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Making a smart city for the smart grid" The urban material politics of actualising smart electricity networks

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Abstract

In a growing debate about the smart city, considerations of the ways in which urban infrastructures and their materialities are being reconfigured and contested remain in the shadows of analyses which have been primarily concerned with the management and flow of digitialisation and big data in pursuit of new logics for economic growth. In this paper, we examine the ways in which the 'smart city' is being put to work for different ends and through different means. Using the case of the Smart Grid Smart City programme in Australia, we argue that the co-constitution of the urban as a site for carbon governance and a place where smart energy systems are developed is leading to novel forms of governmental intervention operating at the conjunction of the grid and the city. We seek to move beyond examining the rationales and discourses of such interventions to engage with the ways in which they are actualised in and through particular urban conditions in order to draw attention to their material politics. In so doing, we argue that the urban is not a mere backdrop to transitions in electricity provision and use, but central to its politics, while electricity is also critical to the ways in which we should understand the politics of urbanism.

Introduction

Cities have become a critical site through which the politics of governing carbon is played out and, as such, are increasingly entwined within wider debates about the nature of energy systems and their future viability (Rutherford and Jaglin 2015). Urban municipalities have adopted targets and timetables for action to reduce carbon emissions, and have in some cases become involved in innovative and experimental activities, often in partnership with other local government authorities, corporations or community organisations (Bulkeley et al. 2015). At the same time, in a highly urbanized society, cities have become the arenas within which other agencies have sought to intervene in order to reconfigure energy systems. Central to such attempts at reconfiguration is the notion that energy systems can be made 'smart' in order to address the new forms of (renewable) energy generation and (flexible) demand with which they are tasked (Bulkeley et al. 2015; Powells et al. 2015; Strengers 2013). The co-constitution of the urban as a site for carbon governance and a place where smart energy systems are developed is leading to novel forms of governmental intervention. These include, for example, the (re)development of Hyllie as a 'climate smart' city district in Malmo, Sweden, the Smart Cities Mission in India which aims to build 100 smart urban developments over five years (see http://india.gov.in/spotlight/smart-cities-mission-step-towards-smart-india), or Low Carbon London, a utility led project to develop smart metering and new economic models for electricity services. In various guises, low carbon transitions are increasingly being configured in relation to the notion of smart energy systems, while smart as a discourse, practice and set of interventions is also being related to the task of reconfiguring and transforming (urban) infrastructures (Vanolo 2014).

Yet, as Rutherford and Coutard (2014: 1354) argue, "the important notion that energy transition processes (and changes to energy systems more generally) constitute (or might constitute) a largely urban set of processes has received less attention than it arguably deserves." By and large, the literature on urban climate governance has not engaged with the politics of energy system transition while that which focuses on the rise (and rise) of the smart city has also neglected its environmental and energy related dimensions. More recently, analysts have sought to engage with the forms of intervention that are emerging in relation to urban climate governance, particularly attending to the material politics of such projects and programmes (Rutherford 2014). Yet much of this work has remained focused on the municipality as a critical intermediary in such interventions and has been trained on logics and interventions arising from the problematisation of climate change per se rather than attending to the diverse forms of agency at work in and across urban energy systems and which may be derived from other programmes of intervention (Rutherford and Jaglin 2014). Beyond climate-specific policy interventions, "a more direct engagement with urban energy requires seeing it as more than a governance tool or one of the means to address and implement a particular wide ranging policy, and taking seriously both the materiality of its flows and its sociotechnical characteristics, and the varied, contrasting, sometimes competing, political projects for which it works." (Rutherford and Coutard 2014: 1358). Here, we argue that such more direct engagement requires greater attention to the material politics inherent in the creation, maintenance and transformation of urban energy systems.

Similarly, although urban studies has now begun to critically engage in the emergence of the discourse and practice of smart cities, the ways in which smart comes to matter in relation to urban energy systems has largely been in the background to this body of research. For the most part, analyses of smart cities have traced the origins of this formulation to the knowledge economy "increasingly driven by technically inspired innovation, creativity and entrepreneurship," (Kitchin 2015: 131) and/or to the emergence of the data-driven city "monitored, managed and regulated in real-time using ICT infrastructure and ubiquitous computing" (Kitchin 2015: 131). In either case, the discourse and techniques of the smart city are often conceived as the latest wave of neoliberal economic development shaping urban trajectories in line with the strategies of urban governmental and business elites which seek compliance from a largely passive citizenry (Hollands 2015; Kitchin 2015). Yet this 'one size fits all' approach to understanding the smart city has recently come under critique, with proponents arguing that more nuanced accounts are required that examine how, why, by and for whom smart is being enacted and resisted (Kitchin 2015; Gabrys 2014). This is not only a matter of differentiating the discourses and practices of smart as they emerge in various urban contexts, but also of attending to the ways in which smart interventions configure particular urban assemblages and are actualised—formulated, implemented and contested—through particular artefacts, techniques, and practices (see Rutherford 2014). Through this approach city's roles as context, constituent and consequence of urban energy system change (Rutherford and Jaglin 2015: 174) starts to come into view along with the importance of space (and urban spatialities more particularly) in energy transition (Huber 2015).

Recent writing in this field has started to open up the ways in which the discourses and practices of the smart city enrol and intervene in relation to energy, climate and sustainability. On the one hand, a growing body of work has been concerned with the ways in which what we might term smart artefacts and networked interventions are (and are not) becoming embedded in the everyday practices of energy consumption, for example in terms of smart meters, electric cars, time-of-use tariffs, off-grid systems of energy provision and storage (Powells et al. 2015; Strengers 2013). Here, analysts are usually concerned with the ways in which household-based practices are being reformed in relation to smart interventions, both in terms of their potential for contributing to energy, climate and sustainability goals but also for what they might tell us about the nature of everyday practice itself. However, the ways in which such interventions come to reconfigure the urban provision of energy, the urban dimensions of their governing and the consequent ways in which they order the city remain outside the scope of much of this analysis. On the other hand, another body of work is emerging which has sought to interrogate the energy, climate and sustainability dimensions of the kinds of neoliberal smart urbanism set out above. In this work, the digitialisation of data and the emergence of new forms of control system, as well as the kinds of visions of the future city that accompany such interventions, are seen to be bound up with efforts to ensure variants of urban sustainability, from ecological security to resilience and low carbon transitions (Gabrys 2014; Luque-Ayala et al., 2015; Klauser & Albrechtslund 2014). Here, less attention is given to the ways in which such visions and programmes come to intervene in everyday urban practices or how they serve to reconfigure existing socio-technical orders. In short, this work has tended to replicate the study of smart urbanism in general such that there is also a need to move from the analysis of visions and strategies to an understanding of how smart urbanism that seeks to mobilise sustainability concerns is being actualised.

