrastructures as part of the means through which governing takes place in the city.

On this basis, we suggest that a governmentality perspective can extend our understanding of the ways and means of governing climate change in the city by connecting the mobilization of governmental power with the reconfiguration of socio-material conditions. As Kooy and Bakker (2008: 377) argue, "relations of power are inscribed in physical space as well as social relations. Governmentality, in other words, has material effects; and material conditions play a role in constituting and/or contesting, government by constraining and shaping their form and effectiveness." Scholars of urban technology and urban political ecology have long recognized that central to the urban condition are flows of 'metabolic circulation', "the socially mediated process of environmental—including technological—transformation and transconfiguration, through which all manner of 'agents' are mobilized, attached, collectivized, and networked" (Swyngedouw, 2006: 113) and which, in turn, produce the "enabling and disabling social and environmental conditions" of the city (Monstadt, 2009: 10). Understanding urban climate responses as a form of governmentality, through which the 'will to improve' is mobilized and made practicable provides a means through which to engage such insights with the ways in which urban socio-materialities have come to be the object of governance intervention. As Bulkeley and Castán Broto (2013: 363) suggest, this in turn means that "rather than finding coherence in the process of policymaking and its implementation… such a view of the ways in which power is conducted point to the critical role of the manifold sites, techniques and practices, through which conduct is shaped." Governing the city, in this sense, is accomplished through the manifold and seemingly piecemeal interventions through which rationalities and programmes are put to the test — realized, normalized and contested. In responding to climate change in the urban arena, such interventions are frequently explicitly of an experimental mode — demonstration projects, pilots, trials, futuristic one-off eco-homes, enclaves and so on — where forms of testing, technical novelties, learning, alternative institutional arrangements and new kinds of experience are regarded as part of the raison d'etre (Bulkeley & Castán Broto, 2013). This in turn raises important questions about by whom, why, how and to what ends experimentation is taking place.

Climate problematics and the social provision of housing

Housing is a critical urban infrastructure through which the governing of climate change has become established, both as a site for new forms of consumption (Barr, Gilg, & Shaw, 2011) and as an arena for direct intervention. As Lovell (2004) explains, 'sustainable housing' has become framed as a solution to the climate change problem both because of the flexibility of the concept and because of its 'ready to hand' nature, available to be enrolled into discourses and programmes for addressing a multiplicity of issues, from energy security and affordability to climate change. In short, housing has come to be regarded as problematic in "relation to particular schemes of thought, diagnoses of deficiency and promises of improvement" (Li, 2007a: 264) concerning climate change such that it is seen both to require and be able to provide some form of response. Orchestrating and enacting improvement within such arenas is anything but straightforward (Li, 2007b). While housing

might be the 'problem', creating solutions has proven more intractable. Regarding housing as networked infrastructure illuminates its complex socio-materiality, forged through legal frameworks, building practices, materials, design standards, cultural expectations and so on. As Lovell (2005: 824) argues:

"momentum is high in the housing sector because of the durability of the housing product, and the considerable capital cost of production. It means that innovating with new products like low energy housing is more costly and higher risk, because they do not fit easily within the existing socio-technical system".

For Lovell (2005), it is this degree of momentum and obduracy that provides one explanation for the uneven landscape of sustainable housing. She argues that such forms of innovation are more likely to be found in social housing (alongside the self-build sector) where actors are able to forge links such that "close collaboration can help to overcome the conservative tendencies of the existing housing socio-technical system, because the risk of new products failing is reduced if consumer preferences are better known and understood" (Lovell, 2005: 824). In other cases, social housing is also found to be a focus for energy and climate change related interventions, although alternative explanations are provided. In Ljubljana, Solvenia, Castán Broto (2012: 83) find that the work of the Public Housing Fund "builds upon a long history of engagement with energy efficiency and social housing provision" in the city but that a "growing interest on low carbon projects has intensified their activities in this area during the last decade" leading to new forms of experimentation with housing retrofit and refurbishment premised on addressing energy vulnerability and ensuring that households can meet the costs of social housing. Beyond individual cases, a study of the energy approach of housing organizations in 11 countries indicates that:

"state-led housing organisations, such as municipal providers (Sweden, Canada, the Czech Republic), might be relatively easy to influence by governments to invest in the energy efficiency of their housing stock through bureaucratic mechanisms. Market-led, non-profit housing organisations (the Netherlands, Austria, Germany) are sensitive to the return on investment and could be reluctant to invest in the energy efficiency of their stock if it cannot be recovered by an increase of rental income" (Nieboer, Gruis, van Hal, & Tsenkova, 2012: 243).

Although distinct in their approaches and the factors which are thought to be driving the interweaving of climate change and social housing agendas, each of these analyses suggests that the work of forging alignments, "linking together the objectives of the various parties to an assemblage" (Li, 2007a: 265), is critical. Even where states are not engaged in the direct provision of social housing, they retain a role in defining the "reality and dimensions" of housing practice (Dodson, 2006: 227) that in turn structure such alignments. The government of housing requires not only the creation of distinct problems, and forms of alignment that enable intervention to proceed, but also works through the constitution of subjectivities and their self-government. Writing in the UK context, Flint (2004: 169) finds that the 'freedoms' offered by the social provision of housing have become a site for new forms of governmental intervention, through new mentalities of housing that entail "the reformation of a consumerist and rights paradigm through the incorporation of a communitarian focus upon duties and responsibilities" such that living within social housing requires new forms of self-regulation

and accountability. For example, in Brazil an expansion of social housing programmes in the 21st century was linked to a series of pro-poor and socially active governments and in South Africa the provision of housing and the creation of a housing market have been central to post-Apartheid national and urban development. In each case, publically financed housing is also defined as a key tenet for the integration of the population with a market economy and in this way a mechanism to achieve social improvement and create new subjectivities (Lemanski, 2011). Whilst commentators (Butcher & Oldfield, 2009; Gilbert, 2002) have suggested such housing based mechanisms may fail to stimulate a low income housing market, tackle poverty or bring household security, they illustrate both the dominance of the state in financing housing infrastructures and the means through such mechanisms both envisage new urban futures and forms of citizenship.

Rather than regarding social or publically financed housing as a 'niche' within a wider housing market, these perspectives suggest that the social provision of housing can be seen as a means through which problematizations, practices of assemblage and conduct are gathered in order to achieve different forms of improvement. As a site for realizing responses to the climate change problematic, we suggest that understanding how and with what implications forms of experimentation are emerging at the intersection of housing/energy infrastructures can provide us with critical insights into the ways in which infrastructures are being mobilized towards a low carbon transition, the extent to which dominant modalities of experimentation are emerging in different urban contexts, and insights into their implications for social and environmental justice.

