Smart Grids in the City: Splintering Urbanism in a Smart Urban Future

MCLEAN, ANTHONY,JOHN

Abstract

Anthony McLean

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This thesis examines how the emergence of smart grids is changing urban development practices and shifting the power relations between the government, private industry and end consumers. The research was undertaken as part of the Customer Led Network Revolution – a UK smart grid research project investigating a shift towards a low carbon economy. This thesis is just one outcome of the project and examines the ways in which smart grids are being produced internationally across a variety of different contexts, conducted with qualitative research with the aim to understand the implications for public responses to new energy technologies. The study first surveyed the development of smart grids projects internationally before selecting the case of the Pecan Street Project in Austin, Texas, to examine the drivers and barriers to the development of smart grids in detail. Drawing on the concepts of splintering urbanism and using the literature of large technical systems, the thesis argues that there are three critical dynamics to the emergence of the smart grid in Austin – the energy discourse that allows a smart grid to emerge; state backing of the project for economic development purposes; and changes in urban planning structures to facilitate smart growth. This study suggests that the growth of smart grids can be tailored to benefit a wide variety of stakeholders, but could "splinter" urban environments with potential risks for rising inequality. The research offers a valuable contribution to how smart grids can be produced in the UK and how they should be managed.

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Anthony McLean

Masters (by Research)

Department of Geography

Durham University

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Table of Contents

List of Illustrations

List of Tables

Chapter 1 - Infrastructure Networks, Theories and Splintering Urbanism

1.1) Introduction

This thesis examines how smart electricity grids have the potential to change urban environments. Advanced technologies offer consumers new ways to gather and use information on their energy use, from aligning their activities according to real-time pricing signals to actively producing their own power using decentralised generation technologies. Smart technologies have the potential to change power structures within society and 'splinter' urban environments and infrastructures, providing benefits to those with access to new technologies and constraining those without the means or funds to participate. While smart grid technologies offer opportunities to increase renewable generation and encourage a shift towards a low-carbon economy, they also offer opportunities to create new markets within the grid infrastructure, allowing consumers to make their own decisions about how they produce and consume energy. This thesis will examine these issues, exploring how smart grid projects are changing urban environments and what benefits and constraints they create.

This thesis focuses on the changes in urban environments because since 2009, for the first time ever, the majority of the world's population live in cities, with the urban population expected to increase by 3 billion between 2010 and 2050 (Buhaug and Urdal 2013). Modern cities have been constructed around a variety of complex and interlinked infrastructure networks with gas pipes, roads and electric cables crisscrossing the landscape. Smart grids offer more potential to impact urban areas than elsewhere, changing the behaviour of large groups of people and allowing better opportunities to reduce carbon emissions. Modern cities (and the residents that live within them) have come to rely on the often hidden variety of networks to provide gas, water, energy, telecommunications, waste disposal and transport but the evolution and rollout of these developments was often slow, piecemeal and by no means inevitable (Hughes 1983). Transitions from one network state to another took years, requiring the input of multiple actors and the introduction of many co-dependent technologies. The roles of governments, private enterprises, consumers, and the prevailing economic, political and cultural climate all need to be examined when studying large technical systems. Many urban areas today are in the middle of a "third industrial revolution" moving from a large, centralised, fossil fuel-based energy generation system towards a dynamic,

decentralised renewable network (Rifkin 2011). Because of the importance of urban areas in infrastructure research, this thesis involves examination of one smart grid case study – the Pecan Street Project in Austin, Texas – and explores the potential impacts on the urban environment, the potential to boost economic development, and changing consumer behaviour in a smart future.

This thesis is structured as follows. Chapter 2 looks at the Pecan Street Project (PSP) in detail, placing it within the context of the energy discourses that exist within Texas generally and Austin in particular. I will examine how efforts to increase renewable energy generation (mainly wind) have been so successful despite the state having an external image of, at best, environmental ambivalence. Wind generation in the UK has faced opposition from people raising concerns about the impact on the visual landscape. Understanding how Texas has largely been able to avoid this offers a lesson to policy makers around the world and the state's ability to turn wind into another natural resource that should be exploited has been very successful.

Chapter 3 examines how the PSP is being used by the city of Austin as part of a wider economic development strategy. I link the project to discussions of neoliberalism and an attempt to use the state apparatus to *create* markets, as opposed to letting markets evolve freely without any interference. I describe the history of public-private-partnerships in Austin and analyse how the structure of the PSP has evolved from earlier attempts to attract international investment and bring jobs into the city. Austin has a variety of ingredients that has allowed a smart grid project to emerge. It is the state capital, providing easy access to policy makers; it has a large research-intensive university (the University of Texas); it has previous experience in managing public-private projects; and it has a new urban development available to be used as an experimental lab for researchers. In this chapter I examine how all these components are being used to attract international finance to the city of Austin within a neoliberal framework, before examining the impact of this on residents using the theory of splintering urbanism discussed below.

Chapter 4 looks at the Mueller development within Austin – a new urban development project that is being used by the PSP as a test bed for smart technologies. This district – built on a former airport – has the largest concentration of electric vehicles in the US. Its homes are highly energy efficient and the district has numerous social goals developers have to adhere to, such as providing a certain percentage of affordable housing. The site has been opened up for smart grid researchers wanting to test their technologies in a real-world setting within the homes of consumers. This chapter will examine what impact the smart grid is having on the urban landscape within the development project, how energy use can be changed within an urban setting and how social and environmental views can overlap.

In the rest of this chapter I will begin by exploring the motivations behind the deployment of smart grids around the world. Different regions are designing their smart grid infrastructures for different purposes. Some countries are focused on the economic benefits, others are motivated by environmental concerns and others are motivated by a desire to provide benefits to consumers. I will then outline the academic literature on large technical systems and the development and 'splintering' of infrastructures. Economic liberalisation over the past few decades has seen a shift away from centrally planned infrastructures to smaller one-off investment projects, often funded by private finance and aimed towards affluent consumers at the expense of disadvantaged groups. Smart grids could provide for the next generation of unbundled infrastructure systems allowing for

true free markets within the energy system and offering consumers a choice in how they buy and sell their energy. Yet the unbundling of energy systems has not provided benefits to everyone within urban environments. The "splintering urbanism" theory outlines how the liberalisation of infrastructures could create inequality of access. Finally I will discuss the research methodology for this project, the research questions I have set out to answer, and the reasons behind choosing Austin as a city to conduct field work.

1.2) Smart Grids Internationally

Although different urban environments in different countries around the world have their own aims and objectives for developing a 'smart' grid, and their own interpretations of what 'smart' actually means, they share similar characteristics. 'Smart' has become shorthand for 'intelligent' and a 'smart grid' usually refers to a scheme to introduce information and communication technologies (ICTs) into the energy network. A key element is the "utilization of networked infrastructures to improve economic and political efficiency and enable social, cultural and urban development" (Hollands 2008: 307). A large scale introduction of intermittent renewable and low carbon energy generation (wind and solar) coupled with new loads (i.e. electric vehicles) is expected to put the existing energy infrastructure under great strain. One simple, although costly, solution is the upgrading of the current infrastructure to enable it to carry more power. A more ambitious solution is the deployment of ICTs. By providing consumers with more information about their energy use, encouraging them to use their appliances during off-peak times with real-time pricing signals and allowing them to generate and consume their own power, a future smart grid could "improve both the physical and economic operation of the electricity system by making it more sustainable and robust, more efficient by reducing losses while at the same time offering economic advantages for all stakeholders" (Verbong, Beemsterboer et al. 2013: 117). Smart grids could also help governments meet tough carbon reduction targets, improve efficiency and provide an economic stimulus to various sectors. In this section I will examine the range of smart grid projects that are underway internationally in order to identify the different rationales underpinning their emergence in different political and economics contexts

1.2.1) Different Strategies for Different Ideologies

In 2010 there were estimated to be 90 smart grid projects in operation around the world with a similar number estimated to be in development (World Economic Forum 2010). Table 1 outlines the primary agendas underpinning their development. The majority of smart grid projects that are at an advanced stage are being developed across Europe, North America and Australia, but a large number of smart meter-only projects have been rolled out globally. In 2009 the United States alone earmarked $4.5 billion from its federal stimulus package for the development of smart grids funding a wide range of projects to upgrade the infrastructure networks (US Department of Energy 2009).

However different utilities have taken their own approach resulting in various successes and failures with differing strategies and public engagement practices. A single one-size-fits-all approach to designing and implementing a smart grid system has not yet been achieved.

Table 1 - Global Smart Grid Development Strategies

	Low-Carbon Agenda	Improving Consumer Experience	Experience National Export Strategy	Fast Growth Infrastructure
Examples	UK, Germany, Australia	United States	South Korea, Japan, UAE, Singapore	China, India, Brazil, Kenya
Local Industry Drivers	Strong commitment to carbon pollution reduction. Integrate with other initiatives – intelligent city, electric vehicles, renewables, transnational supergrid, broadband roll-out Facilitate competitive energy retail markets. Empower and inform consumers	Improve supply reliability, quality, grid resilience and peak load reductions. Diversify energy dependencies and secure energy supply. Integrate with other initiatives – smart city, electric vehicles, renewable. Empower and inform customers	Development of an industrial complex to export smart grid technologies and solutions globally. Green economic growth agenda. Integrate with other initiatives – intelligent city, electric vehicles, renewables, transnational supergrid, broadband rollout	Fast build out of infrastructure to keep pace with urbanization and economic growth rates. Improvement in supply reliability, power quality and grid resilience. Reduction of system losses, especially for long distance transmission, theft and long-term energy cost
Market Model	Liberalized market	Vertically-integrated	State-owned monopoly	State-owned monopoly
Regulatory Incentives for Smart Grid Pilots	Smart grid regulatory competition funds and standard development funds. Innovation funding. Mandated smart meter rollouts, renewables and energy efficiency targets, reliability incentives, feed-in tariffs 2010 smart grid investment: - Germany US$ 397 million - Australia US$ 360 million - UK US$ 290 million	Fiscal stimulus packages including investment for upskilling workforce Less money available for R&D Standard development NIST funding 2010 smart grid investment: - US $7 billion	International knowledge sharing programmes, e.g. the Korea-Illinois Smart Grid Collaboration Program National smart grid roadmaps Smart city new builds, e.g. Songdo, Masdar 2010 smart grid investment: - Japan US$849 million - S. Korea US$824 million	Global financial institution funding e.g. US$330 million World Bank grant to increase electricity access and green energy in Kenya Power sector transformation roadmaps e.g. India Strong synergies with accelerated telecommunications growth 2010 Smart Grid investment: - Brazil US$ 204 million - China US$ 7.3 billion
IP Development Focus	• Integration of large-scale renewables and distributed generation • Open metering standards • Innovative product/service development	• Software and data architectures • Transmission and distribution solutions • Electric vehicles	• Transmission and distribution solutions • Storage technology • Electric vehicles	• Large-scale renewable • High voltage transmission networks

Smart Grid Maturity	Medium	Medium	Low	Low
Local Industry Challenges	Current market models do not incentivize all value chain players to invest in smart grid	Some examples of poor execution in early smart metering pilots have increased regulator's sensitivity	Domestic regulatory markets may not be strongly conducive limiting ability to develop innovation in a local context	Capital constraints in some developing countries and the scale of development required

Table 1 - World Economic Forum (2010) Accelerating Successful Smart Grid Pilots.