In this paper we seek to contribute to this debate through exploring the interface between forms of urban climate governance on the one hand and notions of the smart city on the other and the ways in which these are being intermediated in systems of urban energy provision. We examine the material politics through which smart cities are actualised, and the configuration of 'smart grids' within the urban milieu. Smart energy systems are emerging in a variety of guises in different urban contexts. Most often associated with the roll-out of smart meters, which seek to provide utility companies and users with real time information about the use of energy , smart grids encompass a host of interventions aimed at managing the increasing complexity of (particularly) electricity networks in relation to the development of distributed sources of power generation and changing patterns of daily demand, from new algorithms, battery storage, micro-generation technologies, electric vehicles, and forms of demand side intervention (Strengers 2013). Here, rather than being primarily used to refer to the digitialisation of data, smart is a term which seeks to capture a broader set of (desired) system capacities, including real-time decision making, learning, self-organisation, and even self-healing in response to intensified demand, increasing uncertainty concerning power sources and network viability, and the increased complexity emerging from the sheer number of diverse and independently controlled devices operating within energy networks (Wade et al. 2010). Smart grid projects are being advanced by a range of actors internationally, through programmes such as the EU *Strategic Energy Technology Plan*, the UK's energy regulator-led Low Carbon Network Fund, and by engineering, telecommunications and utilities companies such as IBM, Cisco, Toshiba, Google, General Electric, Hitachi and others as they seek to establish dedicated teams aimed at developing business opportunities in the smart grid sector. Smart grids are in these arenas regarded as central to managing distributed and intermittent forms of power generation that accompany the growing use of renewable energy technologies whilst also potentially offering a more cost-effective alternative to standard forms of network maintenance and replacement. As such they can be conceived as a means of climate-energy governance.

While often considered as national or corporate projects, we suggest that the political project of smart grids is also a deeply urban one which in turn seeks to constitute new forms of (smart) urbanism. If "energy flows connect up (and disconnect) different groups, artefacts, logics and practices as they seep through the urban fabric and interlink across global space urban localities, territories and the processes and practices within them" (Rutherford and Coutard 2014: 1362) then interventions to reconfigure such flows also serve to reweave the urban fabric, creating new forms of connection, flow and practice. Yet the materialities of urbanism are not necessarily so readily entrained (Hommels 2005). We concur with Rutherford (2014) that the task for analysis is one of understanding how urban politics and materialities come to matter in the production of smart grids—their material politics— and how in turn smart grids come to intervene in the assemblages through which urbanism is composed. Here, we draw on a broadly Foucauldian reading of the materiality of politics. For Foucault, the art of government, a mode of power which operates through the 'conduct of conduct' is essentially a socio-material endeavour. Governmental programmes seek to govern at the level of the 'population': 'a sort of complex of men and things' (Foucault, 2009: 96). Governing takes place through this relational assemblage, as he elaborates in relation to his example of governing the town, a milieu or 'a field of intervention in which, instead of affecting individuals as a set of legal subjects capable of voluntary actions … one tries to affect, precisely, a population … a multiplicity of individuals who are and fundamentally and essentially only exist biologically bound to the materiality within which they live' (Foucault 2009: 21; see also Bulkeley et al. 2015). This in turn means that as Barry (2001: 5-6) argues, politics is "*inevitably a technical matter"*, operating through various technical interventions but also configured through the complex interrelations between 'men and things' that make up the urban order. At the same time, socio-material orders are not neatly configured in relation to one governmental project, but rather subject to multiple and often conflicting programmes – such as efforts to both increase mobility to maintain economic growth and interventions that seek to reduce demand for travel. Equally, socio-materiality is an emergent phenomenon, with its own 'vibrant' dynamic that exceeds, flows between, and undoes the particular relations and forms of assemblage which governmental interventions seek to establish (Barry 2013; Braun 2014; Whatmore and Braun 2014). A material politics of smart grid urbanism needs then to attend both to the ways in which politics made material and the ways in which materiality makes politics.

In the first part of the paper, we develop this argument by considering the ways in which interventions to govern climate and energy in the city are *actualised*. In the second part of the paper, we focus on one case of a smart city in practice – the Commonwealth funded and Ausgrid led *Smart Grid Smart City* (SGSC) project enacted in the Sydney and Newcastle Metropolitan region in NSW, Australia between 2010 and 2013. SGSC was argued to be "one of the widest-ranging technology assessments of smart grid products in the world" (Arup 2014a). Using analysis of interviews with key participants, alongside documents on the project, we examine the nature and emergence of this project and the tensions and negotiations that arose in and around the material politics of its actualisation. These tensions relate to the simultaneous desire to find a generic space through which to test the smart grid and enable its market expansion, and the need for the particular urban contexts of Newcastle as a means through which to bring the project to life. Moreover, the tensions relate to the insistent socio-materiality of the urban and its role in shaping what the grid could come to be in the city. In conclusion, we reflect on the implications of this case and the broader politics of governing energy in Australia's cities and the insights this might generate for understanding the practice of urban energy politics.

Actualising Urban Climate-Energy Governance

Rather than being confined to policies, programmes and decisions of government authorities, the urban governing of (and through) climate change is mobilised through the assembly of the authority, or will, to govern (Bulkeley 2012; Li 2007a). From this broad perspective governing is a dispersed form of rule that takes place through a wide variety of mechanisms and entities, and which entails a range of diverse logics (Miller and Rose 1990; Paterson and Stripple 2010). Moreover, we think of governance as an assemblage, working across state and non-state, public and private domains, embedded in concrete practice and achieved through practical means that order and regulate activities towards particular governance objectives (McGuirk 2004; Ekers et al. 2009). Climate governance in this reading takes place through the problematisation of particular entities, in this case energy systems, and the design and practice of projects/programmes through which they can be improved towards new ends. Such interventions can be regarded as relational configurations (McGuirk et al. 2014): sets of devices and techniques that gather, align and maintain the relations between the diverse elements - human, institutional, representational, material - that constitute intervention projects and the exercise of governing. In this paper, we extend this analysis to explore the politics of actualising such interventions in the socio-materiality of the urban. Such projects/programmes are far from uniform or totalizing, but rather are fragile endeavours, always in the making and open to contestation, negotiation and the playing out of the material politics of the urban. They provide the frames and the practical means through which dispersed social and material elements and sites might be articulated together to organise institutional spaces and behaviours in line with specific aims and objectives (see McGuirk 2004; Ekers et al, 2009; Raco and Imrie, 2000).