Experimenting with climate change and housing in São Paulo and Cape Town

In order to generate new insights about the ways in which climate change experimentation is emerging in relation to housing infrastructures, in this paper we focus on the experience of two cities in the global South. As Kooy and Bakker (2008: 1845) suggest, such a strategy may offer "more flexible theories of urbanization, which can generate more appropriate explanatory frameworks … and provide a useful counterpoint to Foucauldian readings of urban life focused on the West." Our focus on São Paulo and Cape Town emerged from bringing the results of two independent PhD research projects into comparison: one which focused on the development of new urban energy systems in São Paulo and Thane, India, and one which was concerned with the political ecologies of urban climate responses in Accra, Ghana and Cape Town. Whilst there are significant differences in the urban economies and metabolisms of each city, we find that both face challenges of poverty alleviation and the provision of housing at scale whilst also responding to international, national and local pressures to address climate change. As key urban centres within what are often termed the BRICS (Brazil, India, China and South Africa) group of countries, where growing economies and consumption levels amongst the middle classes are leading to rising levels of greenhouse gas (GHG) emissions, São Paulo and Cape Town are increasingly being regarded as places in which regional and municipal governments have the capacity to show leadership in responding to climate change, as witnessed, for example, in their membership of the C40 Cities Climate Leadership Group. At the same time, both cities face significant challenges in terms of addressing inequalities and socio-environmental justice, and have embraced major commitments towards local development with an emphasis on discourses the centrality of housing and service delivery. These juxtapositions raises interesting questions about how, in the context of urban neoliberal economies, low carbon transitions may provide a platform

from which São Paulo and Cape Town can address the limits of their wider political economic conditions. It is in this context that, through a range of new financial flows (from climate change funds through to private energy utility investments), both cities are experimenting with low carbon interventions in housing infrastructures. We suggest that by analyzing each case in relation to one another we can begin to discern the potential, and the limitations, of seeking to bring climate change into the development policies and priorities of rapidly developing cities in the global South, whilst at the same time recasting our conceptual understandings of the nature of governing climate change in and through the city.

The remainder of this paper looks in detail at the attempts to govern through climate change experimentation in social or publically financed housing in each Cape Town and São Paulo. In so doing, we find that collective and market logics are combined in a variety of ways, enacting a variety of discourses, and governing a variety of subjects such as populations, energy systems and industrial processes. We examine experiments led by regional and municipal authorities: the introduction of solar hot water (SHW) technologies in the dwellings built by the Housing and Urban Development Company of the State of São Paulo (CDHU) and efforts of the City of Cape Town at retrofitting existing Reconstruction and Development Programme (RDP) housing in the township of Mamre with roof insulation. In undertaking this analysis, we draw on a range of primary and secondary data. In Cape Town, as part of the broader PhD research project a survey examining the experiment from the perspective of the community using a range of household indicators and perceptions was conducted with 140 of 250 households involved in the retrofit. This survey was accompanied by 25 interviews with community members and a further 15 interviews with stakeholders including municipal officials and NGOs (for detailed analysis see Silver, Phillips, & Rowswell, 2011, p. 32). Both the community survey and interviewing were conducted in partnership with the City of Cape Town and ICLEI (Local Governments for Sustainability) Africa as part of the evaluation process of the Mamre project. This research was undertaken in collaboration with community members, with the surveys being sent to all participating households and the interviews advertised widely across the community. In São Paulo, the broader PhD research involved a total of 58 interviews with a diverse range of stakeholders involved in the solar hot water sector. Nine of these interviews were conducted with staff members of the CDHU, focusing exclusively on the interface between social housing and solar hot water. This was complemented with 14 interviews with households who had received SHW systems. Institutional interviewees were selected through snowballing techniques, whist households were interviewed over the course of project visits. These activities were carried out with the support of *Vitae Civilis*, a Brazilian environmental NGO involved in promoting solar technologies in São Paulo, and encompassed a range of experimentation with SHW alongside the specific projects analyzed here. In both projects, interview material was transcribed and subsequently analyzed using techniques which identify thematic codes through a close reading of the interview and other research materials (diary, policy documents, photographs) and then seek to apply these codes to the transcripts in order to assess their significance, the extent to which discourses, positions and ideas are held in common across different participants and any patterns that arise, and where there might be significant differences. In the analysis that follows, we focus on two particular thematics — how climate change came to be regarded as relevant in relation to the provision of housing in each city, and the extent to which addressing climate change was regarded as compatible with wider development challenges in the city. Selected quotes illustrate these thematics rather than provide a comprehensive record of all of the research material gathered in relation to these issues.

Developing a housing with dignity agenda through solar hot water in São Paulo

With a population of over 40 million and 645 municipalities, the State of São Paulo is responsible for a third of Brazil's GDP. The majority of the state's population is concentrated in three contiguous metropolitan regions: São Paulo, Campinas and Santos. The largest of these, the São Paulo Metropolitan Region (20 million), is composed of 39 municipalities including the City of São Paulo (11 million) covering 8000 km^2. Recent estimates suggest that across the state there is a housing deficit of 4 million units, mostly concentrated in the three metropolitan regions mentioned above, representing one of the main social challenges for the region (Secretaria de Habitação, 2013). Within this context, the CDHU, a publicly owned company attached to the State of São Paulo's Housing Department, has been building in the order of 30,000 dwellings per year over the past decade (CDHU, 2013a). Of the housing needs of the state, 80% fall within families earning between 1 and 3 times the legally defined minimum salary (CDHU, 2011), equivalent to US$300–US$900 per month, and the large majority of the CDHU's dwellings are for families within this bracket. Through a system of subsidies and low interest rate loans the CDHU provides beneficiaries with ownership of the dwelling. In order to facilitate this, CDHU establishes maximum limits for monthly housing payments, ranging from 15% of the total income for families earning between 1 and 3 minimum salaries to 25–30% for those earning between 8.5 and 10 minimum salaries (CDHU, 2013b).

National level drivers for the use of solar hot water

Since 2005, the CDHU has experimented with the use of solar hot water systems (SHW) in social housing in a variety of guises. Occurring in the context of national governments characterized by a marked social policy and poverty alleviation approach, these efforts have arisen as a result of three interrelated and often overlapping drivers: sustainability, climate change and energy security. In 2007, the CDHU adopted a systematic approach to sustainability in which it took a threefold approach that incorporated social concerns: sustainability retrofit via the incorporation of sustainable urban planning principles in existing neighbourhoods; the adoption of sustainability standards for new construction; and the development of actions that promote social and economic well-being (UNEP, 2010, p. 63). These goals were addressed through a variety of means, with a focus on pilot experimentation in water — shower timers, water saving devices and rain water harvesting — and energy. Addressing energy consumption through the use of SHW systems was seen as an appropriate entry point to further the debate on sustainability within the CDHU, develop a knowledge base about sustainable construction, and demonstrate feasibility by showcasing a range of environmental and social benefits associated with sustainability interventions.