Governments in Europe and Australia are committed to a low carbon future and this appears to be the main impetus for the funding of smart technologies. Within a liberalised marketplace governments are financing demonstration projects in the hope of encouraging take-up amongst the various private energy utilities. Once a viable business model has been proven it is hoped the utilities will voluntarily switch from a role of simple energy *providers* to those of energy *managers* with improvements in efficiency and increased integration of renewables. However different stakeholders have varying levels of enthusiasm. Why would energy retailers help consumers generate their own power and therefore damage their own revenue stream? In the US many smart meter deployments have been introduced by private utilities with the backing of a 2009 federal government stimulus bill. States across the country have seen large-scale roll outs of smart meters, although the degree of success varies widely. Some utilities have encountered public opposition to the technology, which has not been helped by the activities and public engagement policies of the companies themselves. Many consumers see little to gain from the new meters as most are designed simply to eliminate the need for monthly call-outs. In some states various scare stories have emerged about the negative health impacts of the wireless technology used to transmit data with some opponents claiming the electro-magnetic radiation can cause "dizziness, nausea, migraines, muscle spasms and insomnia" (Smart Meters: Telling It Like It Is 2010).

In many of the tiger economies of Southeast Asia the carbon reduction benefits of smart grids are seen as less important than the desire to create a future export strategy, with governments offering private companies access to test bed areas in the hope new appliances and technologies can be developed for future export. In South Korea a project on Jeju Island is serving as a development town for renewable energy and research into the smart grid. Some 3,000 homes are signed up and private companies can use the town to develop products and software, evaluate their effectiveness and sell the successful appliances internationally. Similar schemes are being developed in Japan and Singapore. In the newly-emerging economies (such as China, India, Brazil) smart grids are being introduced in tandem with the roll-out of national infrastructure to cope with the huge demands on a growing economy.

The term 'smart grid' therefore does not represent a homogenous strategy to update the energy grid. Some projects are leaving the existing network relatively intact and replacing old meters and transformers with updated models. Some projects however, which offer full integration, could change the definitions of energy providers and energy consumers. Individual consumers could turn their homes into small-scale power generators with localized estates connected to each other to become virtual power plants. In Groningen, The Netherlands, residents within a small housing estate are being given tools to manage and generate their own energy. Competition is promoted within the scheme by comparing a householder's energy use to the estate's average. The project is designed to

reduce energy use, encourage users to manage their own consumption and generation and reduce the need for an external utility to provide power. The energy utility is becoming a *manager* of the network rather than a simple *provider*, enabling consumers to make their own choices.

1.3) Background Literature and Concepts

This thesis seeks to look at smart grids using the literature on large technical systems and the theory of splintering urbanism. The thesis will attempt to examine how smart grid developments could impact on urban spaces and the effect it could have on consumers in cities, using Austin, Texas, as a case study. In this section I will begin by outlining the history of large technical systems research before moving on to a multi-level perspective used to research innovations in infrastructures. Large technical systems such as electricity networks consist of huge, capital-intensive technologies and necessitate the involvement of a range of actions (Markard and Truffer 2006). As such, it is important to establish how to research large infrastructures, what factors should be assessed and to understand what signs researchers can look for to identify possible institutional changes.

Also, modern smart grids are not being developed on infrastructures in isolation to the surrounding socio-economic world. Many projects today are being developed within a neoliberal economic framework, allowing new players to enter the market, changing the roles of actors and shaping new rules and regulations. The splintering urbanism theory offers an explanation for these developments and could offer a predictive tool for explaining changes in urban centres for the future.

1.3.1) The Development of Large Technical Systems

In the late nineteenth century new technologies offered revolutionary advances in the standards of living for citizens within western cities. Electrification allowed energy to be produced in remote power plants and transported through wires and grids across continents, removing large sources of pollution from highly populated urban areas. Yet the technologies which allowed significant shifts in energy production did not spring up overnight. When Thomas Edison first designed his electric power and lighting system in the 1870s he realised he would need a suite of other products to be sold alongside (such as light bulbs and home appliances) and thus a whole new industry evolved alongside the infrastructure. Early research into these technologies often overlooked the interplay within and between societies and cultures. Marshall McLuhan's famous maxim that the "medium is the message" was a popular phrase for technological determinists (McLuhan 1963). For them *how* people used new technologies (such as televisions in McLuhan's case) did not matter as much as the fact that they were using them in the first place. The content of television programmes was irrelevant. The important area of study was the fact that people would now spend hours each evening in front of this strange box in the corner of a room. Technological determinists believed it

was the new technologies that shaped society, for example Karl Marx said "the handmill gives you society with the feudal lord: the steam-mill society with the industrial capitalist" (Rigby 1987: 145). To extend this to the energy sector it could be argued that the availability and high energy content of coal, oil, and gas, and the technologies that allowed their extraction and large-scale electricity generation, created the demand for a suite of new associated products and services, while culture and society adapted to use these new technologies. In the 1980s however the historian Thomas Hughes challenged this view. For Hughes "no technology is, has been, or will be a 'natural force'" moving independently through human history (Nye 1998). New technologies do not change the world in isolation without outside involvement. They need a variety of externalities to become normalised and accepted within a culture. To Hughes a large technical system is a socio-technical system, or a system that is shaped by its social construct and is "both socially constructed and society shaping" (Hughes 1987). Hughes outlines the necessity of 'system builders' who not only invent new technologies or discover how to harness the forces of nature but who also change the cultural and social landscapes of a society so their new technologies can take root (Hughes 1983). They need financiers able to back their new ideas; they need to be able to market and promote their new products; and they need a willing public able to see the benefits of the offerings and to pay for them. Although the electric light bulb was invented some 20 years before Edison perfected his incandescent design, previous attempts to promote the product failed because they lacked the infrastructure needed to provide the necessary power. Gas lighting was already standardised within society and it would take a significant cultural and socio-technical shift to adopt a different system. Edison was a business manager, rather than a classical engineer, and intentionally designed his new light bulbs to be able to compete on price with existing gas and arc lighting. Examinations of the development of electrification that take a determinist viewpoint would fail to explain the interactions of actors such as Edison.

Technologies therefore are never autonomous agents within societies but are reliant upon cultural, social, political and economic forces to become accepted. Allen and Hecht (2001) argue:

> "Though no particular set of values, political institutions, or cultural expressions necessarily accompanies technological change, history has shown time and again that those caught up in that change will always attempt to fix its cultural or political dimensions. Understanding these persistent yet ever-changing links between technology and cultural, political and social power requires strong voices informed by history" (Allen and Hecht 2001: 2).

Therefore studies on large technical systems should not examine new technologies in isolation. They are examples of systems:

> "…made up by a cluster of elements, involving technology, science, regulation, user practices, markets, cultural meaning, infrastructure, production and supply networks. This cluster of elements forms a socio-technical system. The elements of socio-technical systems are created, maintained and refined by supply-side actors (firms, research institutes, universities, policy makers) and demand-side actors (users, special-interest groups, media)." (Geels and Kemp 2007: 442)

1.3.2) The Multi-Level Perspective

Large technical systems are made up not only of physical artefacts (transmission lines and power generators) but also of organisations and institutions (manufacturing firms, banks, universities) rules and government regulations, and natural resources (Bijker, Hughes et al. 1987: 51). Hughes' system builders (charismatic agents of change who help transform systems and societies) travel between different domains in economics, politics and scientific research in a 'seamless web' within society. Electricity networks, along with transportation links, telecommunications, waste systems and gas pipes, should not be examined in purely technical, engineering terms from a determinist viewpoint. Infrastructure networks need to be seen "as a set of social, cultural, economic, and political interests fused together with technology, rather than a 'black box' of generators" (Sovacool 2009: 4501).

Despite this interest in the social dimensions of large technical systems studies have tended to differentiate between production agents and end use actors. Geels argues that "evolutionary economics, business studies and innovation studies tend to focus mainly on the production-side and the *creation* of knowledge and innovation" with markets and consumers simply assumed to be "out there" (Geels 2004: 902). Conversely "cultural studies and domestication studies focus more on the user side" and although work is focused on the *adoption* of technologies many of these studies end up neglecting the actual development of new products. Geels argues studies need to encompass both the *creation* and *adoption* of technologies in order to fully explain processes and concepts. Although Hughes widened the debate to include the cultural, political and socio-economic dimensions involved in the development of networks, end users are still overlooked and are "treated as passive recipients of system-builders' products" (Guy, Moss et al. 2001: 51). In reality the adoption of strategies such as demand side management cannot be explained without placing the end user at the centre of the investigation. Geels expands this debate by developing three interlinked analytic dimensions – the socio-technical system itself, the rules and institutions which exist within a society, which in turn guide (but not determine) various actors (figure 1).