Actualising projects/programmes therefore involves a continual negotiation of the diverse interests and logics they attempt to articulate, and ongoing negotiation, compromise and adaptation in light of the socio-materiality of the time-space contexts in which projects are enacted. Considering the materiality of urban climate-energy governance is then not just a question of which things come to be enrolled in assemblages, but rather of attending to how urban materiality is "present in the connections between things, technologies, people, bodies, signs, texts, etc. with none of these as inherently more material or immaterial than the others" (Rutherford 2014: 1453). Focussing on the actualisation of governmental projects/programmes ensures that the socio-material form of the compromises, negotiations and adaptations that are inherent to the process of governing are not tuned out. Nor can they be read off from an *a priori* notion of settled interests or hierarchical power relations. Rather, in bringing the material politics of actualisation to the fore in the analysis of urban governance of carbon, the analytical traditions we draw on here offer insight on the emergent textures, tensions, limits and possibilities taking shape as the city is increasingly problematized as a site and subject of climate-energy governance.

Smart Grid, Smart City? The smart grid meets the city

To tease out our arguments, we work through the actualisation of a major Australian Federal government initiative—the Smart Grid Smart City initiative (SGSC)—its title being emblematic of the meeting point of the city and the grid. Our analysis of the case is based on interviews, conducted across 2012-13, with over a dozen senior stakeholders in the project across its multiple partners, including Federal and Local Government, private sector, research and academic partners. Interviews ranged between one and two hours long and were recorded, transcribed and thematically coded. This analysis was supplemented by documentary analysis of websites, press releases and media reports, community engagement and specialist presentations, communications and detailed interim and final reports from the project itself. Below we examine the ways in which the Smart Grid vision enrolled and was actualised through negotiations of the materiality of the urban. Specifically our analysis highlights how the project was dependent on engaging with specific material characteristics of the city and place-based aspirations, to actualise its multiple interventions, yet simultaneously sought to flatten the city's materiality, informed by the abstract spatial and technological aspirations of grid logics. Notwithstanding these tensions, the materiality of the city and the socio-technic characteristics of the smart grid determined the nature of many of the negotiations and contestations encountered by the project as it sought to bring about its smart grid, smart city imbrications. The case reveals the material politics of actualisation in making, remaking and negotiating what it is that the smart grid could become in the city and what the city can become in relation to the grid. We begin with a brief history and summary of the problematics addressed through SGSC, before turning to its material intersections with the urban.

Making the smart grid problem in SGSC

In 2009, cognisant of the growing international interest in smart grids, the Federal Government commissioned an international consultancy firm to undertake a pre-deployment study to examine the international experience with the development of smart grids and to assess the potential for a large trial in Australia. At the end of this process, the Federal Government decided that what was needed was "a commercial scale project in a single location that actually looked from transmission right through to consumers" (RET Interview, November 2012).[1] The intent to examine not only the technical but commercial and social feasibility of smart grids in the Australian urban context arose from a particular problematisation of energy, underpinned by four related logics that served to configure and align different agencies within the energy industry and policy community in relation to a smart grid, smart city intervention.

First, there was a sense that smart grids were "the future" and were increasingly being adopted internationally, as the very premise of the programme to draw international experience into the Australian context makes clear. Within the management of energy supply companies, there was a sense that they "can see the benefit from overseas, they can see a lot of work done in Korea, and starting to see - hang on, this is the future, let's get involved in looking at the future" (Ausgrid Interview, November 2012). Second, by the late 2000s, the growth and changing nature of peak demand was becoming central to the problematisation of existing systems of electricity provision (Strengers 2011, 2012), particularly for energy distributors whose "whole business is geared around peak demand" (IBM Interview, November 2012) and the critical issue of maintaining electricity provision and avoiding blackouts and brownouts during late afternoon peaks. With these "compelling events" rendering the problems of the electricity grid visible to the public (IBM Interview, November 2013), recognition of the costs of meeting the peak demand created new forms of calculation within the energy supply industry about how demand could be met or managed.

Third, the development of smart grids was conceived as a means through which to address the recent and rapid uptake of solar photovoltaic energy generation at a domestic scale. Supported through various state and utility rebate programmes, including a feed in tariff that created "payback periods of three or four years for people. So it really was a good investment" (LMCC Interview, November 2012), and promoted to different degrees through municipalities, domestic PV penetration has reached up to 25% of households in some areas of New South Wales (Australian PV Institute 2015). The presence of such high levels of PV on the low voltage network has the potential to create problems of voltage control and phasing, such that new means of storing and consuming the electricity created and monitoring the network are required to prevent the need for large scale investment in the network or limits being placed on the number of connections to renewable energy generation that can be sustained (Ausgrid 2013). Fourth, the allure of smart grid systems lies in their ability to reduce or defer the costs of network reinforcement. When the SGSC project was initially conceived, such concerns rested largely in the hands of the distribution companies themselves and

[1] The generation, supply, distribution and retail of energy in Australia has traditionally been vertically integrated and operated under monopoly conditions. In NSW, generation and transmission were operated by a single monopoly business while distribution and retail were undertaken by a number of state-owned monopoly businesses. In 2011 NSW retail businesses were privatized. Recently, reform to the retail market has meant that customers have become contestable such that they can choose their supplier.

their interest in reducing the costs of infrastructure investment while maintaining the levels of safety and reliability in service provision through which they secure income. By 2010, the costs of such investments had become vividly public and politicised. Network charges more than doubled between 2008/09 and 2014/15 (CEM 2015), and, given that over half of an Australian household's electricity bill relates to network charges (Australian Government 2012), led not only to rising consumer energy bills but also widespread and critical popular commentary. In offering means through which such costs could be avoided or deferred, smart grids also began to be seen as part of the solution not only to rising network operator costs but also to increasing consumer energy bills.

In SGSC smart grids came to be seen as a means of converting a potential ''spiral of death' for the electricity providers' (suggested by the combined pressures of new grid technologies, distributed energy, generally declining demand with marked peaks, and network upgrade costs) into a 'vortex of opportunities'' (Smart Grid Australia, 2015).