The second driver was the need to respond to a climate change agenda. Both the State and the City of São Paulo have pioneered the development of policies and action plans in response to climate change. The City of São Paulo has played a national and international leadership role in translating climate change concerns into municipal actions. In 2005 the city commissioned its first urban GHG emissions inventory (Prefeitura do São Paulo, 2005, p. 20), followed by city and state climate change policies in 2009. The Climate Change Policy of the State of São Paulo includes specific guidelines requiring the construction sector to address issues of sustainable energy and energy efficiency in buildings. The policy provides a context that both reaffirms the validity of experimenting with SHW systems and strengthens the political legitimacy for its continuation. This has provided the basis for new ways of relating

to housing, as the energy efficiency manager of the CDHU suggests, "we're thinking in a different way, […] always thinking about how not to generate carbon emissions." In this way, climate change became an important political discourse at both State and City level, providing context and harnessing political support to secure continuity in the experimentation.

The challenges and opportunities provided by a national crisis in the electricity sector are a third driver shaping the adoption of SHW in social housing. In the early 2000s, Brazil's electricity system entered into a state of crisis, as the government was forced to draft nationwide plans for planned electricity outages of up to 5 h a day. Subsequently, the National Electricity Regulatory Agency has mandated private electricity utility companies to invest 1% of their net income in energy efficiency measures. Since 2005, a significant portion of this investment has been directed towards energy programs in low-income population. SHW investments in social housing have become an attractive option for utility companies (Governo do Brasil, 2010b), replacing other mechanisms for domestic water heating, particularly the electric shower, a pervasive technology that contributes 18% of the country's daily peak electricity demand (Governo do Brasil, 2010a, p. 271). In this sense, the experiment with SHW was driven by concerns for national energy security and as a means of introducing more flexible forms of energy provision.

Building low carbon logics

In response to these drivers, the CDHU started experimentation with SHW in partnership with product manufacturers aimed at testing its social and technical feasibility. Successful results led to a widespread adoption of SHW systems. By 2011 the company had used three different mechanisms to install over 30,000 SHW systems: building retrofit via SHW systems donated by energy utility companies; direct purchase of SHW equipment for dwellings completed or under construction through public tenders aimed at solar manufacturing companies; and the incorporation of the SHW system within the normal design and construction practices of the CDHU, where the housing unit is conceived with SHW from the outset and the party responsible for delivery is the building contractor.

Whilst these three mechanisms share the same objective of installing SHW in social housing, they rely on different rationales and techniques. The first mechanism, where the key delivery actors are commercial energy utility companies, relies on private intervention guided by a regulatory environment that requires a liberalized energy sector to invest in low-income population in the name of energy security. Here, the low carbon quality of the energy service is perhaps less important than its decentralized nature, and it comes to stand for a form of energy security. In contrast, the second and third mechanisms function through the everyday technologies of public investment and local government action: procurement mechanisms, public tenders and terms of reference. They play out in a space of market competition within a social service organization, with a variety of private sector companies (house builders and solar manufacturers) competing for large-scale government contracts through lowering prices. In this case, the discourses are more avowedly low carbon, but are also married with a sense of the overall 'lifecycle' costs of such systems for the inhabitants (Lovell, 2004), so that sustainability is seen as both an environmental and economic issue. Here, it is the contractual terms of reference and procurement tools which act as the instrumental techniques for rolling out SHW experiments in social housing.

Throughout its experimentation with SHW the CDHU has been aware of the power of the public sector to influence the development of an emerging 'green' industry. The decision of the CDHU to install thousands of SHW systems in its housing stock facilitates economies of scale capable of lowering the cost of low carbon transition technologies while making them more competitive, as was noted by a sustainability manger from CDHU: "we pay and buy in large scale, and in that way we create a market." The CDHU has used this power, through negotiations with the manufacturers association of SHW systems, to push for technological development, quality improvements and a broader recognition of additional sustainability dimensions such as the manufacturer's extended responsibility for product disposal after its life cycle.

The interaction between the CDHU and the manufacturers association shows the extent to which technological innovation and industrial development is promoted and governed by state intervention, but also requires different stakeholders within the social housing industry to self-regulate and exercise different forms of control. The different drivers, rationales and techniques behind the adoption of SHW reflect an experimentation mode that attempts to draw different forms of flexibility in energy use into the energy market. The SHW systems perform an important market function by freeing the energy market from the constraints imposed by the daily peak electricity demand. Utility companies are able to devise flexible strategies and free up resources earmarked for the expansion of the electricity network in order to cope with the daily demand in the context of a limited supply, opening up new opportunities in the circulation and marketization of energy. At the same time, concerns with sustainability and a growing political interest in climate change have ensured that such flexibility is sought through low carbon technologies. Controlling carbon, here, relates to delivering flexibility during particular peak powers of the electricity network and providing a form of economic investment in long term household economies. Such an approach, in parallel, also serves to enact logics that support social justice and poverty alleviation through social housing, as we explore below.

Dignified housing

Established social housing strategies are particularly sensitive to the adoption of new practices or technologies that could increase the price of housing units. For this reason, the decision of the CDHU to experiment with SHW systems was not to be taken lightly, as the new systems would upset a carefully balanced equation between the amenities provided, the cost of each unit, and the number of units built per year. The implications of increasing the unit costs and thereby reducing the number of houses built and the fraction of population served is politically contentious, particularly in a contest where well-established social housing movements vocally advocate for a reduction in the housing shortage and politicians are judged on their ability to deliver social benefits. However, the social housing debate in the State of São Paulo is far from limited to the annual number of units built, with the level of 'substandard' housing also recorded in the Brazilian census. The 'qualification' of the social housing debate represents a significant shift in the social housing agenda, advanced largely through the efforts of São Paulo's social housing movements, such that increasing housing is not enough, but the quality of this provision is fundamental. This approach is enshrined in the State of São Paulo's Housing Plan 2011–2023, which establishes "the continuous search for the promotion of dignified housing, ensuring the qualities and conditions of habitability to all individuals in an egalitarian manner" as one of the foundational principles of the state's housing policy (Governo do Estado São Paulo, 2011: 235). In this logic, 'quality' housing is associated with providing 'dignified' housing − housing through which it is possible to lead a dignified life (Tatagiba, Paterniani, & Trindade, 2012).