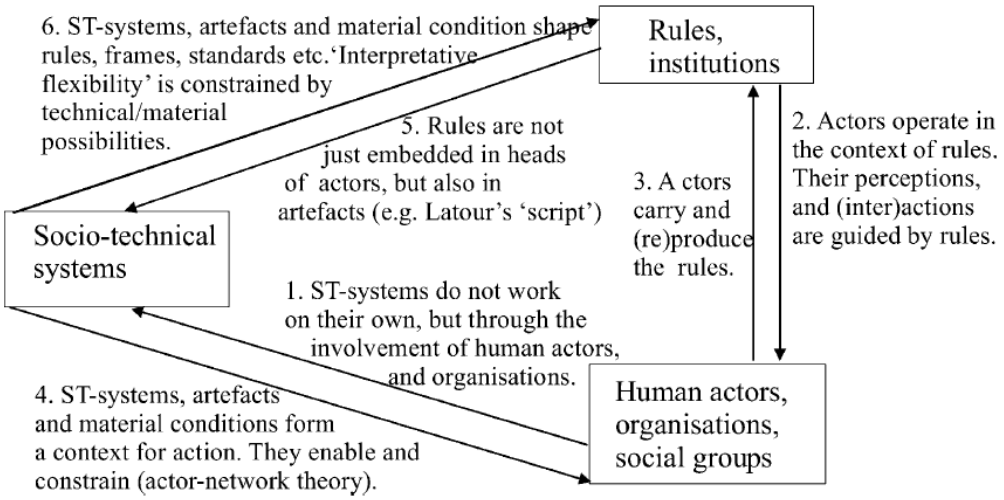

Figure 1 - Three interrelated analytic dimensions (Geels 2004: 903)

The arrows in this system go in all directions as the elements reinforce each other. This framework avoids failing into the trap of technological determinism as human actors are free to choose which

technologies they adopt, although they have to abide by the rules and regulations that exist within the regime. Geels and Kemp (2007) argue:

> "Actors in social groups do not act autonomously, but in the context of social structures and regulative, normative and cognitive rules. Companies react to problems posed by existing technology based on engineering insights and managerial lessons. Products are embedded in consumption patterns, through routines and cultural meanings. Infrastructures very much determine the economics of use. Practices are reproduced because of economics and rules." (Geels and Kemp 2007)

Although most smart grid projects are being developed by engineers and scientists it is important to take a step back and look at wider considerations surrounding the social, cultural and political landscapes being changed by new technologies. By their very nature smart grid technologies rely on the participation of a large and diverse group of end consumers. End users have to be willing to adopt their energy habits, to use technologies during off-peak hours and to shift from petroleum-based to electric cars. The literature surrounding LTS suggests that without the active participation of consumers, smart grid technologies will only ever be a back office upgrade to the infrastructure and not the revolutionary change needed to meet climate change and renewable generation targets as cited by advocates. Researchers not only need to examine the actual technologies that are being developed, but also how and why they need to be adopted. To examine how smart grids can be rolled out within society researchers need to examine what causes a socio-technical regime to *change* from one form into another. To help achieve this Geels and Kemp developed a multi-level perspective (MLP) which goes beyond investigating single technologies (such as wind turbines, electric vehicles or heat pumps) in isolation and instead examines "systemic" changes within a system (figure 2).

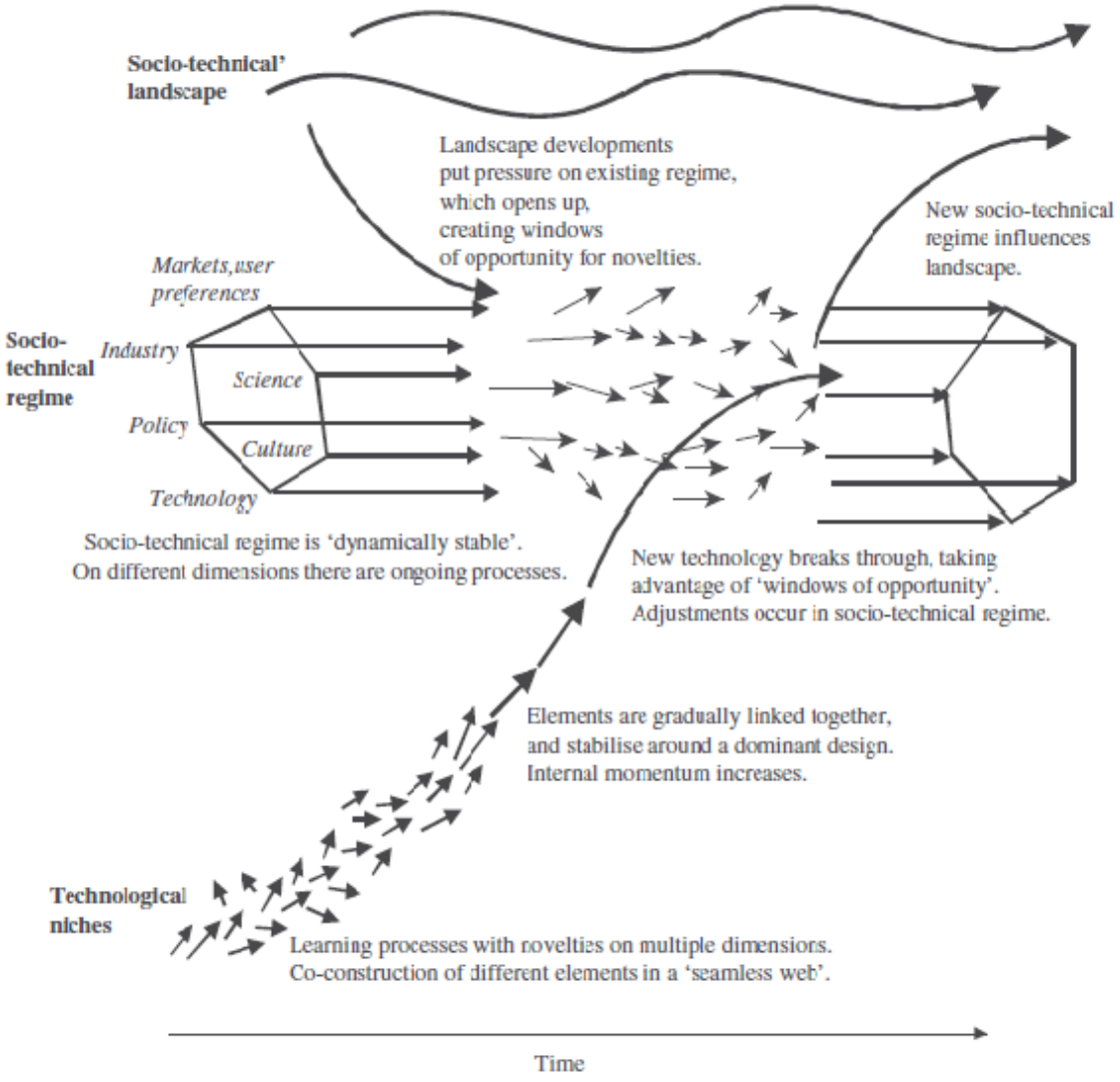

Figure 2 - A dynamic multi-level perspective on system innovations (Geels 2002: 1263)

Most of the changes and innovations that occur within a system are the *reproducing* kind in Geels and Kemp's terminology – small incremental changes that make the system more efficient and more technologically advanced, such as upgrades to individual electricity transformers or the introduction of higher capacity transmission lines. This leads to relative stability within a system. A second process of change is *transformation*. Here interactions take place between regimes and the landscape level, but there is little input from niches which act as incubation rooms for technological novelties or radical new ideas and systems. In a transformation stage there could be changes to the rules, the culture of society or demands from external actors (for example the desire to lower greenhouse gas emissions). However:

> "…these outsiders do not develop competing technologies to replace the existing system. So, the survival of incumbent regime actors is not threatened, and they are the ones to enact the redirection of the

development trajectory of the existing system. In the transformation process, a new system may grow out of the old one, through cumulative adjustments in a new direction" (Geels and Kemp 2007: 445).

For a true shift from one system to another there has to be a *transition*, for example moving from a horse-drawn transport system to automobiles. New innovations that are created in niches have a window of opportunity to break through and become accepted within society. If they do, then a new stable system is created and the process is started again. Yet true transitions are difficult to achieve. Existing technical systems have various "lock-in mechanisms" that can prevent new paradigm shifts. Sunk investments in existing machines, shared beliefs and discourses, power relations and political lobbying can all contribute to the stabilising of existing regimes (Geels 2011).

Depending on the situation smart grids can fit into any one of the three change stages described by the MLP. Projects in New Zealand are focused on incremental upgrades to transmission lines to help detection of outages caused by earthquakes or freak weather conditions (a *reproduction* phase). Smart meter deployments are being rolled out across North America and Europe to provide real time energy usage information to customers in an attempt to reduce energy usage (a *transformation* phase). However smart technologies could also create a *transition* to a new system – a decentralised energy network with each individual home, business or factory producing its own electricity and interacting with the grid to sell excess power to others as needed. This shift will not just see an upgrade in technology but a radical shift in how people view their energy usage and their interactions within the wider grid.

Importantly for this thesis the MLP approach offers the possibility to examine how actors and existing discourses can influence (and be influenced by) innovation processes. As I will outline in Chapter 3 this approach allows researchers to examine the ability of various actors within a system to innovate within technological niches and to identify their actions in trying to change the rules and cultural norms in order to steer technologies towards possible acceptance. It allows researchers to explore the support (or lack of) given to smart grid technologies, the backing of powerful actors within the existing regimes and the ability for niches to break out and become normalised. By examining which technologies could break out into a new transition it could be possible to describe what impact the changes will have on wider society.

Despite the insights the work on socio-technical transitions has provided there are limitations. The definition of each of the changes – reproduction, transformation, transition – is open to interpretation, for example in establishing the start and end points for a transition (Genus and Coles 2008). Although it may be easy to establish that the adoption of a smart energy meter in a homeowners' garage is reinforcing the existing regime, when does the adoption of decentralised generation technologies become transitory? Also the MLP assumes that all transitions are beneficial, ignoring possibilities that changes could be detrimental (Shove and Walker 2007). The backlash against smart meters in certain US states suggests problems in moving from one technology to another. The framework can also be criticised for its lack of predictive ability. Although it is possible to examine when technological niches from historical case studies have occurred (although there are problems in identifying their start and end points) it is difficult to predict which technological niches of today could become the new regimes of tomorrow. This however is not impossible.

While this thesis will use part of the MLP to examine the various technological niches within smart grid projects, and how they are being promoted, the MLP is not the only framework that is being

used. While the MLP can be a powerful tool to describe transitions from one regime to another it offers little insight into the differences *within* a regime or a society as a whole, either an existing one or a transitory one. Infrastructure systems have not been rolled out universally across all environments and there remain differences in levels of provision and access within cities and urban areas, as well as within nation states. The MLP does not deal with this and cannot solely be used to examine power relations between actors within a society. To deal with these aspects this thesis will draw on the splintering urbanism framework developed by Graham and Marvin, which I will explain below.

1.4) Splintering Urbanism

What splintering urbanism can add is recognition that infrastructure provision is not equal or universal within society. While early urban planners responsible for the growth of electricity and other large networks saw the new technologies as an opportunity to unify and homogenise services to provide universal access for citizens, in reality there have always been areas with poor provision. What it can add to the MLP approach is the ability to examine power relations and structures *within* a socio-technical regime. Rather than focusing on the type of technologies that are being developed within a niche or how society and culture as a whole is shaped by infrastructure systems, the splintering urbanism theory can help examine relationships between various actors within the existing landscape and within the existing market economy. To use the theory this thesis will need to explore the roles of the public and private sectors in infrastructure provision but first I will outline the splintering urbanism theory.