Placing the Smart Grid? Abstract urban materialities

The materiality of the city associated with its flows, infrastructure, practices and built environment, substantially structured how the energy problem was conceived and how it was to be governed. The circulation of this multifaceted problematisation of energy in Australia conditioned a competitive bidding process that was opened by the Federal Government for Australia's distribution companies to develop a commercial scale smart grid trial supported by A$100M of federal funding. Four bids were received, one from Queensland, one from Victoria and two from NSW. Several of these bids addressed rural contexts and as such could not provide the urban testbed the Federal Government sought. The winning bid, led by Ausgrid and centred on the local governments of the City of Newcastle and Lake Macquarie, included IBM, GE Australia, CSIRO, TransGrid, Hunter Water, Sydney Water, University of Newcastle, and University of Sydney. Following reform to the energy market in NSW in 2011, Energy Australia joined the trial in 2012 as the retail partner. Participation in the bid from this diverse set of partners was configured by a common interest in addressing issues of peak demand, integrating renewable energy into the grid, and reducing network investment costs. Yet at the same time the process of assembling the coalition and designing the project bid also brought new logics into play that explicitly reference the material politics of the urban: the way in which the smart grid, as a response to the problematisation of energy, translates "as a set of issues which come to matter in the local urban arena in a conjoined political and material sense" (Rutherford, 2014, 1450). Here, as the SGSC was actualised, what the grid could become in the city was shaped by particular urban materialities and artefacts that gained salience and became central to negotiating the project's actualisation.

Foremost amongst these new logics was the drive to promote Newcastle and the wider Hunter region of which it is a part as a centre for low carbon innovation. With a long history of action on climate change (Bulkeley 2000), the City of Newcastle has played a pivotal role in bringing diverse partners together to promote low carbon economic development and to achieve long-term reductions in GHG emissions across the city. Active lobbying on the part of the city and regional interests in 2003 secured the CSIRO Energy Transformed Flagship research centre in Newcastle. In 2007 the city installed Climate Cam, a world first city power meter that displayed Newcastle's hourly electricity consumption and a related suite of action-based learning programs to assist business and the community to achieve substantial cuts in energy and water consumption. In the same year, a failed bid to secure a project under the Federal Government's Solar City[2] initiative led to the creation of *Together Today*, a consortium of local government, utility, business, media, higher education and community interests in the city. This partnership had assembled the relationships to constitute an urban project in response to climate change/energy transition. Thus, while the bid technically incorporated urban and rural elements, its political constituency was distinctly urban. It was through this partnership that Ausgrid mobilised the agencies required for the SGSC bid, including through seconding staff from City of Newcastle and CSIRO to work on the development of the proposal. Looking beyond the confines of the energy sector in order to grasp the dynamics of urban energy system change (Rutherford and Jaglin 2015), the SGSC project came to matter in the Newcastle context through its alignment with an existing local alliance which was repurposed and redirected towards SGSC purposes.

The SGSC initiative's brief to test the market and social feasibility of smart grid applications and technologies required that the successful project be capable of testing a range of electricity network conditions, assets and challenges, including: daily and event-related peaks; high densities of decentralised renewable generation; a variety of forms of renewable generation and storage technologies connecting to the grid; and a diversity of grid topologies from grid-restricted areas to suburban radial networks, to long thin network lines, and from purely residential to mixed use. Framed in this manner, the energy problematic came to be understood as a predominantly urban issue. Thus the SGSC bid encompassed not only urban and suburban areas of wider Newcastle region itself (Newcastle, Lake Macquarie, Cessnock), but urban and suburban areas of Sydney including Sydney CBD, Ku-ring-gai and, in Auburn, the neighbourhoods of Silverwater and Newington, the Olympic Village site for the 2000 Olympics, in which Energy Australia had invested heavily in solar PV. Alongside this urban focus, rural areas in the Hunter region (Muswellbrook and Scone) were

[2] The Federally-funded Solar Cities program was an Australia-wide parallel program that supported a series of urban-based consortia of local governments with energy, finance and land corporations to trial and showcase the large-scale urban integration of solar energy, new grid-based technologies, alternative technologies for electricity storage and consumption, and energy efficiency measures.

nonetheless included to capture the lower density network topologies of these areas. Geographically, a Newcastle/Hunter-centred bid could provide the required set of material conditions which focussed on the urban–from highly urbanised to suburban—yet also incorporated rural settlements (Ausgrid Interview, November 2012). Thus, the Ausgrid-led project provided the particular socio-material geography of Newcastle/Hunter and an appropriate configuration of institutions and agencies that both enabled and shaped the emergence of the smart grid problem as one that required urban intervention.

Yet the role of the urban in the political project of smart grid was far from straightforward and broader than this engagement with the specific urban material characteristics and place-based aspirations. The project attempted to draw simultaneously on different understandings of the urban and its materiality (see Rutherford and Coutard, 2014) and negotiating this tension shaped what the ‘smart grid smart city’ could become. SGSC aimed to carve out a universal governmental and material space in which to test the market and social viability of smart grids and generalise the project’s findings to inform a business case for an Australian smart grid. To do so the project sought to flatten the city’s specific materiality, informed by the abstract spatial and technological aspirations of grid logics. In this sense the politics of making the smart grid demanded an abstract notion of ‘the urban’ as having generic qualities of intensity, built environment and energy demand profiles that could be fitted to the political project of testing and demonstrating the potential of smart grids. Other (unsuccessful) bids put forward were seen as focusing on specific network problems, whether that be related to the effects of marine corrosion on the electricity network in Queensland or the presence of winter peaks of demand in southern NSW. In contrast, the success of the Newcastle bid for Federal funding lay in its claim to be representative of Australia’s electricity grid, even while the SGSC consortium was enabled by, and drew heavily upon, existing configurations of agency and socio-materialities in the particular urban context of Newcastle/Sydney,

> “The Ausgrid bid was seen to be the most representative of all the four bids, because what we actually wanted out of it was representativeness, in particular for the geographical regions, the types of customers, types of systems they had in place, and being able to gather the data and analyse it, I suppose, at a level where it's actually able to be picked up. A distribution company in Queensland or Western Australia or Northern Territory can pick that up, throw it into their own business model, do their own cost benefit analysis, and decide whether it does or doesn't suit their own business needs” (RET Interview, November 2012).

"Essentially one of the criteria of assessment for the programme was that the Government was particularly interested in understanding not only how smart grids could be enacted within … a major metropolis, but also was very keen about the economic development opportunities and also the … state-wide impact of the project. … So Scone represents a rural, which is quite different from a grid operation [perspective]. Newcastle represents fairly well an urban density typical of the western suburbs in Sydney. Newington represented a very integrated area where there's higher density living and every house with solar and a catalytic gas converter to power generate all sorts of different things. Kur-ring-gai represents the McMansions, that are the energy consumers that are just going wild - every conceivable appliance. You've got quite different socio-economic and building performance demographics." (IBM Interview, November 2012).