By increasing the cost of each individual dwelling, the adoption of SHW systems lies at the heart of the tension between quantity

and quality in housing infrastructure. However, this tension was bridged through the integration of the sustainability imperative and the 'housing with dignity' discourse and through several multi-stakeholder discussions on the topic. In this way, the CDHU qualified the meaning and nature of sustainability in social housing, and SHW systems became one of several sustainability interventions contributing to housing with dignity and quality of life: a wide range of amenities and facilities, quality construction materials, better air circulation and increased natural light. Achieving a confluence between the sustainability and housing with dignity debates also relied upon the calculation and articulation of the long-term benefits for the final users, achieved via lower energy bills (up to 30% reductions), and for society at large through the promotion of a set of values that encourage environmental conservation. This 'lifecycle' logic that demonstrates how low carbon measures can reduce housing costs over the life of the building (Lovell, 2004) is applied to a low-income context, providing economic benefits that contribute to social justice and poverty alleviation:

> "Four of us live here. We like the SHW system. First of all because of the economy. But also because it helps with environmental issues. We moved here 3 months ago. Our energy bills have been as follows: the 1st month R$19, the 2nd month $R28, and the 3rd month R$38. […] before moving into this house, we were paying between R$70 and R$90 because of the electric shower…since we moved in to the new house we have only been using the SHW. If we would use the electric shower the energy bill would be higher".

(Interview, 2011, SHW user in a CDHU project in Cubatão, Greater São Paulo).

For the beneficiaries of social housing, acquiring a new dwelling often means a series of additional financial burdens that are unaffordable. In particular, the regularization of housing conditions implies the need to pay water and electricity bills, in many cases for the first time. By reducing the expenditure in utility services, the SHW system frees scarce financial resources that can be used for other domestic commitments associated to housing provision, such as the mortgage and the condominium fees, playing a role in managing financial risks for all parties involved.

> "Why the solar hot water? There is an environmental aspect, but it is a system that generates lower costs. Because who is the population that CDHU serves? We work with […] people of low income. Therefore you are generating possibilities for maintenance of their house. Because very often people who come from a background of informal housing do not pay electricity, do not pay water… Because they are doing their own connections… And in the new model they have to start paying condominium fees, so that is a problem".

(Interview, 2011, Quality manager at the CDHU, São Paulo).

In this way, and through a low carbon strategy, the CDHU managed to promote a perspective that places a significant emphasis on issues of inclusion, dignity and social justice. The incorporation of building sustainability features serves to enact low carbon interventions as a means of responding to the recognition of inequality and the potential of housing dignity as a means of redress. The extension of regularized housing in this manner, and the connection to utility provision and economies, also affords the state the opportunity to integrate new subjects into and to reproduce this project.

Trajectories: mobilizing experimentation

Whilst largely successful, the State of São Paulo's experimentation with SHW has also been fragile and prone to break down, pointing to the challenging work of maintaining alignments and the work involved in sustaining particular governmental projects. Solar manufacturers point to the inherent difficulties of incorporating SHW systems in pre-existing social housing. The technical interface between SHW systems and other infrastructures and building systems has on occasion proved incompatible. In addition, from the manufacturer's perspective, the relationship with the CDHU has been difficult and on unequal terms. While acknowledging the positive benefits that the CDHU's policies have brought to the solar industry, manufacturers see this as a process of learning by doing where the costs of learning have been borne primarily by the private sector.

Many of the challenges limiting the widespread adoption of SHW systems in social housing are related to the specific social and technical mechanisms by which different urban infrastructures interact, highlighting the role of the house as the place where a variety of urban systems converge and the challenges this poses. Housing infrastructure in the form of tall residential towers constrains the adoption of SHW due to the limited amount of roof surface, the distance between hot water tanks and the points of use (resulting in a loss of water and/or temperature), and the incompatibility between individual water metering systems and the collective SHW systems that would be required for system optimization within a limited roof space. Such limitations are experienced more acutely in those areas with the highest levels of urbanization, as land constraints make the use of tall residential towers for social housing a common requirement, particularly in the three metropolitan regions of the State of São Paulo — precisely where the greatest housing shortage is located. The technical conflicts between water provision strategies and solar systems are both material and institutional, as they relate to incompatible product design as much as to a lack of institutional alignment between the requirements of the new solar systems and the metering practices of the local water utility companies. Despite these material and institutional limitations, all stakeholders involved see the CDHU's process of experimentation with SHW as a success. The experience is providing a template for the federal government programme *Minha Casa, Minha Vida*, a large-scale social housing programme aimed at scaling up social housing provision in Brazil. Based on the lessons learned from the CDHU, the *Minha Casa, Minha Vida* programme has decided to include SHW systems in its dwellings aiming for nearly 380,000 homes with SHW for the years 2011—2014.

The introduction of SHW systems reflects the multiplicity of domains that are governed through climate change experiments in urban infrastructure networks, from energy to industrial development and sustainability innovation, and from climate change itself to the wellbeing and 'dignity' of the population at large. It represents the mobilization of urban infrastructure for a variety of purposes, where social and market rationales interact and compete in a variety of ways and through a variety of decidedly political logics. However, it is also a mobilization conducted within the framework of ambiguous rationales, where neither neoliberal modes nor social solidarity take primary roles. In this manner, São Paulo's SHW experimentation leads us to highlight the need for nuanced ways of understanding the rationales and techniques by which neoliberal governmentalities operate in the global South, and to raise the possibility that they may contain the possibilities for a political response. In São Paulo, governing climate change required engaging with the materiality of urban infrastructures, its modes of implementation and its prospects for consolidation or break-down, an intervention that was done through the technological as much as the social and the political.

Retrofitting publically financed housing in Mamre, Cape Town

Issues of housing are also a pressing matter for the City of Cape Town, a spatial legacy of apartheid that has left the country with much poor quality housing (Lester, Menguele, Karurui-Sebina, & Kruger, 2009, p. 79). With housing need in the city estimated at up to 400,000 people (Mongwe, 2011), mostly concentrated in townships, this housing deficit alongside the challenges of wider service delivery forms perhaps the foremost infrastructure challenge for the metropolitan area. Throughout South Africa's post-apartheid era, social housing has provided a key platform for the delivery and implementation of various investment programmes beginning with the Reconstruction and Development Programme (RDP) and focused on the empowerment of urban populations through house ownership and infrastructure service delivery (Parnell, Beall, & Crankshaw, 2005). Large scale investment across the city has resulted in up to 10,000 housing units being built per annum, modelled on the initial template for a basic dwelling provided under the RDP, but has been dwarfed by a rapid growth in informal settlements (South African Cities Network, 2011). Furthermore, reflecting land values, most of the housing construction has taken place in the peripheral spaces of the city, reinforcing the apartheid spatiality of segregation and failing to significantly transform the underlying socio-economic relations and conditions of the city. Within this context, climate change is providing new flows of financing that provide the City of Cape Town with the opportunity to experiment with low carbon interventions in the housing arena that also serve to meet other urban objectives of addressing poverty and socio-environmental quality through the improvement of housing. As in São Paulo, we find that this is achieved through the reformulation of housing delivery to focus on quality, alongside that of quantity, suggesting new ways to think about social justice around the idea of dignified housing and new trajectories of what a politics of improvement might constitute for the municipality.