1.4.1) The Splintering of Energy Networks

Until the middle of the twentieth century gas, water, transport, telecommunications and electricity networks became natural monopolies within cities and across regions and the idea of services being a public good requiring universal access was seen as a natural extension of state power. Public ownership or a private monopoly restrained and controlled with tough regulations, together with cross-subsidising price structures, would ensure universal access for consumers. The initial challenge for planners and governmental authorities was to try and standardise the competing large technical systems into services that could be homogenised and offered to all members of the public as part of plans to promote a cohesive community. As Stephen Graham and Simon Marvin write of this "modern infrastructure ideal":

> "From the initial, general picture of heterogeneous, partial networks, of poorly inter-connected 'islands' of infrastructure and of extreme, uneven development in the infrastructural capacities of different urban spaces emerged, over the period 1850-1960, single integrated and standardised road, water, waste, energy and communication grids covering municipalities, cities, regions and even nations. These were legitimised through notions of ubiquity of access, modernisation and societal progress, all within the rubric of widening state power." (Graham and Marvin 2001: 41)

Once the networks became standardised the main issue for modernist planners, at least concerning the electricity network, was figuring out how to generate enough power to satisfy the rapidly growing demand. The logic of expand and upgrade "encouraged the development of large-scale, centralized infrastructure systems of extensive physical networks drawing on increasingly distant natural resources" (Guy, Moss et al. 2001). This fits in with the MLP framework with actors seeking to roll out standardised services and universal provision across the socio-technical landscape. Supply-led solutions encouraged the building of large-scale power plants far from central population areas, with little attention given to any demand-side energy reduction strategies. The logic dictated that increasing the supply and availability of energy would encourage further economic growth. This was an age of (relatively) cheap and abundant energy sources with homes and industrial units consuming power when they needed it. Nationalised or franchised operators would generate energy in far off places and deliver it to where it was needed. Referring back to the LTS theory above, these centrally-planned networks were a product not only of the technology available at the time but also of the dominant cultural and political ideologies that existed within society. The concept of universality within society, of equal access of services to all, and the entire ethos of public services allowed for large-scale, government-financed projects.

1.4.2) The Collapse of the Modern Infrastructural Ideal

Since the 1960s various crises behind rising energy prices (such as the 1970s OPEC oil shock), as well as advancements in technology and changes in the dominant political ideology away from central planning and towards neoliberal free market economies, have led to a shift away from a modernist ideal of standardised, 'black-boxed', homogenous technological networks providing fully integrated services and a near-infinite supply of capacity, towards a more varied, liberalised, often privatised, highly heterogeneous form of large technological networks offering differing services and products to differing groups of consumers (figure 3).

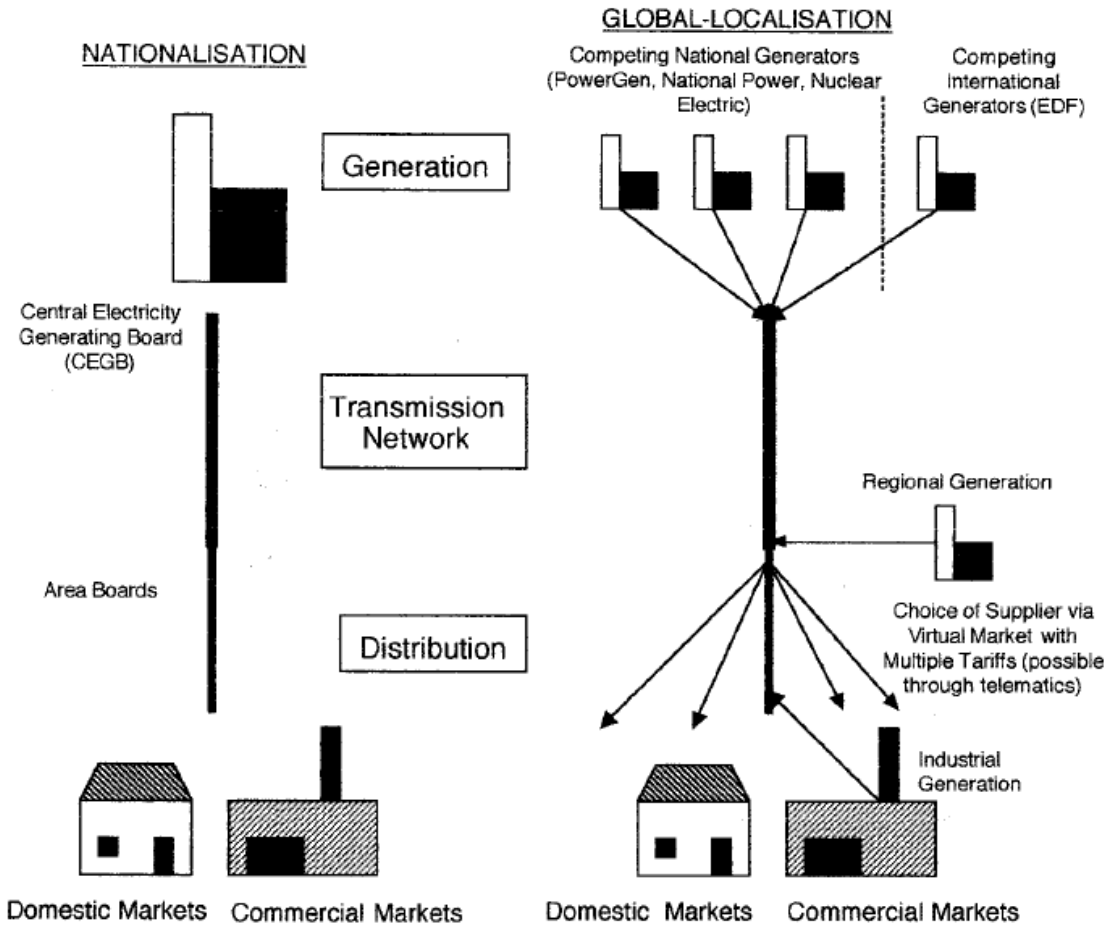

Figure 3 - Integration of the UK electricity sector (Guy 1997)

The shift has occurred in parallel to various underlying capitalist forces helping promote a form of "infrastructural consumerism" within infrastructure networks (Rutherford 2008). Consumers can now choose who their power supplier is based on cost, quality or reliability. In many western developed countries, such as the UK and USA, this liberalisation has trickled through to nearly all areas of society. As Olivier Coutard writes:

> "… from the late 1960s, this [modern infrastructural] ideal was progressively undermined by a combination of powerful factors: the urban infrastructure ''crisis"; changing political economies of urban infrastructure development and governance; neoliberalism and the withdrawal of the state; economic integration, urban competition and the imperatives of global–local connectivity; the development of infrastructural consumerism; the collapse of the comprehensive ideal in urban planning; new urban landscapes; and ''new structures of feeling"(Coutard 2008: 1815).

Recently state authorities, governmental agencies and city planners have dropped commitments to previous all-encompassing zoning plans for large city regions to provide access to all. Instead they now concentrate on smaller, more manageable and financially feasible one-off projects. They have moved from ideas of utopianism to ideas of pragmatism, from being planners to being market managers (Rutherford 2008). Graham and Marvin call this 'splintering urbanism' (Graham and Marvin 2001) . In most contexts around the globe, it seems, "politically neoliberal critiques of the

'inefficiencies' of centralised public control and ownership have fuelled a widespread wave of infrastructural liberalisation and privatisation which is still accelerating" (ibid: 91). Over the past three decades there has been a significant shift internationally in the "dominant logic underpinning service provision, from universal supply to adaptation to demand, with the increasing spatial inequalities in services that this always implies" (McFarlane and Rutherford 2008: 336). The "economic liberalisation of infrastructure and the development of new [primarily information] technologies have made possible an entirely new infrastructural landscape that radically challenges established assumptions that have underpinned the relations between integrated networks and cities" (Graham and Marvin 2001: 139).

1.4.3) The Unbundled Energy Network

Today planners do not take a universal view of how to roll out large technological networks and public services across a city as a whole. The change in cultural, political, social and economic ideologies has led to the "demise of the idea that it is possible or desirable comprehensively and rigidly to plan 'order' and 'rationality' into the form, structure and life of cities" (Graham and Marvin 2001: 92). Instead projects are done on a piecemeal one-off basis. Planners and public authorities seek private finance to fund large scale developments, and private finance will only be available if there is the possibility of a financial return. As such cities are now in competition with each other to attract outside investment. They must make themselves attractive to large multinational firms willing to invest their private capital and they must demonstrate the project can provide a viable return. Today many state authorities lack the finances (or the will) to undertake huge and expensive roll-outs of new network provision, especially in the western world post the 2008 financial crisis. Instead the maintenance of existing networks and the creation of new ones have been delegated to private companies, specialised arms-length organisations, and public-private-partnerships, allowing international private finance to invest in the world's infrastructure wherever they are likely to see a return. However this leads many financiers (often very large transnational corporations) to 'cherry pick' more affluent populations of consumers, while the less well-off are left with poorer, basic levels of services (for example relying on pre-payment electricity and water meters or pay-as-you-go telecommunication tariffs, rather than being able to use often cheaper direct debits). This has created 'bypass strategies' or "strategies that seek the connection of "valued" or "powerful" users and places, while at the same time bypassing "non-valued" or "less powerful" users and places" (Coutard 2008: 1816). As Graham argues:

> "... the diverse political and regulatory regimes that supported the 'roll out' of power, transport, communications and water networks towards the rhetorical goal of standardized ubiquity are, in many cities and states, being 'unbundled' or even 'splintered', as a result of widespread movements towards privatization and liberalization. What this amounts to is the uneven emergence of an array of what I call 'premium networked spaces': new or retrofitted transport, telecommunications, power or water infrastructures that are customized precisely to the needs of powerful users and spaces, whilst bypassing less powerful users and spaces" (Graham 2000: 185).

Gated communities cut off from their surrounding localities are now likely to be better connected technologically to affluent areas in cities around the globe than they are to their surrounding

neighbourhoods. High value localities have access to real time flows of information while in the UK pre-payment meters have allowed some utilities to "withdraw from having any direct contact with poorer users at all" (Graham and Marvin 2001: 298). What this means, as Campbell argues, is:

> "While traditional state initiated planning is no longer affordable, the radical shift to neo-liberal planning policies fails to offer inclusive models that will lead to our competitive cities, our stable communities or our sustainable development" (Campbell 2011: 15).