The need to represent the grid was realised not only through its design, but also through the practice of selecting sites and types of intervention. In Newcastle, for example, Elermore Vale was chosen as the test site for the project because of the suitability of the network feeder as serving a totally residential area of the city:

"We didn't know what the community appetite was going to be, we didn't know what the housing configuration was going to be, we didn't know necessarily what the gas connection situation was. … [The approach was] That's the feeder we want, go forth and do it. Ignore the demographics, ignore the socioeconomic, ignore the geographical, even the topography of the area, ignore the housing…" (Ausgrid Interview, November 2012).

The Ausgrid bid was seen to deliver a generic urban context which smoothed over its socio-material particularities, based on Newcastle's recognition in the marketing world as 'Anywhereville':

"…. The *Smart Grid, Smart City* trial locations were designed to provide a sound representation of the geographic, climate, customer demographic and electricity network characteristics of a number of regions throughout Australia. It was felt that this would produce nationally transferrable results." (Arup 2014a: 10)

Yet, the material politics of the urban are not reducible to an abstract grid logic. Rather the political project of SGSC is deeply imbricated in the material politics of its actualisation. What the smart grid can become in the city is worked through and coproduced by the continual negotiation of diverse interests and logics they attempt to articulate, and ongoing negotiation, compromise and adaptation in light of the urban materialities in which projects are enacted. It is to these that we now turn.

Actualising the smart grid in the city: negotiating the material politics of SGSC

How, then, did the smart grid, as a means of energy-climate governance aimed to 'improve' the energy problem, translate "as a set of issues which come to matter in the local urban arena in a conjoined political and material sense" (Rutherford, 2014, 1450)? Before attending directly to this question, we need first to understand more about the component trials and material elements of the SGSC itself. The project was divided into a network component and a retail component. The network component involved several parts. First, the deployment of up to 25,000 advanced smart meters, capable of sending signals through the radio network owned by Ausgrid and providing real time information about energy demand. Different levels of feedback were provided to customers. Participants were selected across the trial areas based on the work of statistical consultants on the basis of "their demographics, their usage … and their signal strength" as both suitable for participation in the trial and as representative of the Australian population at large (Ausgrid Interview, November 2012). From this cohort, a group of customers were involved in demand side response measures in relation to particular network 'events' when temperatures exceed particular thresholds and more capacity for transmission is required: "depending on the size of their air conditioning unit, there'll be seven events per year for each customer and they can potentially earn between $25 and $45 for each event" (RET Interview, November 2012). Second, SGSC involved the deployment of new micro-scale storage and generation capacity, including *BlueGen* gas fuel cells, which produce heating, cooling, hot water and electricity, as well as *RedFlow* battery storage units, and wind turbine generators. In all, the project installed 60 consumer batteries, 25 fuel cells and 10 small wind turbines. Third, the network component involved various forms of enhanced network monitoring and fault-detection technologies, as well as the development of a typology of networks in order to identify the potential applicability of different kinds of smart grid solution across the national network.

The retail component of the SGSC included customer application trials led by Energy Australia of "time of use based, seasonal based, peak demand based tariffs" (Ausgrid Interview, November 2012). Trials were launched in late 2012 and involved participants in various forms of demand-side responses, collectively called Powersmart solutions. Cohorts of consumers, again stratified by demographic characteristics, were recruited to participate in trials of 4 products. Each product involved a specific tariff and various layers of technology (see Table 1). Following technical challenges of installing equipment, and challenges of recruiting customers in the appropriate demographic categories of the trial, approximately 8000 households were recruited and the period of the trial was extended by 6 months to finish in 2014. A summary of trial outcomes is presented in Table 2. By 2014, the SGSC final report concluded that "there is an economic business case … across all network topologies for deployment of smart meter infrastructure in conjunction with a customer voluntary take up of a dynamic tariff with customer feedback technologies, or the installation of distributed generation, distributed storage, electric vehicle smart charging and (demand) control products" (Arup 2014a: 63). In short, the SGSC project was seen to demonstrate that smart grids did indeed have value in the Australian context.

INSERT Table 1

INSERT Table 2 here

The design and deployment of the project largely put the urban conditions that had shaped its configuration to the side as it sought to pursue a logic of testing the universal applicability of smart grid interventions across networks and demographics that could be scaled across the Australian context. Yet we find that the materiality of the urban and the socio-technical characteristics of the grid worked insistently against any attempt to exclude the city from the project. To start with, fitting smart metering into existing urban-electricity conditions was a complex endeavour. The initial intention of the project was to deploy advanced smart meters in households according to their demographic attributes and patterns of energy consumption in order to ensure that the trial encapsulated the different conjunctions of social and technical challenges facing the network as a whole. However, as the project unfolded, the specificities of the urban assemblages enrolled into its design made their presence felt. Initially project designers imagined a suite of energy consumer profiles that constituted particular market segments and sought to populate a series of cells in a sample matrix. However, the aspiration to populate this matrix was quickly compromised by the socio-material realities of urban energy use:

> So there are all these kind of - there are gaps out there, but you know, even more than that, just recruiting to the right kind of demographics and the different cells that we've set up has been challenging…We also found… that certain segments don't exist. Units (apartments) with high gas consumption (for example). The only thing units use gas for is cooking really (Energy Australia interview July 2013).

The selection of households for smart meters—a fundamental entry point for integrating a smart grid into the urban energy system—proved more complex and required more negotiation than first envisaged both technologically and socially. The physical structure of the built environment, particularly in the more densely-developed urban locations, created multiple challenges to the transmission of the radio signals that are essential for the smart meters to communicate with the network:

> “[In] a multi-dwelling unit, which we have as part of the trial sampled, primarily in Sydney, you have meters that are under several layers of cement reinforcement, which works really, really well at containing radio signals! Then we have to run an antenna up through the building to be able to communicate with the outside world. It then comes back to the cost efficiency thing of if we've chosen that building to have one meter in it and we're putting in an antenna solution that costs so much per meter - okay, that's not going to work.” (Ausgrid Interview November 2012).

Issues of variable signal strength reshaped ideas about how the trials could be rolled out, who could be involved and where and how the grid could be integrated with the city:

> “So we had a range of meters, people going out and putting meters in and then suddenly going we can't get a signal. Okay, we might add signal strength testing to the home, and they can only do that physically. So right, we've chosen someone, go out and measure - okay, we're good - okay, we're not so good. Suddenly the number of meters we installed or didn't install –related to signal strength—dropped literally over the week by adding that layer of process to it. So that ruled out a whole bunch of people who we'd originally sampled because they couldn't get the signal strength.”(Ausgrid Interview November 2012).