Climate finance and housing retrofit

In 2009, some 250 RDP houses in the deprived community of Mamre (CCT, 2013) were selected by the City of Cape Town's Environmental Resource Management (ERM) Department to be retrofitted with insulated ceilings, through a project funded by the Danish International Development Agency. This intervention acted as an experiment in improving the energy infrastructure of social housing whilst exploring the potential of climate change financing in funding such improvements. Over the last decade, the South African government have provided a National Housing Subsidy for insulated ceilings in new RDP housing in the Western Cape in recognition of the need for increased thermal efficiency in the region and the low energy efficiencies of traditional RDP housing. However, the initial RDP housing built in the city did not have access to these measures and, as privately owned properties, cannot be retrofitted using municipal funds owing to the Municipal Funding Act. In this case, the focus of experimentation is not simply on the material outcomes of the intervention (i.e. energy efficiency) but with different forms of delivery models to improve existing RDP housing in the city. The Climate Change Strategy of the City of Cape Town (CCT, 2006, p. 55) and its goals to reduce GHG emissions and improve energy efficiency, together with low carbon financing from international development agencies and the Clean Development Mechanism instrument of the Kyoto Protocol have provided a number of means through which to invest in urban infrastructure that mediate (at a macro level) state finances and capacities in relation to housing improvement in the city.

The insulated ceilings intervention in Mamre has primarily been constructed by the actors involved as an experiment to improve the energy efficiency of poor households, mobilized through the logic of housing improvement as an extension of a developmental mode of governing. Firstly, the project is aimed at improving the energy efficiency and climate resilience of poor households in the city through retrofitting and as such is positioned as a solution to energy poverty and climate change dynamics that affect the urban poor. Secondly, it is positioned as a potential solution in terms of improving wider housing conditions in Cape Town. As a result, sustainable housing has become a site of convergence in addressing the interface between energy poverty and security, climate resilience, livelihoods and poverty alleviation. Discourses around sustainable housing act as a space from which the municipality can extend the potential application of the experiment — both in terms of its material benefits and its model of financing — to address broader issues relating to heath, livelihoods and economic growth via urban infrastructures. This conjunction illustrates the ways in which different conceptualizations and visibilities produced by the experiment are important to different urban intermediaries. It shows how the relationships and tensions between these different governance actors co-produce the experiment from multiple positions in which "[a]n explicit, calculated program of intervention is not invented ab initio. It is traversed by the will to improve, but it is not the product of a singular intention or will. It draws upon and is situated within a heterogeneous assemblage" (Li, 2007b: 6).

The retrofitting of ceilings in Mamre emerges through forms of governing that can be characterized as a shared 'will to improve' on the part of the municipality, linked to its developmental mode of urban governance. But it is also co-produced (or problematized) through the multiple logics embodied across the different departments and sections of the City of Cape Town, the donors and other actors focusing on generating solutions that speak to their constituencies and policy areas. In this way, a range of potential solutions generated from the experiment have supported its emergence. The need to create a solution concerned with climate resilience forms a key logic in the problematisation of the experiment and is partly constructed through the requirements of the international donors, upon which the experiment is dependent, but also the emerging municipal policies and politics relating to climate change action. Within the City of Cape Town, different intermediaries within the municipality conceive and communicate the ways in which the experiment generates solutions dependent on the nature and scope of their work objectives, policy areas and discourses. Underlying these different problematics and the diverse potential solutions generated by the experiment is the political importance of poverty alleviation through housing improvement, characterized and defined as a "developmental local government" (Parnell & Pieterse, 2010: 152). It is this 'housing improvement' logic, which embodies the developmental nature of urban governance in Cape Town and mediates the different logics in which the experiment is engaging, through which the City of Cape Town's shared 'will to improve' is articulated.

Building low carbon logics

Amongst these different and competing notions of the problems that housing retrofit can resolve, it has been the notion of 'low carbon' housing that has proved to be able to mobilize intervention. Central to this mobilization have been the interests and discourses of external agencies, who have come to view RDP housing in South Africa as an amenable site through which to produce reductions in carbon, to be traded or otherwise exchanged as forms of 'offset'. This reduction is important due to the high carbon content of South Africa's electricity, with the country one of the highest per capita greenhouse gas (GHG) producers in the world (Bond & Erion, 2009). This mitigation imperative together with the significant energy

security and affordability challenges facing the development of the electricity network nationally and in Cape Town (Jaglin, 2013; Ruiters, 2009), have contributed to the production of household energy use as a site within which external agents can be aligned with other actors to produce such forms of intervention. Challenges of security, affordability and access have also produced a growing demand for such interventions on the ground. For households in Mamre, as in other low-income areas, the financial burden of energy is high, reflecting and reinforcing the socio-economic position of the community. The siting of low carbon experiments in RDP housing becomes a new way in which the municipality can approach energy efficiency issues at the household scale and respond to demands for the effective provision of energy services, while also enacting wider discourses of energy security at the city scale.

Emerging from a very different context to São Paulo at the intersection of the flows of carbon finance and development aid seeking viable places for intervention, the Mamre experiment is imbued with a logic of low carbon development that is externally orientated in seeking to secure funding. Simultaneously, this logic works to create financial resilience for poor households, through addressing energy efficiency and poverty via an investment in energy and housing infrastructure at the household level. This suggests that the experiment is closely connected to discourses of economic growth and development. Yet the economic understanding of low carbon is wider in this context, linking to the direct economic impact of the experiment (e.g. jobs and training) and the longer term economic impact on the community (improved health and sustainable livelihoods). Rather than being concerned with the creation of carbon markets, in the sense of the creation and trade of carbon, here notions of carbon control and energy security are put to work to develop a wider form of low carbon economy. This logic is partly predicated on the municipal led nature of the project, rather than, for instance, the market orientated energy companies operating in São Paulo. Whilst the macro political economic context of South Africa can be considered a form of neoliberalism, the local state seeks to operate a developmental form of governing from within the wider political economy, which has in turn created a further series of logics around improving different aspects of the lives of households. These include improved energy efficiency, improved physical and psychological health and wellbeing, and climate resilience.