While more affluent consumers have seen an expansion in choice for how they access the once homogenised infrastructure networks, the less well-off are being left with the very basic services, if anything at all. While transnational corporations can compete to offer bundled services to selected affluent communities around the globe – some users can now pay just a single monthly charge for all their telephone, internet, television and electricity needs – poorer consumers are left having to rely on poorly maintained and more sporadic networks. Over the past 30 years the idea of large infrastructure networks being a universal public good has fallen by the wayside. Over the past decade previous research on the splintering city has found numerous examples across the developed world. In Stockholm the unbundling of the various networks and the privatisation of the utilities has led to urban planners losing specialist knowledge about the city – "when the energy company was split from the City, the City was also split from its knowledge" (Rutherford 2008). In Buenos Aries, Argentina, the lack of central authority control has led to the creation of a myriad of different and unique transportation and water networks with many homeowners installing their own stop-gap technologies in an attempt to create their own networks (Dupuy, Van Schaik et al. 2008). In Durban, South Africa, the roll out of information and communication technologies is less directed from a central planning authority for city-wide benefit, but more a matter "subject to deal-making and the co-ordination of vested interests"(Odendaal 2011: 2395). But there are winners in the new city landscape for residents willing to work together to provide their own services. In Berlin, a select number of homeowners and workers from the city's parks department have taken over from the water utility in managing their own rainwater collection, reducing the amount of runoff into the city sewers and lowering the local flood risk, while elsewhere in the city a number of tenement buildings have introduced their own separate water meters "regarded by the tenants as one of the most useful green technologies, because of the opportunity to reduce their water bills not available under the traditional charging system" (Guy, Moss et al. 2001: 110). However worldwide, the market forces unleashed in the infrastructure sector are leading to "quality services where demand is great and solvent, and services of lesser quality, or even inexistent, where demand is considered insufficient" (Offner 2000: 175). As MacLeod argues:

> "At the risk of generalising across the globe, the political temperament has tended to favour a withdrawal of 'interfering big government' or a 'centralising state' as discourses of 'empowerment', 'freedom', 'decentralisation', 'devolution' and, most recently in the UK, 'localism', are routinely and blithely trumpeted in political mantras at local, national and supranational scales" (MacLeod 2011: 2458).

1.4.4) Splintering Urbanism or Already Splintered?

There are limitations with the splintering urbanism theory. First, as Graham and Marvin themselves admit not "all networked infrastructures in all places are somehow moving *en masse* from an era of standardised coherence to one of splintered fragmentation" (Graham and Marvin 2001: 385). It is difficult to find a city that ever developed a fully homogenised and universal network. There have always been (and will always be) pockets of deprivation within regions that suffer from poor connectivity, even more so in the developing world. Looking at the example of Buenos Aires highlighted earlier, the city has always been splintered – there has never been a homogenised city-wide ideal. Even in the golden age of the networks when universality was the dominant ideology "variations in the quality and degree of social and geographical access to networked infrastructures remained stark" (Graham 2000: 185).

Second, as Olivier Coutard has argued the theory suffers from comparing a theoretical notion of universal service access that (nearly) existed in the developed world with the notion of unbundled provision that is occurring in low income countries without exploring the histories behind the separate network developments. Just because Buenos Aires has small enclaves of high network connectivity linking its elites to the rest of the world does not necessarily mean that the majority of citizens in the city are suffering from declining levels of service. In a low-income city that has never had universal access provisions it is difficult to assess whether residents are benefiting from neoliberal reforms. For example in Jakarta the network is not so much *splintering*, as it is already *splintered* (Kooy and Bakker 2008). In many cases an increase in competition is leading to lower costs and allowing many more residents to benefit from basic levels of service provision (Coutard 2008).

A third criticism is the absence of geography as a factor influencing the splintering of networks. Although the low cost of fossil fuels and the relative ease of consumption which enabled the modern infrastructural ideal pushed geographical constraints to the background they have never been made totally irrelevant. As the theory acknowledges past research has demonstrated that energy systems have had a huge impact on the spatial structures of urban areas. Through the:

> "long period of falling energy prices in the twentieth century the built environment has evolved, indeed has often been planned, in forms which reflect diminishing energy constraints in the transport system and the absence of concern for space-heating efficiency in predominantly low-density dispersed residential development. The result has been resource-intensive urban sprawl and increasing separation of activities in most Western countries" (Owens 1986).

Geographical constraints have never been eliminated from the concept of large technical systems. For decades consumers have been tantalised with the possibility of being able to work wirelessly and effortlessly from home with global connectivity making long-distance commuting obsolete. Time after time this has been proved wrong as large networks have never led to an end to the constraints imposed by territory or space (Offner 2000). Even the highly connected affluent areas have not seen these kinds of revolutionary changes. If anything it seems likely geographical concerns may become more prominent in future smart grid networks. Wind turbines will only be built in areas of high wind yet can attract opposition from residents objecting to ascetic impacts; solar panels will only be useful large scale in areas of constant sunlight, while energy efficiency drives could lead to higher density

urban developments compared to the suburban sprawl of the past. If smart grid technologies lead to a truly decentralised network then geographical concerns will remain on the agenda.

1.5) Research Questions

This thesis will examine the growth of smart grids in relation to the two theories outlined above. It will use a case study approach of one project – the Pecan Street Project in Austin, Texas. Using the multi-level perspective I hope to be able to examine the technologies and the systems that are being developed within niches within Austin, examining the range of actors involved and the rules and regulations in operation. It is important to examine the discourses surrounding energy in Austin and in Texas as a whole, to evaluate if certain conditions have to be met before a smart grid project can emerge. I also hope to examine if the Pecan Street Project fits into a neoliberal, free market framework as discussed in the splintering urbanism literature. The theory predicts future infrastructure projects will progress on a piecemeal project-by-project basis and financed by multinationals looking for a financial return

This thesis is not an analysis of customer responses to the technologies of smart grids on an individual level. A focus on consumers and an investigation into whether residents are willing to adopt smart technologies will inevitably lead to discussions on issues such as data privacy, the motivations of segmented customers and changing power relations within families inside the home. While these are all important issues, I did not want the focus of this research to become diluted with additional research themes that take the focus away from the larger urban arena. Diverting time and resources to studying smart grids on the micro level (within individual homes) would lead to neglecting the opportunity to examine the impact and changes on a macro level (city-wide). The time period devoted to the research was spent seeking out interviews with actors at an executive level, with the ability and power to change the direction of the smart grid research and with the potential to create impacts across the city of Austin. I did not think it would be suitable, or indeed very useful in a research sense, to seek out a handful of families and examine how they were adopting technologies on an individual level. Therefore, rather than focusing on the individual consumer this thesis instead examines how the smart grid is being constructed and implemented by the Pecan Street Project on a wider urban scale.

With this in mind, the thesis will examine the socio-economic issues, drivers and potential outcomes that surround the emergence of the smart grid. The overarching question for this thesis is:

> What are the socio-economic conditions present in an urban area that allow for a smart grid experiment to emerge?

Using this overarching research theme, and using the literature outlined above, this thesis will answer the following questions:

> 1) What conditions within the socio-economic framework are needed for a smart grid project to emerge?

2) In what ways can splintering urbanism explain the creation of the Pecan Street Project?

3) In what ways is the smart grid project affecting the socio-economic fabric of urban life?

The methodology used in answering these questions is discussed below.

1.6) Methodology

To answer these questions this thesis uses a case study approach. Like all qualitative research this thesis cannot provide a complete picture of how smart grids are impacting the political economy in all urban areas across the world and the choice of Austin as a case study could draw criticism that I have focused on a project well underway, in a high-income city in the developed world, which may have little relevance to issues elsewhere. Despite this, case studies can provide valuable insights and the "advantage of the case-study method is that it helps to reveal the importance of contingency, and shows tensions that exist within the complex workings of institutions and actors" (Tretter 2013: 2).

Criticisms can revolve around claims that the research often generates common-sense results or data in need of verification or replication (Campbell 1961). In the past it has also been characterized as a study of a single foreign setting by an outsider, often based on one-time, anecdotal, single-case and naturalistic observations (Xiao and Smith 2006).By their definition case studies require qualitative research and analysis, leading to claims they are intuitive, primitive, unmanageable, and less well formulated than "hard" scientific data (Miles 1979). Despite these limitations researchers in the social sciences still use case study approaches in their work. Yin found that use of the approach has been high and increasing over the years (Yin 2003) and is frequently found in "anthropology, psychology, sociology, political science, social work, business/marketing, organizational research, community studies, innovation and technological changes, life histories of individual or families, industrial relations, education, law enforcement, public health, planning and development, and even program evaluation" (Xiao and Smith 2006: 739). This wide application of the approach itself says something about its usefulness. Case studies allow researchers to gain a holistic understanding of issues and can examine problems from different angles and dimensions. Yin states case studies can provide valuable data on solving problems in "real life" situations. While the technologies surround smart grids are developed in laboratories by engineers and scientists, it is how people are using the technologies in their everyday lives and how they are changing urban environments that is the subject of this thesis. As a result a case study approach provides the best tool to answer the research questions and will avoid the context-free analysis which could form had I chose another research method. The case study allows for an understanding of the historical background and physical settings of the smart grid under observation and as Stoecker outlines, offers the best way to "refine general theory and apply effective interventions in complex situations" (Stoecker 1991: 109).

Once the decision had been made to adopt a case study approach, it was then necessary to find a suitable case study to research. The first few weeks of this study involved examining the variety of

smart grid projects underway around the world. Helpfully, the World Economic Forum had produced a report in 2010 highlighting the four major motivations behind smart grid developments, separating them into regional factions and outlining their benefits and challenges (table 1). Initial choices for this project rested on whether to examine a project that involved full smart grid integration (such as projects involving grid upgrades, decentralised generation and major changes to in-home technologies) or whether to examine less ambitious smart meter-only projects which, although may not represent such a major leap in infrastructure as the fully-integrated projects, still create their own challenges surrounding privacy and data collection. Comparative tables were drawn up to choose suitable projects, which are provided as appendices A and B.