Eligibility and inclusion became a conjoint matter of demographic characteristics and radio signal strength. The physical character of the smart meters themselves, as key material artefacts of the smart grid, brought forth the need for further significant negotiations. The physical dimensions of the smart meter boards were larger than conventional non-smart spinning disc boards and differed in dimension to some other smart meter products in circulation. In many cases there was insufficient space to allow for the installation. Again, multi-unit dwellings proved especially problematic when it came to finding suitable space in which to locate mounting points, antennae and terminals and non-smart meters were not able to be replaced without incurring excessive costs. Similarly, issues arose around barriers to interoperability between the meter and the communication module—at the very heart of smart’s integration of energy and communications technologies—that arose from the lack of standardisation of smart meter infrastructure in Australia. These complications generated customer dissent, where would-be trial participants refused to accept the disruptions associated with smart meter installation. In short, the material properties of smart meters generated their own effects as the project was actualised (see Stengers 1997). Certain general properties of smart meters—their size, reliance on transmitting radio signals, requirements for particular building locations— and the ways in which these properties were made and resisted in relation to other agents, from the fabric of buildings to individual concerned with disruption, were expressed in specific ways in the urban settings of the SGSG project that made certain problems visible and salient. These socio-materialities thus constituted the practice of negotiation, shaped a political texture, and ultimate the pathway of the grid's actualisation (see Barry 2013).

Ultimately 30 per cent of all anticipated sites, but between 70 and 90 per cent of multi-unit sites, proved unsuitable for installation of the smart meter infrastructure involved in the SGSC trials (Arup 2014b: 104). The materiality of multi-dwelling units was particularly problematic, being less a passive foundation on which the project's negotiations played out and more an agent constitutive of those negotiations (see Barry 2013). Developments in smart meter technologies are likely to produce greater capacity to work with the particular urban materialities. Nonetheless, the abstract spatial and technological aspirations of grid logics are clearly brought to ground by the insistent and often disruptive materialities of the city. SGSC authorities' attempts to manage the unruly conduct of the material assemblage that constituted the grid in the city involved multiple points of negotiation at the core of how the problem of energy, and its proposed governance solution through smart grids, translated into issues that came to matter in the city.

Fitting the distributed storage and distributed generation technologies that were part of the network trial into the urban (and rural) spaces of the Sydney-Newcastle region also required working through and around the urban contexts of which they became a part. This was on the one hand a matter of finding the spaces in which such devices could be installed:

> "(the battery is) quite a large device. They need a certain amount of space to operate and maintain and they generate noise, about the same as an air conditioner…. So we had someone say yes, I'll have one and we go round and say right, we'll do a site inspection. We go well, there's your meter box there, it needs to be close to that, there's your neighbour's bedroom - not going to work. Or your access is that close we'd have to crane them in, and we've got the crane in the neighbour's yard to crane it into your yard - not going to work. Some yards are like that. Some houses were rentals, the landlord says no." (Ausgrid Interview, November 2012)

> "[In terms of siting the wind turbines] Unfortunately Elermore Vale and Wallsend, there's nowhere that's 150/160 metres from the nearest receiver. There was Thomas Street, which is the big roundabout that was going onto link road F3, so we were going to put them along there [but the road widening scheme prevented this]" (Ausgrid Interview, November 2012)]

The network trial was to have included a large-scale grid battery storage at Newington, to operate within a 'saturated' suburban network with a high density of rooftop solar PV installations (Newington has over 1000 installations). But the unruly size of the grid battery device—approximately that of a shipping container—

meant that limits were encountered as to the number of possible appropriate sites in residential areas. Lengthy negotiations to site a battery failed and the grid battery trial component of SGSC could not proceed (Arup 2014b). It was not only the physical size of available sites that mattered however. The installation of the Blu Gen gas fuel cells required sites that enabled connection between the cell and all utilities (electricity, gas and water). The effective operation of the cells also requires constant water and power supply and continuous monitoring via a reliably available ADSL internet connection. Like many urban contexts, Newcastle could not provide a flat plain of utility and internet service reliability and, as a result, the siting of technologies such as the Blu Gen gas fuel cells demanded considerable trial, error and negotiation, highlighting some of the ways in which energy system change comes to be path dependent through their material imbrication with urban configurations and the challenges this presents to actualising transformations.

Simultaneously, the adoption and uptake of grid technologies themselves was dependent not only the particular properties of urban contexts, but also their political, legal and social constitution (see Barry 2013). Here, specific material artefacts become central to the negotiations that shaped SGSC's actualisation. The siting of wind turbines proved challenging due to constraints imposed by regulatory settings. Existing planning regulations dictate that the devices cannot be installed within 100m of a residence: the material objects themselves having become the focus of tight regulations relating to the social acceptance of their bulk, noise and kinetic nature and wider-scaled controversies about their potential impacts (Bell et al 2013). The material visibility of grid-integrated technologies (particularly turbines) sets them apart from more invisible forms of energy infrastructure and technologies and renders them subject to regulation and debate around their social acceptance which complicated the trial's intended roll out:

> "[for the wind turbines we] went through a DA process. Then you start hitting all the things that DA processes hit. You hit heritage, you hit mine subsidence[3], you hit … you hit - potentially locate them in areas where endangered bird species are located… And mine subsidence meant that the footing, for example, had to be that much bigger in case - to distribute the load so it wouldn't go through the hole into the coal mine, which adds more costs to the experience.…" (Ausgrid Interview, November 2012)

Ultimately, wind turbines could not be located in any of the SGSC's urban settings but were sited in rural contexts where location could be negotiated and site limitations could be more easily overcome.

[3] Vast areas of the Newcastle and Hunter region's built environment is undermined as a result of a 200 year history of coalmining in the region. The mined lands were subsequently extensively developed for residential and commercial purposes.

In terms of the social context of grid/city integration, the final analysis of SGSC recognised that optimised network and market considerations may not be achievable through a smart grid rollout because “although it is likely that customers who install technology such as photovoltaic generation or small wind turbines are driven primarily by the value proposition of the device, other factors may also drive their decision” (Arup 2014b, 147). This was evident in Elermore Vale, in Newcastle where SGSC’s novel technologies were taken up amongst households not (only) because of their innate properties or the benefits that might accrue to individuals, but through the neighbourhood effect offered by an early-adopter household:

> “… the Jeffkins family, who have been on *Catalyst* (popular TV science show) and all the stories we've done….have basically then acted as advocates for us in their neighbourhood to the point where every second home in their street has something. Finding them was probably the biggest success, influencer, of the whole process…. He said my family aren't really into it, but I am and I'm trying to educate them to being better with the stuff. He could see the benefit…. Without him it would've taken us a lot longer to get those ones out there” (Ausgrid Interview, November 2012).