Dignified housing

This concern with households 'economies', livelihoods and wellbeing as central to the development logic of the city is accompanied by a more avowedly social project of enhancing housing quality as a means of delivering on the promise of post-apartheid politics. From the demands for shelter and services from shack dwellers to the pronouncements of politicians, discourses on dignity have provided an important way for Cape Town to think about issues of social justice, equality and poverty alleviation. The RDP houses are failing to comply provides a key site in which to support dignified lives amongst the city's urban poor, and has become a mainstay of municipal policy in which the provision of housing, and thus creation of home ownership, is a key poverty alleviation strategy. However, for low-income dwellers, acquiring a house through the RDP housing programme does not necessarily translate into achieving 'dignified housing'. Research by Lodge (2003, p. 315) shows that around 30% of new publically financed houses fail to comply with building regulations. The Mamre experiment, and its contribution to 'dignified housing', can be seen as a corrective to a 'housing at any cost as long as it's cheap' practice which has guided Cape Town's municipal housing policy and arguably failed to uplift

the poor (Charlton & Kihato, 2006). Cape Town's substandard RDP housing reveals how the scale of the challenge in not just delivering basic housing and service infrastructures, but in addition providing the housing quality for the urban poor to lead dignified lives and infrastructure that improves the ecological footprint of the city (Swilling, 2006).

Dignified housing can be viewed, in this context, as a decent standard housing that moves away from the cheaply built housing in which key costs – such as thermal efficiency – are transferred from the state to households. Low carbon interventions into housing infrastructures offer the potential to improve housing quality and the socio-economic status of households, and to rectify the growing sense of the failure of the home ownership model to generate dignified lives for the urban poor. Yet these emerging low carbon experiments take place in a context in which the City of Cape Town's post-apartheid municipal policy of significant investment in housing infrastructures remains constrained, by resources and capacity, in addressing the issue of a huge housing shortage in the city. The municipality has hitherto focused on delivering as many units as possible in the belief that home ownership alone will provide a dignified life and, in contrast to São Paulo, these low carbon interventions remain regarded as an additionality compared to the basic work of building as many houses as possible. For some in the municipality, social movements and others, forms of low carbon interventions are seen as less important than the need to accelerate house building for those waiting, which in turns leads to the calling into question any investment around housing that is not focused on this problematic. Yet for other urban policy actors low carbon interventions into RDP housing provides an opportunity for the state to build upon the project of delivering dignified lives for the urban population, recognizing the need to improve the model upon which RDP housing has been delivered since 1994. The impact of the Mamre experiment on debates about publically financed housing in Cape Town is therefore potentially significant. The raising of the quality of housing infrastructures, via low carbon interventions, rationalities and financing may provide a potential platform for social justice campaigners to coalesce around and further articulate the demand for dignified lives through housing quality as well as quantity.

Trajectories: mobilizing experimentation

The Mamre experiment suggests that the City of Cape Town will increasingly site low carbon interventions and climate change action within and across housing infrastructures in the city, reflecting wider urban policy practices (Castán Broto, 2012; Lovell, 2004). Furthermore, the emerging problematization of climate change requires the municipality to act on these new urban policy imperatives in conjunction with long standing policy work around poverty, housing and energy poverty. RDP housing thus provides a visible site for the local state that can address (and be seen to address) a range of problematizations, whilst providing a signifier of its response to issues of low carbon development and climate change. This is perhaps hardly surprising where "eco-homes are said to be widely regarded today as the most media-friendly 'vehicle' for bringing across the message of climate change, and the related need for the restructuring of energy economies" (Marres, 2008: 32). Such forms of response have been made possible by the growing global financialization of carbon and its circulation into infrastructures of the global South, which appear to provide a range of opportunities for municipal and regional governments such as the City of Cape Town and the State and City of São Paulo to reinforce and expand developmental discourses, actions and logics, through low carbon interventions. On the one hand, this reinforces particular neoliberal rationalities and

narratives, such as the notion of poverty alleviation through home ownership, that are increasingly challenged by civil society groups. On the other hand such financial circulations are providing a means through which the developmental ambitions of the local state can be mobilized. The importance of the Mamre experiment is closely related to the political imperative of housing delivery and improvement in Cape Town, the most politically contested and charged issue facing post-apartheid urban governance. The experiment acts as a technique of government (Dean, 1999, p. 231), in which the intervention is a mechanism through which the City of Cape Town's authority is constituted. By appearing to act or 'do something' around issues of poverty, housing improvement and sustainability the experiment (and importantly its potential upscaling) becomes a governmental technology in which the local state legitimizes its political power and prestige and visibly re-inforces its supposed current developmental approach and pro-poor agenda. The validity of this siting of low carbon and climate change action within housing remains contested, within and outside the municipality and at the same time the potential for socially progressive climate politics remains finely balanced and limited by the small scale nature of experimentation in Cape Town offering no guarantees of being upscaled and contributing to the significant task of transforming urban infrastructures in the city.

Conclusions

This paper has sought to address the set of evolving urban configurations and practices that are emerging across urban infrastructure systems in São Paulo and Cape Town. Arguing that experiments in infrastructure networks form a central means through which governmental rationales and techniques are mobilized and contested in the city, we have developed an analytical approach that seeks to examine how such governing is accomplished through practices of intervention and alignment. Viewed in this manner, housing is an infrastructure network that is constituted through multiple logics and agents, providing a critical means through which state projects (in the wider governmental sense) are realized and come under pressure. Using this framework to analyze low carbon experiments in housing systems in São Paulo and Cape Town generates a number of interesting perspectives on urban infrastructure and climate change politics. At the outset, this comparison is underpinned not by a concern to create a smooth or simplistic sense of the urban as a common condition in the global South, but on the need to uncover "the prolific and uncertain associations created by various kinds of connections or flows and their diverse territorializations and assemblages" which "hold open the possibility of more fragmentary and limited relationships" (Robinson, 2011: 8).