Having looked at representative smart grids globally, it was decided to narrow the research to focus on three similar projects (appendix C). The three chosen for further investigation were projects in Austin, Texas; Newcastle, Australia; and Boulder, Colorado. All three projects were aiming for full smart grid roll outs, providing technological upgrades to the black-box grid infrastructure as well as increased renewable decentralised generation and new gadgets for end consumers. Although the problems surrounding privacy relating to smart meter only rollouts are important and largely unresolved, it was felt these projects represent only modest updates to the existing infrastructure system. Replacing old analogue meters with wireless digital ones does not signify a major change in the urban environment or represent significant changes to urban infrastructure. It was felt that only by examining a fully integrated smart grid system would it be possible to extrapolate the findings for future consumer behaviour.

Once the three projects for further study were identified it quickly became clear that time and cost limitations on this project would prevent an in depth analysis of all three. Spending a significant amount of time investigating the projects, interviewing those involved and reading documentary material would prove to be too time consuming for the short duration of this one-year project. The cost involved in travel and accommodation would also be prohibitive and take a significant bite out of any research budget (two projects in the US and one in Australia).

In consultation with this project's supervisors, it was decided to focus solely on the Pecan Street Project in Austin, Texas. Rather than have a three-way case study of smart grids, the time and cost constraints directed this project to focus on a single one. Although this could be seen to be a disadvantage in terms of wider extrapolation of the thesis' results and in drawing comparative themes between three varied schemes, an in-depth study of a single project would provide more insight than a brief skim of three. Initially the PSP seemed to be the most ambitious in its aims and was clear about what it wanted to achieve. What the PSP represented was a chance to redefine the energy network, turning passive consumers into active participants in the infrastructure. Reading the literature surrounding infrastructures I felt that the PSP was the project which offered the most benefits in social science research. The literature, from Thomas Hughes' work on electricity networks, to Geels' on infrastructures in transition and Graham and Marvin's splintering urbanism, all discuss the changes in urban infrastructure and I felt the PSP offered the best opportunity to understand how the literature relates to smart grids. Selecting case studies should be done on the basis of the particular research questions posed at the outset (Becker 1998) and of the three smart grids chosen for consideration the PSP offered the best chance to answer all three.

A four week period in May 2012 was set aside for the field research which involved semi-structured interviews with stakeholders involved in the PSP, analysis of policy documents and the attendance of community meetings with residents of the Mueller development. A total of 18 interviews were conducted with various executives in the organisations involved in the PSP, as well as representatives of the Mueller community and environmental organisations with an interest in the project (see appendix D). Although the community meetings were not arranged to discuss the PSP itself, attendance allowed further exploration and analysis of the discourses that exist within Mueller, and allowed examination of the everyday concerns of residents within the urban environment. Data collection via stakeholder interviews is a widely used approach in qualitative research (Mason 2006) and is an excellent way to gain data. Interviews were arranged with officials from the City of Austin, planners, representatives of environmental groups, the energy and water utilities and various other interested partners. All interviewees were provided with an information sheet describing the larger Customer Led Network Revolution (CLNR) project, of which this project is but one small part (appendix E). To ensure openness and honesty during the interviews a consent form was provided by email beforehand, promising anonymity of name to all interviewees but not of their organisation (appendix F). Helpfully the PSP's own website features a list of stakeholders involved and this was used to arrange interviews while on the ground in Austin. Several interviews were conducted via Skype with parties who were unable to attend in person. These conversations were recorded with a Dictaphone, transcribed and then analysed with the NVivo software. The texts were 'coded' to filter the various recurring themes in the data and to allow for issues to be arranged and drawn together. Examining these codes allowed me to focus the on three relevant issues arising from the PSP, which form the basis for the three findings chapters of this thesis.

Chapter 2 - The Pecan Street Project – The Discursive Politics of Energy as a Resource

2.1) Introduction

To understand how a smart grid project can break out of its technological niche and become a successful part of the infrastructure it is important to examine the social, cultural, political and economic factors that exist in wider society. What is it about Austin and Texas that has enabled the Pecan Street Project to emerge and can it offer lessons for elsewhere? In this chapter I will examine the discourses of energy and climate change that exists within Texas which offers an insight into how successful a smart grid project – designed to increase renewable generation – can be. I will then look

at Austin in particular, exploring what it is about the city that has allowed the Pecan Street to take root. To begin with though I will outline the Pecan Street Project itself, describing its ambitions and the range of actors involved.

2.2) The Pecan Street Project – An Overview

The Pecan Street Project (PSP) is a non-profit public-private partnership that has the "very modest goals of reinventing the energy system of the United States" (Planet Forward 2012). Based in Austin, Texas, the organisation is a smart grid project that is not only trying to roll out the new generation of smart meters, electric vehicles and solar panels, but also examining future business models that could be used in a decentralised marketplace. The project began in 2008 as a small start-up in an Austin coffee shop as one of many international efforts to develop the "electric internet" digitizing the national grid to monitor and manage energy usage (Copelin 2012). It is as a "bottom-up" approach to the smart grid and new technologies are being deployed in tandem with end user input. As one interviewee said, the technology needed to create a smart grid already exists but:

> "…the question is how do you get them into scale, how do you make it work, how do you reward people for using those? So for us now Pecan Street is a proving ground for the technologies and the ideas that we are going to be using in our advocacy for changing the rules, changing the market, providing new incentives, educating consumers, that can dramatically reduce the amount of all pollution, but particularly carbon pollution, coming from the electric side" (Interview, Environmental Defense Fund representative).

Unlike other projects looking at the grid from a utility perspective the PSP is examining how the smart grid can benefit energy consumers and external private companies. One aim is to figure out how to move away from the current situation where utilities make money by selling more and more energy, towards a model where customers use energy efficiently and generate their own power from renewable sources. As one interviewee outlined, unlike other projects which are trying to save the utility money, the PSP is interested in:

> "…understanding how you develop smart grid technologies that actually benefit the home owners and the business owners. How do you develop technologies that people actually want to buy? If the utility is trying to design the product, how do you know that someone is going to want to buy this and put it in their home, and get a lot of value out of it? And I think that that is the most unique part of our project" (Interview, Austin Chamber of Commerce representative).

Another respondent said the PSP differed from other smart grid projects in one key way:

> "It's not really difference in funding. If anything I don't think we have received as much funding as some as other projects. But I think what makes Austin's project so unique is that we have a different perspective on smart grids. We are approaching it from the customer perspective. Other projects, such as in Los Angeles, San Diego, Sacramento, Boulder, they are all driving their smart grid projects through their utility, so it is all utility focused. It's what benefits the utility. How can the utility save money? Or it's to avoid having to purchase additional peaking power or having to institute or implement rolling blackouts to keep up with demand. This is all utility focused. The end consumer, you know, really doesn't benefit at all. The end consumer doesn't want to see rolling blackouts, but at the end of the day whatever cost savings the utility

is able to achieve from a utility-focused smart grid programme really doesn't benefit the end consumer directly" (Interview, University of Texas professor).

So the "bottom-up" approach by the PSP is focused on how the end consumer uses energy and smart products rather than the energy utility. Are people willing to adapt their behaviour to enable high-volume roll outs of electric vehicles or large scale deployments of solar power? Are consumers willing to spend time managing their own energy usage? Are they willing to spend money on smart consumer products that incorporate market information about energy use? One university researcher, when asked about what he wanted out of the project, replied:

"…knowledge. How to develop knowledge and understand what the development of a smart grid means, and what technologies are involved and what we can learn in these different environments for power systems in general" (Interview, University of Texas professor).

While the project hopes to be able to eventually change the entire grid system its current scale is a lot smaller than that, focused on a volunteer group of 1,000 residents and 75 commercial businesses. The partner organisations involved see the PSP more as a way to "get things understood, experiments set up, information out into the public domain about what's good, what's bad and so forth" (Interview, University of Texas professor).

The project is registered as a 501(c)3 venture – a non-profit organisation under US law covering scientific research which can attract tax deductible charitable donations. Although the University of Texas provided an initial $50,000 to kickstart the project major work did not begin until the US Department of Energy provided a $10.4 million grant in November 2009 (The DoE itself was awarded $36.7 billion under the 2009 American Recovery and Reinvestment Act to develop renewable generation and promote energy conservation and efficiency schemes across the country). This grant money has been matched with $14 million from external partner organisations, mainly private companies, providing funding for research for five years (see figure 4).

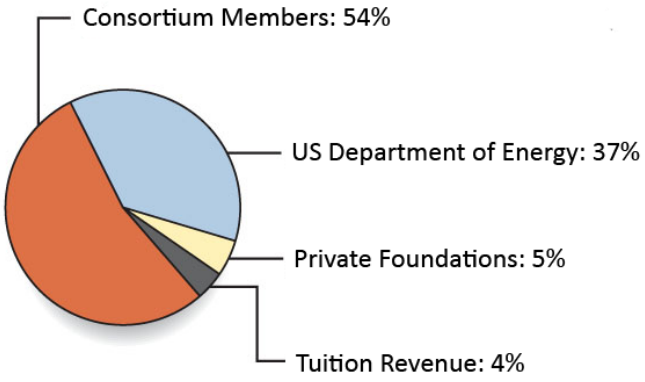

Figure 4 - Funding Sources for the Pecan Street

The PSP status as non-profit allows it to act as an arms-length organisation outside of the control of any single actor, although its founding partners still play a key role in directing research and outcomes. Six organisations have seats on the board –The University of Texas, the City of Austin, Austin Energy, the Chamber of Commerce, the benchmark-providing Environmental Defense Fund and the Austin Technology Incubator (itself a business investment arm of the university). Below this

board are a range of external companies who have provided funds and seconded staff to the project (table 2).

Board Members	City of Austin Austin Energy University of Texas Austin Technology Incubator Environmental Defense Fund Austin Chamber of Commerce		
Private Companies	**Local** Freescale Incenergy	**National** Green Mountain Energy Intel Oracle Sun Edison Best Buy Check-it Chevrolet Whirlpool	**International** Landis + Gyr LG Sony
Partner Organisations	Oncor Texas Gas Service Austin Water Electric Reliability Council of Texas Bluebonnet Electric Coop CPS Energy Pedernales Electric Coop		
Consumers	1,000 residential and 75 commercial volunteers in Austin's Mueller neighbourhood.		

Table 2 - Organisations involved with the Pecan Street Project -

The combination of local Austin-based companies, national US corporations and large multi-nationals was an intentional part of the project's initial setup. As one interviewee said:

> "…we had some other companies that wanted to be corporate partners, but either couldn't meet the criteria that we set or we just thought it would be unbalanced. We didn't want to have too many Austin companies; we wanted to have some national companies" (Interview, Environmental Defense Fund representative).