In this case, the trial of new generation technologies was determined not by the energy resources available, network demands, or the requirement to create a generalizable and replicable trial. Rather it was actualised through the iteration and negotiation of the material assemblage of particular urban landscapes, the localised political and social context and the ways in which such interventions come into proximity to a wide range of other urban concerns (see Rutherford 2014). SGSC was shaped by particular urban challenges related to the socio-spatial, politico-legal and material make-up of the urban fabric (see Criqui and Zerah 2015). The materiality of the urban, its properties and behaviours, are not incidental to but are active constituents of the practical negotiations through which what SGSC could become in the city took shape. Far from serving only to constrain the intervention or reveal contestation based on conflicting interests, the particularities of SGSC’s urban context and its intersections with the materiality of grid technologies, and the compromises necessary to negotiate these across multi-scaled aspirations over-determine its actualisation.

Conclusions

As systems of energy provision come under pressure, smart grids are increasingly heralded as a means through which multiple problematics can be simultaneously addressed. Yet while such interventions are usually considered in technical and economic terms, they are also political projects that require the will to improve current conditions. In this paper, we have argued that understanding the nature of such politics, and the broader matter of the governing of energy transitions, requires an engagement with their geographies and materialities. Converting the ‘spiral of death’ facing electricity networks to a ‘vortex of opportunities' requires not only that problems are recognised and solutions devised, but also that that interventions intended to improve energy systems are actualised. Energy transitions and the politics of climate governance of which they are (sometimes) part are enmeshed in the messy realities of particular socio-material conditions that serve not only as a platform across which they are played out but come to form part of the politics of, in this case, smart grid.

We have argued that particular attention be paid to the city as 'context, constituent and consequence' of the reworking of energy systems (Rutherford and Jaglin, 2015: 174). Not only does the city's materiality shape the politics of the smart grid, it shapes what the grid can become in the city and ultimately, in turn, is part of the reworking of the city through its energy system. In this sense, the urban is an object of improvement that also becomes known, delimited, calculated and understood through the workings of smart grid as a governmental programme. In this regard, the SGSC project wears its heart on its sleeve: the intimate and continual conjunction between the grid and the city is configured through the project from the outset. Yet, through the actualisation of the project, the tensions apparent in adhering on the one hand to the notion that smart grids could be demonstrated and rolled out in smooth space and on the other to a conviction that urban specificities were essential to the making of smart grids came to shape its trajectory. The SGSC initiative was an exception in many respects. It was well funded, underpinned by high-level political support and given an experimental imprimatur. Nonetheless, despite its designed exceptionalism, it could not escape the mundane materialities of the everyday nor the banal workings of day-to-day infrastructural changes. In this respect the material politics of its exceptional experimentalism and, the socio-material orders it sought to produce, were entangled, through its actualisation, in the politics of the everyday and could not achieve more than those everyday politics and would afford.

It is in this work of actualisation, and the socio-material negotiation it entails, that we find a politics of smart grid. It is through the making of SGSC as both an urban and a grid project that the 'political situation' (Barry 2013) of smart grid as a means through which energy transitions may be directed to particular ends is constituted. From an initial framing as part of a shift towards a low carbon energy system, the complexities of engaging demand reduction and low carbon energy technologies, serve to re-determine smart grids in terms of their potential to create new kinds of electricity economy. Such complexities were actively constituted through the socio-material relations through which smart grid smart city came to be actualised, from the relation between concrete walls and smart meters, to that of backyards and batteries. In this sense, the material politics of infrastructure emerge "as much in the socio-political negotiations they demand as in the technical deployment of physical networks" (Rutherford 2014:1451). Yet this is not a politics that gives rise to rupture or dissent. Rather, it is manifest in an ongoing negotiation, a quiet contestation, compromise and attrition of different positions through which new kinds of grid-urban energy-climate realities are forged,, come to be compromised, and configured anew.

References

Ausgrid (2013) *Smart Grid, Smart City Energy Resource Management Program: Rooftop Solar Trial Update*, February 2013, Online at: http://www.smartgridsmartcity.com.au/Tours-and-events/~/media/Microsites/SGSC/Files/Presentations/Rooftop%20Solar%20Trial%20Update%20Feb%202012%20FINAL.pdf (accessed December 2013)

Arup (2014a) *Smart Grid, Smart City:* Shaping Australia's Energy Future Executive Report. Available from https://ich.smartgridsmartcity.com.au/. Accessed August 20 2015.

Arup (2014b) *Smart Grid, Smart City:* Shaping Australia's Energy Future National Cost Benefit Assessment. Available from https://ich.smartgridsmartcity.com.au/. Accessed August 20 2015.

Australian Government (2012) Electricity Prices Fact Sheet, Dept of Resources, Energy and Tourism, Canberra

Australian PV Institute (2015) Mapping Australian Photovoltaic installations. Available at http://pv-map.apvi.org.au/ . Accessed 18 August 2015.

Barry, A. (2013) *Material Politics: Disputes Along the Pipeline*. Wiley-Blackwell: London.

Braun, B. (2014) A new urban dispositif? Governing life in an age of climate change. Environment and Planning D: Society and Space 32: 49-64.

Bulkeley, H. (2000) Down to earth: local government and greenhouse policy in Australia, *Australian Geographer* 31 (3): 289 – 308

Bulkeley, H (2012) Governance and the geography of authority: modalities of authorisation and the transnational governing of climate change, *Environment and Planning A* 44: 2428–2444

Bulkeley, H. Powells, G., and Bell, S. (2015) Smart Grids and the Constitution of Solar Electricity Conduct, *Environment and Planning A*, 48 (1): 7-23

Bulkeley, H., Castan-Broto, V. and Edwards, G. (2015) *An Urban Politics of Climate Change: experimentation and the governing of socio-technical transitions*, Routledge, London.

Carbon and Energy Markets (2015) Network tariffs applicable to households in Australia: empirical evidence. Report prepared for Uniting Care Australia. Available at https://www.nsw.gov.au/sites/default/files/miscellaneous/attachment_f_-_uniting_care_australia_report.pdf. Access August 2015.

Cormack, L. (2015) Solar mapping tools show real-time feeds of solar uptake in Australia, Sydney Morning Herald, April 29, Available at: http://www.smh.com.au/environment/solar-mapping-tools-show-realtime-feeds-of-solar-uptake-in-australia-20150428-1mvdgg.html#ixzz3jFMpwjff

Criqui, L. and Zerah M.H. (2015) Lost in transition? Comparing strategies of electricity companies in Delhi. *Energy Policy*, 78, 179-188.