Through this governmentality analysis, we find the increasing centrality of low carbon logics and the emergence of discourses of sustainable housing is providing an expanding, although contested, economic dynamic in which to deliver a series of broader objectives via publically financed housing. The case studies highlight how a range of environmental and ecological discourses are being mobilized through new flows of finance — international climate change financing in Cape Town and private-sector utility funding in São Paulo — in turn creating new forms of infrastructure through connecting these discourses to wider urban issues via publically financed housing systems. But whilst São Paulo provides example of an experiment that has gained momentum and significant upscaling through a sustained financing model, the Mamre case in Cape Town provides an example of the fragility of forms of carbon finance for the remaking of local infrastructure and local economies. Such logics are critically being forged through particular institutional, political and economic contexts in

ways that are creating quite distinct forms of (neoliberal) carbon economy.

At the same time, we find an alternative logic, in which intervening to address climate change in urban infrastructure is regarded as an important way to consider and act upon issues of inclusion, poverty alleviation and social justice. Both case studies show the ways by which local and regional governments are incorporating the low carbon discourse into wider concerns that have a more tangible local relevance, particularly through the notion of housing with dignity. Here, low carbon discourses and material infrastructures are being mobilized to address an important local and national concern that goes beyond debates on carbon control and energy security to act through the problematization of the provision of housing as a means of leading lives of value. Housing with dignity, achieved through sustainability and low carbon interventions, provides a focus for an urban governance of climate change in tune with local realities in the global South. Yet 'dignity' represents more than quality housing; it is also an attempt to subvert the humiliation that accompanies a condition of vulnerability (Kowarick, 2009, p. 320; Tatagiba et al., 2012). In the context of a neoliberal state which seeks to secure the basic needs of those identified as poor or 'deprived' through individualizing need (Giavedoni, 2012), it is worth asking to what extent calls for 'dignity' in the housing/low carbon axis operate as a means to overturn this approach towards a more universalizing understanding of urban infrastructures. With significant housing deficits and restrictive macro-economic climates, the City of Cape Town has continued to focus on the quantity of RDP housing provided by the state despite acknowledging the problems with this model, whist the CDHU in São Paulo has sought to shift the debate towards notions of housing quality alongside the need to preserve the quantity of housing delivered towards upholding notions of 'dignity'. The relative success of both experiments in improving a variety of household indicators contributes to growing debates in both cities about the quality of publically financed housing that is currently being delivered, how this is failing to provided dignified lives for the urban poor and the potential for low carbon technologies to shift the debate.

Thus, we find that the interface between housing and climate change governance is "not necessarily opening up a space of politics, but placing a social politics at the centre of debate, asserting the social and rejecting the potentially depoliticizing act of applying sustainability" (Davidson, 2009: 617) in ways that create space for potentially progressive responses. As the case-studies show, this a fragile logic which is open to significant contestation. Rather than being characterized by one dominant model, we suggest that the governing of climate change in cities in the global South is multiple, combining market and social logics in eclectic ways, where one is not predominant and both are in negotiation, dialogue and contestation.

to thank our colleagues Colin McFarlane and Cheryl McEwan for their support, insight and encouragement as co-supervisors of the two PhD projects which have provided the basis for the development of this paper.

References

Barr, S., Gilg, A., & Shaw, G. (2011). Citizens, consumers and sustainability: (re) framing environmental practice in an age of climate change. *Global Environmental Change, 21*(4), 1224–1233.

Bond, P., & Erion, G. (2009). South African carbon trading: a counterproductive climate change strategy. In D. McDonald (Ed.), *Electric capitalism: Recolonising Africa on the power grid* (pp. 338–358). London: Earthscan.

Bulkeley, H. (2010). Cities and the governing of climate change. *Annual Review of Environment and Resources, 35*, 229–253.

Bulkeley, H., & Castán Broto, V. (2013). Government by experiment? Global cities and the governing of climate change. *Transactions of the Institute of British Geographers, 38*(3), 361–375.

Butcher, S., & Oldfield, S. (2009). De facto v/s de jure home ownership: women's everyday negotiations in Lusaka and Cape Town. *Feminist Africa, 13*, 45–64.

Castán Broto, V. (2012). Social housing and low carbon transitions in Ljubljana, Slovenia. *Environmental Innovation and Societal Transitions, 2*, 82–97.

Castán Broto, V., & Bulkeley, H. (2013). Maintaining climate change experiments: urban political ecology and the everyday reconfiguration of urban infrastructure. *International Journal of Urban and Regional Research*. http://dx.doi.org/10.1111/1468-2427.12050. Online First.

CDHU. (2011). *Sustainability report 2011*. São Paulo: Governo do Estado de São Paulo.

CDHU. (2013a). *Distribuição Territorial da Produção*. São Paulo: Governo do Estado de São Paulo [online] http://www.cdhu.sp.gov.br/producao-new/distribuicao-producao.asp# Accessed 01.07.13.

CDHU. (2013b). *Política Social de Subsídios*. São Paulo: Governo do Estado de São Paulo [online] http://www.cdhu.sp.gov.br/a_empresa/politica-social-cdhu.asp Accessed 01.07.13.

Charlton, S., & Kihato, C. (2006). Reaching the poor? An analysis of the influences on the evolution of South Africa's housing programme. In U. Pillay, R. Tomlinson, & J. Du Toit (Eds.), *Democracy and delivery: Urban policy in South Africa* (pp. 252–282). Cape Town: HSRC Press.

City of Cape Town. (2006). *Energy and climate change strategy*. Cape Town: Environmental Planning Department.

City of Cape Town. (2013). *Demographic profile of ward 029* [online]. Cape Town: https://www.capetown.gov.za/en/stats/Documents/2011%20Census/Wards/2011_Census_CT_Ward_029_Profile.pdf Accessed 11.03.13.

Davidson, M. (2009). Social sustainability: a potential for politics? *Local Environment, 14*(7), 607–619.

Dean, M. (1999). *Governmentality: Power and rule in modern society*. London: Sage Publications Ltd.

Dodson, J. (2006). The "roll" of the state: government, neoliberalism and housing assistance in four advanced economies. *Housing, Theory and Society, 23*(4), 224–243.

Evans, J. P. (2011). Resilience, ecology and adaptation in the experimental city. *Transactions of the Institute of British Geographers, 36*(2), 223–237.

Flint, J. (2004). Reconfiguring agency and responsibility in the governance of social housing in Scotland. *Urban Studies, 41*(1), 151–172.

Foucault, M. (2009). *Security, territory, population: Lectures at the College de France 1977–1978*. New York: Picador.

Gandy, M. (2004). Rethinking urban metabolism: water, space and the modern city. *City, 8*(3), 363–379.

Giavedoni, J. G. (2012). Del Estado en crisis a la crítica del Estado: Diálogo en torno a la perspectiva del Estado y la gubernamentalidad en el análisis de la nueva cuestión social en América Latina. *Revista Mexicana de Ciencias Políticas y Sociales, 57*(214), 89–109.