Several respondents outlined the relationships they had with colleagues and other groups as being fundamental to the formation of the PSP. One said:

> "…when we formed the coalition of Pecan Street, and I mean it arose first of the idea of a councillor, he came to me, we got the utility and the city involved early on, brought in the Chamber of Commerce and the university, and then Environmental Defense Fund, and Austin is a very environmental city, a lot of environmental organisations, so there was a very close fit, we all knew each other well, we all worked with each other for a long time, before Pecan Street was formed. There were already relationships formed and for the right purposes" (Interview, University of Texas professor).

The sense is a city with lots of revolving doors between the various organisations, both public and private, involved in economic and environmental development. One key attraction for external

partners is the ability to test new technologies and products in a working grid environment with Austin Energy allowing companies to use the grid as "sort of a platform" so they can "play around and test out new technologies". One home in Mueller, the test bed community built on a redeveloped former airport (see chapter 4), is being used as a test home for various products. Five different home energy management systems are in use, along with three different setups for charging electric vehicles and numerous gadgets. A press release calling for private partners to develop their own technologies explains:

> "For smart grid to be truly transformative, the magic has to happen inside the house, and that's where we're going to focus our attention," said Pecan Street Project executive director Brewster McCracken. "We know that utility-side improvements will play an integral role in solving major energy, economic and environmental challenges. But customer value can't be an after-thought. Instead of imposing solutions on customers, smart grid must address these challenges by creating products and services that customers will value and voluntarily adopt" (Pecan Street Inc 2011).

Aside from redesigning the energy grid, one key goal of the PSP is economic development. Austin has a history of high-tech research consortiums going back to the 1980s (see below), with the public and private sectors working together to create products that can be competitive internationally. In some areas, the PSP is an economic strategy for the City of Austin, with board members hoping companies will be created in the city to take advantage of the high-tech economy, while existing multi-nationals will relocate to Austin, providing jobs and a boost to the tax intake.

Although the project is still at an early stage, university researchers have already discovered key facts about the deployment of solar panels in the sun belt of North America. Although south-facing solar panels produced more power over a 24 hour period:

> "…it didn't actually produce power when you really needed it. Because here in Texas peak demand is actually later in the afternoon, say 3pm or 4pm until 7pm or 8pm. South facing solar produces power when the sun is directly overhead. That's when it peaks, about noon, mid-day. The west facing was actually more valuable. It produced less overall power, but it produced more power during the hours it was needed. So that was another big discovery that has come out of this" (Interview, Austin Chamber of Commerce representative).

One respondent summed up the PSP as:

> "…a proving ground for the technologies and the ideas that we are going to be using in our advocacy for changing the rules, changing the market, providing new incentives, educating consumers, which can dramatically reduce the amount of all pollution, but particularly carbon pollution, coming from the electric side" (Interview, Environmental Defense Fund representative).

The PSP therefore is a smart grid involving a range of organisations from the public and private sector trying to test new technologies that can be sold to the public. Unlike other smart grid projects the PSP is not forcing smart meters or other energy saving devices on to end users. Instead the hope is that consumers will *choose* to buy smart technologies, and this in turn will lower demand, reduce carbon emissions and increase efficiency. To understand why it is important to examine the discourse that exists within Texas, both in terms of what energy is, and the importance of free markets and the consumer experience. In the rest of this chapter I will examine the discourses within Texas and Austin and explore how they have shaped the PSP.

2.3) The Energy Discourse of Texas – Energy as a Resource, State Isolation and Markets over Mandates

To understand how a smart grid project can be successful in the US it is important to look at the current discourse surrounding energy and its use in wider Texas. Geels argues that actors operate in the context of rules and regulations, and these are defined by institutions and organisations (Geels 2004). New infrastructure systems will only emerge if the surrounding socio-economic climate is favourable and economic and political discourses are pivotal. In terms of energy and smart grids it is important to examine the discourse on resource extraction, energy generation, efficiency and perceptions on climate change, which could all influence take-up of smart grids. Perceptions of new technologies are constructed not just through their technical and economic potentials, but also through the prevailing discourse or "through compelling narratives about what a technology is, what a technology might become and why it is needed and preferable to competing technologies" (Feldpausch-Parker, Chaudhry et al. 2011: 6369). This is especially true in the stage prior to commercialization when efforts are focused on research, development and demonstration, as is apparent within the PSP. But what are discourses and how can we examine them within the energy and environmental sector? Hajer defines a discourse as "a specific ensemble of ideas, concepts, and categorizations that is produced, reproduced, and transformed in a particular set of practices and through which meaning is given to physical and social realities" (Hajer 1995: 60). Discourses are not simple single-issue concepts that can be identified immediately, and identifying a discourse is not an exact science. Many, especially those concerning environmental issues, are "inherently contradictory and ambivalent" (Hajer 1995: 23). People may feel strongly about climate change and voice strong objections about greenhouse gases, but may not be prepared to pay extra to use renewable energy, or switch from the ease of the car to more environmentally beneficial forms of public transport. As I shall outline in Texas residents are reluctant to believe in anthropogenic climate change yet are supportive of the huge growth in wind power. This thesis cannot begin to explore the rise and potential success of the smart grid without examining the social and political structure that exists around it. It cannot be explored without an investigation into the politics that allow a wide variety of actors to pursue highly diverse interests as part of the "smart grid" project. In this section, I will explore the discourse of energy and free markets within the state of Texas.

2.3.1) Texas Politics – A Red Sea of Republicanism

To outsiders Texas is a deeply Republican state. Famous for its oil wells, cowboys and animosity to the federal government Texas seems an unlikely place for a revolution in renewable energy. One respondent described Texas as having "its own kind of image and perception outside, especially globally. It's perceived as an oil and gas state, it's perceived politically as right leaning, conservative. It's the home of George Bush" (Interview, Austin Chamber of Commerce representative).In the 2008 presidential elections the state maintained its status as a sea of red Republicanism (figure 5).

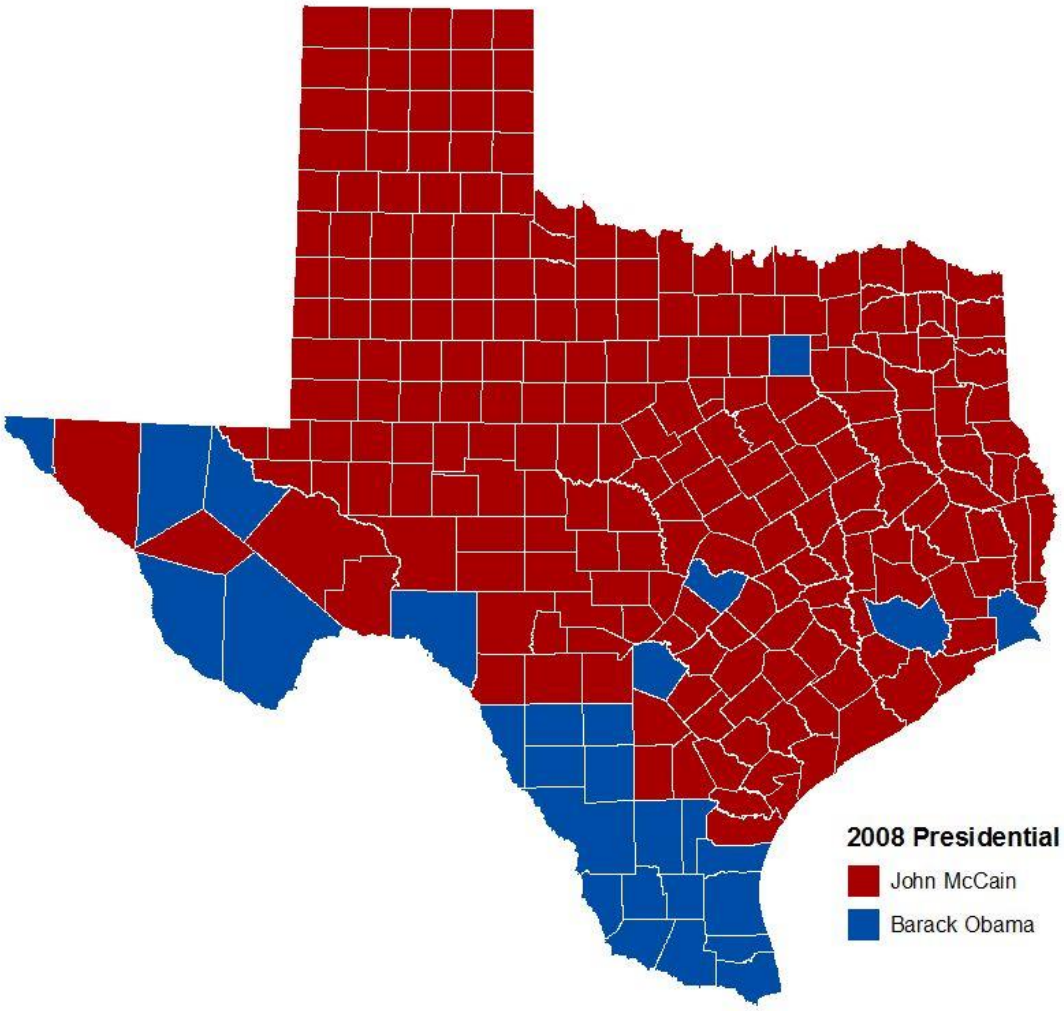

Figure 5 - Texas 2008 Presidential Election Results (Stiles 2010)

Yet this risks oversimplifying politics in the state. Republican John McCain won 56% of the vote, compared to 44% for Democrat Barack Obama (Texas Secretary of State: Elections Division 2012) and while a Democratic presidential candidate has not won the state since Jimmy Carter in 1976 the party does have a foothold in the major cities and the area bordering Mexico (populated by large groups of minority voters). Austin, the state capital, is a Democratic-controlled city. Houston and Dallas are more conservative, yet most mayors in the major cities are affiliated to the Democrats. Julian Castro, the Democratic mayor of San Antonio, is seen as a rising star in the party and a potential presidential candidate in 2016 or 2020 (Pilkington 2012). So while Texas is strong Republican territory as a whole the Democrats have pockets of support in the major population centres.

To understand politics in Texas, it is important to realise that politicians in the United States do not attempt to curry favour with voters from the centre ground as in many European countries. The discourse nationally gravitates towards the extremes at both ends of the political spectrum and Texas is a prime example of how polarised the political culture has become. Texans are happy to wear their political beliefs with pride as “badges”, happy to demonstrate that they a Democrat or Republican. As one interviewee noted:

> "Moderates are going away in this country. That goes for anything. We have the most obese people and some of the fittest athletes in the world. In Europe more people are just moderate. It goes for all types of things, these fundamental Christians, along with radical atheists here. It's always 'I am this'" (Interview, senior PSP architect).