Duinveld, M., VanAssche, K. and Beunen, R. (2013) Making things irreversible: object stabilization in urban planning and design *Geoforum* 46: 16-24

Ekers, M., Loftus, A. and Mann, G. (2009) Gramsci lives! *Geoforum* 40: 287-291

Energy Supply Association (2015) Solar PV Report, June 2015 *http://www.esaa.com.au/Library/PageContentFiles/3f4867ad-fb5f-47a6-b2f8-3bc97732747d/Solar%20report%20June%202015.pdf* (accessed August 2015)

Foucault, Michael (2009) *Security, Territory, Population: Lectures at the College de France 1977 – 1978*, Ed. Senellart, M., Trans. Burchell, G. Palgrave Macmillan: Basingstoke.

Gabrys, J. (2014) Programming environments: environmentality and citizen sensing in the smart city. *Environment and Planning D: Society and Space*, 32(1): 30-48.

Hollands, R. (2015) Critical interventions into the corporate smart city *Cambridge Journal of Regions Economy and Society* 8 (1): 61-77

Hommels, A. (2005) Studying Obduracy in the City: toward a productive fusion between technology studies and urban studies, Science, Technology, & Human Values, 30 (3): 323-351

Huber, M. (2015) Theorizing energy geographies, *Geography Compass* DOI110.1111/gec3.12214

Jessop, B. (2002) *The Future of the Capitalist State*, Polity Press, Cambridge

Kitchin, R. (2015) Making sense of smart cities: addressing present shortcomings. *Cambridge Journal of Regions, Economy and Society*, 8, 131–136

Klauser F. and Albrechtslund A. (2014) From self-tracking to smart urban infrastructures: towards an interdisciplinary research agenda on Big Data. Surveillance & Society 12: 273-286.

Li T. M. (2007a) *The Will to Improve: governmentality, development, and the practice of politics*, Duke University Press, London

Li, T. M. (2007b) Practices of assemblage and community forest management. *Economy and Society* 36: 263-293.

Luque-Ayala, A., C. McFarlane, S. Marvin (2014) Smart Urbanism. In: Hodson M and Marvin S (eds) After Sustainable Cities? London: Routledge.

Miller, P. and Rose, N. (1990) Governing economic life, *Economy and Society* 19: 1-31

McGuirk, P. M. (2004) State, strategy and scale in the competitive city: a neo-Gramscian analysis of the governance of 'global Sydney', *Environment and Planning A* 36: 1019-1043

McGuirk, P., Bulkeley, H. and Dowling, R. (2014) Practices, programs and projects of urban carbon governance: Perspectives from the Australian city, Geoforum, 52: 137-147

Paterson, M. and Stripple, J. (2010) My Space: governing individual's carbon emissions, *Environment and Planning D*, 28: 342-362

Powells, G., H. Bulkeley, A. McLean (2015). Geographies of smart urban power. Smart urbanism: utopian vision or false dawn? S. Marvin, A. Luque-Ayala and C. McFarlane. London, Routledge: 126-145

Raco, M. and Imrie, R. (2000) Governmentality and rights and responsibilities in urban policy *Environment and Planning A* 32: 2187-2204.

Rutherford, J. and Jaglin, S. (2015) Introduction to the special issue – urban energy governance: local actions, capacities and politics, *Energy Policy* 78: 173-78.

Rutherford, J. (2014) The vicissitudes of energy and climate policy in Stockholm: politics, materiality and transition *Urban Studies* 51(7):1449-1470.

Rutherford, J. and Coutard, O. (2014) Urban Energy Transitions: places, processes and politics of socio-technical change, *Urban Studies*, 51(7) 1353–1377

Smart Grid Australia (2015) Webside, http://www.smartgridaustralia.com.au/. Access August 2015

Stengers, I. (1997) *Power and Invention.* Minneapolis: Minnesota University Press.

Strengers, Y. (2012) Peak electricity demand and social practice theories: reframing the role of change agents in the energy sector *Energy Policy* 44: 226-234

Strengers, Y. (2013) *Smart Energy Technologies in Everyday Life: Smart Utopia?*, Palgrave Macmillan, New York.

Wade, N.S., Taylor, P.C., Lang, P.D. & Jones, P.R. (2010) Evaluating the benefits of an electrical energy storage system in a future smart grid. *Energy Policy* 38(11): 7180-7188.

Vanolo, A. (2015) Smartmentality: the smart city as disciplinary strategy *Urban Studies* 51(5): 883–898.

Table 1 Customer application trail product features

POWERSMART SOLUTION PRODUCTS			
BudgetSmart: participants receive a 12.5% discount off their whole bill if their account is kept in credit	…with PowerSmart Monitor: real time display of power use and costs	…with PowerSmartOnline portal: uses Smart Meter data to show real time power use and costs; accessible from computer/ smart phone.	…with PowerSmartOnline and Home Control: can turn on/off 10 nominated appliances remotely from any computer /smart phone.
FlowSmart: participants receive financial reward for reducing energy use during pre-notified events during which air-conditioners' compressors are remotely switched off for 15 minutes per hour.	X	√	X
PriceSmart: participants receive lower rates throughout the year with the opportunity to manage electricity usage during high rate peak price events.	√	√	√
SeasonSmart: participants receive substantially lower rates in Spring and Autumn; provides insights on managing costs in higher priced Summer/Winter period	X	X	X

Table 2 Key results of SGSC based on customer application trial participant survey and project data

Key results of SGSC based on customer application trial participant survey and project data	
	Participants reduced their energy use by between 1.8 and 3.5% (dependent on products used).
	Pricing structure, rather than feedback technology, had a greater impact on both electricity usage and peak demand reduction
	83 per cent of respondents reported that customer feedback technology and/or tariff product led to their acting to reduce or change how they consumed electricity
	Products that involved peak events were the most popular (where tariffs rose to a high of $3 per KwH and customers could use smart metre infrastructure (SMI) to reduce their demand).
	70 per cent of respondents felt their ability to reduce electricity bills was enhanced by SMI products' effects on their awareness, energy literacy and control over electricity consumption bills.
	50% of respondents reported persistent changed energy behaviours.
	The majority of respondents had participated in a 'peak event' and 66% reported that it created an enduring change in their energy use.
	Participants in peak events demonstrated average peak reduction of 38.9 per cent.
	Products involving regular proactive customer engagement with their account also proved effective.

Source: Arup (2014b)