Gilbert, A. (2002). On the mystery of capital and the myths of Hernando de Soto: what difference does legal title make? *International Development Planning Review, 24*(1), 1–19.

Governo do Brasil. (2010a). *Plano Nacional De Eficiência Energética*. Brasilia: Ministerio de Minas e Energia.

Governo do Brasil. (2010b). *Lei 12,212/10-Tarifa Social de Energia Elétrica*. Brasilia: Presidência da República.

Governo do Estado São Paulo. (2011). *Plano Estadual de Habitação de São Paulo*. São Paulo: Secretaria de Habitação.

Graham, S., & Marvin, S. (2001). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. London: Routledge.

Harvey, D. (1996). *Justice, nature and the geography of difference*. Oxford; Blackwell.

Hodson, M., & Marvin, S. (2010). *World cities and climate change: Producing urban ecological security*. Maidenhead, Berkshire (UK): Open University Press.

Jaglin, S. (2013). Urban Energy Policies and the Governance of Multilevel Issues in Cape Town. *Urban Studies*. http://dx.doi.org/0042098013500091.

Kooy, M., & Bakker, K. (2008). Splintered networks: the colonial and contemporary waters of Jakarta. *Geoforum, 39*(6), 1843–1858.

Kowarick, L. (2009). *Viver em risco*. São Paulo: Editora 34.

Lemanski, C. (2011). Moving up the ladder or stuck on the bottom rung? Home-ownership as a solution to poverty in urban South Africa. *International Journal of Urban and Regional Research, 35*(1), 57–77.

Lester, N., Menguele, R., Karurui-Sebina, G., & Kruger, M. (2009). *Township transformation timeline*. Johannesburg: Department of Co-operative Governance and Traditional Affairs.

Li, T. M. (2007a). Practices of assemblage and community forest management. *Economy and Society, 36*(2), 263–293.

Li, T. M. (2007b). *The will to improve: Governmentality, development, and the practice of politics*. Durham: Duke University Press.

Lodge, T. (2003). *Politics in South Africa: From Mandela to Mbeki*. Cape Town: David Philip Publishers.

Lovell, H. (2004). Framing sustainable housing as a solution to climate change. *Journal of Environmental Policy & Planning, 6*(1), 35–55.

Lovell, H. (2005). Supply and demand for low energy housing in the UK: insights from a science and technology studies approach. *Housing Studies, 20*(5), 815–829.

Marres, N. (2008). The making of climate publics: eco-homes as material devices of publicity. *Distinktion: Scandinavian Journal of Social Theory, 9*(1), 27–45.

Mongwe, R. Race, Class and Housing in post-apartheid Cape Town, 2011, Human Science Research Council. http://www.hsrc.ac.za/en/review/november-/race-class-housing.

Monstadt, J. (2009). Conceptualizing the political ecology of urban infrastructures: insights from technology and urban studies. *Environment and Planning A, 41*(8), 1924–1942.

Nieboer, N., Gruis, V., van Hal, A., & Tsenkova, S. (2012). Conclusions. In N. Nieboer, V. Gruis, A. van Hal, & S. Tsenkova (Eds.), *Energy efficiency in housing management: Policies and practice in eleven countries* (pp. 232–244). New York: Routledge.

Okereke, C., Bulkeley, H., & Schroeder, H. (2009). Conceptualizing climate governance beyond the international regime. *Global Environmental Politics, 9*(1), 58–78.

Parnell, S., Beall, J., & Crankshaw, O. (2005). A matter of timing: African urbanisation and access to housing in Johannesburg. In D. Brycson, & D. Potts (Eds.), *African urban economies: Viability, vitality or viitation?* (pp. 229–251). London: Palgrave Macmillan.

Parnell, S., & Pieterse, E. (2010). The 'right to the city': institutional imperatives of a developmental state. *International Journal of Urban and Regional Research, 34*(1), 146–162.

Paterson, M., & Stripple, J. (2010). My Space: governing individuals' carbon emissions. *Environment and Planning D: Society and Space, 28*(2), 341–362.

Prefeitura do Município do São Paulo. (2005). *Inventário de Emissões de Gases de Efeito Estufa do Município do São Paulo*. São Paulo: Centro de Estudos Integrados sobre Meio Ambiente e Mudanças Climáticas (Centro Clima).

Robinson, J. (2011). Cities in a world of cities: the comparative gesture. *International Journal of Urban and Regional Research, 35*(1), 1–23.

Ruiters, G. (2009). Free basic electricity in South Africa: a strategy for helping or containing the poor? In D. McDonald (Ed.), *Electric capitalism: Recolonising Africa on the power grid* (pp. 248–264) London: Earthscan.

Secretaria de Habitação. (2013). *Conheça melhor a Secretaria de Habitação* [online]. São Paulo: Governo do Estado de São Paulo. Available from http://www.habitacao.sp.gov.br/secretariahabitacao/conheca_melhor_a_secretaria_de_habitacao.aspx Accessed 01.07.13.

Silver, J., Phillips, C., & Rowswell, P. (2011). *Mamre Ceiling Evaluation: Energy retrofitting in low income communities*. Cape Town: ICLEI Africa Secretariat and City of Cape Town Sustainable Livelihoods.

South African Cities Network. (2011). *State of city finances report*. [online]. Available from http://www.sacities.net/images/stories/2011/Publications/State_of_City_Finances_Report_2011.pdf Accessed 01.07.13.

Star, S. L. (1999). The ethnography of infrastructure. *American Behavioral Scientist, 43*(3), 377–391.

Swilling, M. (2006). Sustainability and infrastructure planning in South Africa: a Cape Town case study. *Environment and Urbanisation, 18*(1), 23–50.

Swyngedouw, E. (2006). Circulations and metabolisms: (hybrid) natures and (cyborg) cities. *Science as Culture, 15*(2), 105–121.

Swyngedouw, E., & Heynen, N. C. (2003). Urban political ecology, justice and the politics of scale. *Antipode, 35*(5), 898–918.

Tatagiba, L., Paterniani, S. Z., & Trindade, T. A. (2012). Ocupar, reivindicar, participar: sobre o repertório de ação do movimento de moradia de São Paulo. *Opinião Pública, 18*(2), 399–426.

UNEP. (2010). *Lessons learned: Sustainable solutions in social housing from the experience of the housing and urban development company of the state of São Paulo*. Paris: UNEP/SUSHI/CBCS/CDHU.

While, A., Jonas, A., & Gibbs, D. (2010). From sustainable development to carbon control: eco-state restructuring and the politics of urban and regional development. *Transactions of the British Institute of Geographers, 35*(1), 76–93.