Describing a study which gave residents information on their energy usage compared to the neighbourhood as a whole the respondent continued:

> "…but this study, depending on the political affiliations, people would see what their averages are and in liberal neighbourhoods they would compete to see how little energy they could use. When they showed it to conservatives it was "I'm going to burn up more energy". That's a whole other complex political thing. That, to me, is testament to how crazy this country is" (Interview, senior PSP architect).

The polarisation in the politics of Texas extends into its economy. Texas is a huge oil and gas producer, yet is also at the forefront in wind energy in the US with some of the largest wind farms in the world. In this section I will outline the importance of energy as a resource to the economy of Texas, examining the use of fossil fuels and what has allowed the growth in renewable energy.

2.3.2) The Energy Landscape of Texas

Texas has a history of being an energy-rich economy with huge reserves of oil and gas. Until diversification in the 1980s resource exploitation dominated the economy (Zarnikau 2011). Although the first oil well in the US dates back to the 1860s the boom in Texas production did not get underway until the Spindletop discovery in 1901. Since then Texas has maintained its position as one of the world's largest producers of oil and gas. Since its peak in the 1970s oil and gas production has declined by 50% and the state became a net importer of energy in the 1990s (Texas Comptroller of Public Accounts 2008). Recently new technologies and a shift towards hydraulic fracturing techniques have led to a new boom in fossil fuel extraction. "Fracking" has allowed oil production in Texas to climb above one million barrels a day for the first time since 2001 (Landers 2012). Production of shale gas is also increasing rapidly. In 2009 production had risen to 1,789 billion cubic feet or about 57% of all the shale gas produced in the US that year (Rahm 2011). Politically the state is heavily pro-drilling, supporting both oil and gas extraction. Some states in the US have moved to legislate and control shale gas drilling within their jurisdiction yet the regulatory and political climate has prevented any similar action in Texas. Fears over the effect on the economy, along with opposition to any programmes intended to tackle global climate change, has put the state at odds with federal regulators. In 2010 Texas was the only state to refuse to enact the Environmental Protection Agency's rules covering greenhouse gas emissions. Several states have joined Texas in suing the EPA for its policy, but Texas is the only one that has refused to implement the federal regulations as not only do "top Texas elected officials deny the scientific basis for regulating greenhouse gas emissions" but they are also worried that the rules "will harm Texas' dominant fossil-fuel industry" (Michaels 2010). Although just 2% of the state's workforce is employed in the oil and gas industry – 224,200 workers were employed in exploration and production in June 2011 – some sources claim as much as two-thirds of job creation through 2010 and 2011 could be tied directly and indirectly to the oil and gas business (Fowler 2011). Aside from employment the state benefits from tax receipts from the exploitation of its resources. Around 30 years ago gas and oil

production amounted to 24% of state tax collections and although the economy is less tied to the industry today, oil and gas production is soaring. Some commentators have talked about an "Oil Boom 2.0". In West Texas a huge growth in shale oil and gas exploration has created an economic boom boosting "every job category, including construction, trade, hospitality, and business services (Schnurman 2012). Describing the recent boom in the West Texas Permian Basin oilfields Schnurman wrote:

> "Oil production in the Permian grew 8.5 per cent from 2009 to 2011, according to the state. But drilling permits soared from 3,369 to 9,347 over the same period, an indication of what's to come. As producers find better ways to get rich oil deposits, they're pumping in more money and personnel. Approach Resources of Fort Worth has nearly tripled its capital budget in the past two years, from $90 million to $260 million. It has boosted spending plans twice since late 2011 for opportunities in the Permian. FTS International, another Fort Worth company that provides hydraulic fracturing services, has been moving its pressure pumping fleets to Odessa. The company said its Odessa workforce has grown 68 per cent in the past year" (Schnurman 2012)

Texas it has also seen major growth in its wind industry. In 2006 Texas overtook California to become the number one producer of wind power in the country with a quarter of all US wind capacity. More than 40 projects in the state generate 10,377MW of wind power (American Wind Energy Association 2012). It has three times as much wind-capacity as the next-closest state Iowa (Texas Tribune 2012). Nolan County, West Texas, is home to some of the largest wind farms in the world. If it were classed as a separate nation, it would rank sixth in terms of wind energy production (Reed 2008). The growth in wind power has led to massive boosts to surrounding economies. The tax base in Nolan County has grown from about $500 million in 2000 to $3 billion today (Hanna 2012).

How has Texas achieved this? Seen by outsiders as a primarily oil and gas state, populated with ranchers, climate-change denying politicians and with a mentality at odds with federal government, Texas has seen remarkable growth in its renewable energy industry. There are many reasons for this transformation. First, the state has very strong private property rights. As Swearingen describes:

> "In a capitalist economy, and especially in Texas, land is property. Property has monetary value, and in Texas, property ownership is seen by most as sacrosanct, conferring on its owner a God-given right to make money" (Swearingen 2010: 1)

This allows land owners to build wind farms without concerns over visual aspects as experienced in the UK. It is seen as being their land so, within reason, they can build whatever they like. Neighbours may not like the look of huge turbines spoiling their view but many people feel it is not their place to voice their concerns. A second issue is a desire to reduce dependency on oil and gas imported from abroad. Although the state is again experiencing an oil boom for many years production has been in decline, forcing consumers to rely on imports. As one commentator described the growth in renewable energy:

> "When asked why the Texas renewable energy program has been so successful, McCoy said, in his comfortable Texas twang, 'the one big thing is everybody is ready to go for this renewable energy stuff, and reduce our dependence on foreign oil'" (Upham 2010).

However I want to focus on two other reasons for the growth in renewable energy. Firstly, the Texas grid is isolated from the rest of the US, allowing easier experimentation for utilities. This, coupled with a highly deregulated energy market has allowed companies to develop and test new renewable

technologies under just one legal framework, with the rules and regulations of a single state, rather than having to deal with complex cross-state and federal laws. Secondly, wind is seen as just another energy resource that can be exploited by entrepreneurs, similar to oil and gas. It is seen as a tool that can be used for economic development. The debate is focused on cost, and although wind is subsidised by federal government, for the consumer it does offer a cheap source of electricity and for landowners with turbines on their land it is another source of income. Smart meters have been presented in a similar way and described as a "cash register" for energy use, thereby playing down concerns over privacy. I will explore these issues below.

2.3.3) The Texas Grid – An Isolated Experimental Lab

Historical institutions and interests are an important part of any discourse. They are products of previous discursive interactions and provide the context for new discourses to emerge. In Texas the setup of the electricity grid is critically important to its current success in renewable energy. One reason is the isolation of the grid from the rest of the country (figure 6).

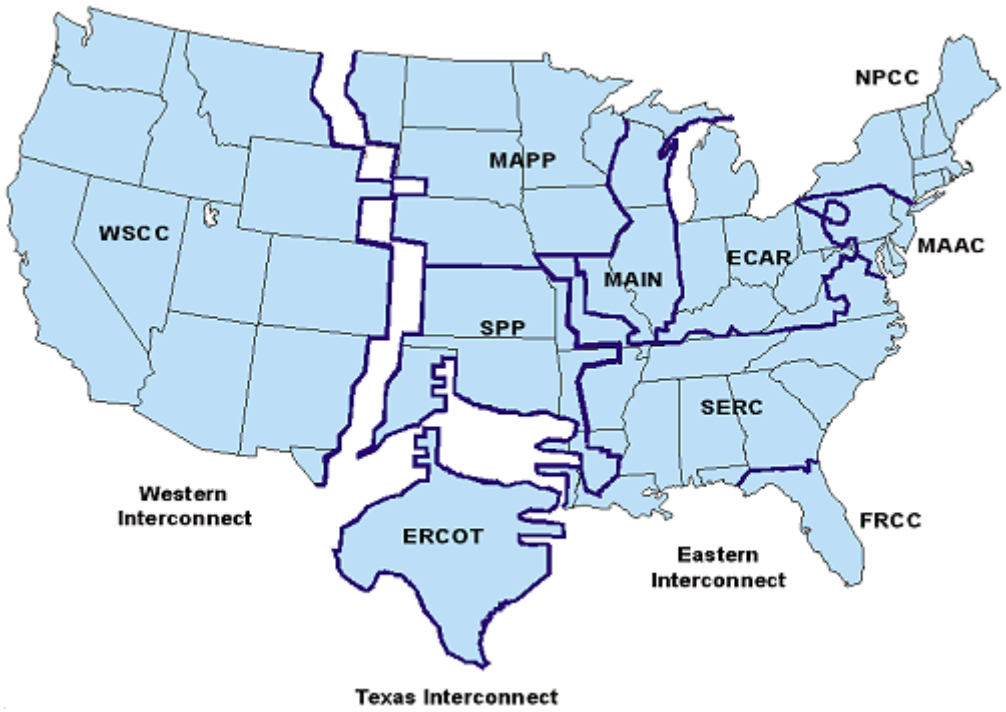

Figure 6 - The US Power Grid (US Energy Information Association 2000)

With utilities and power providers operating almost exclusively within the borders of Texas they avoid regional conflicts over who pays for the long-distance transmission lines for renewable energy – in Texas all customers share the cost equally (Behr 2010). Traditionally about three quarters of the electricity usage in Texas were satisfied by utilities that were members of the non-profit corporation ERCOT, or the Electric Reliability Council of Texas. ERCOT was originally created in 1970 to maintain the reliability of service by encouraging transmission interconnections, coordinating planning and

facilitating the transfer of power among utilities during emergencies. ERCOT however was not considered to be a government entity that exercised state power but rather a voluntary membership organisation made up of the various utilities operating in Texas. The US does not have national laws that constitute a competitive wholesale and retail market model. Energy policy is largely left to the individual states. The lack of any overall national agenda has led to small utilities operating discretely in their own franchise area with little incentive to branch out and join a wider grid. Across the US only a few states had "established formal investment planning criteria or operated a formal investment planning process, relying instead on utilities to do so under the general legal obligation to provide safe, reliable and economic service to retail consumers" (Joskow 2005: 98).

The first waves of deregulation in the energy market came in 1978 when congress adopted the Public Utility Regulatory Policy Act (PURPA) which to a limited degree allowed competition in the generation of electric power (the airline industry was deregulated in the same year, closely followed by the telecommunications industry). This deregulation was largely an extension of previous policies allowing states to develop their own energy policies. Before PURPA there were effectively no unintegrated independent power generating companies in the US. The Act required utilities to buy power produced by certain Qualifying Facilities (QF), primarily cogenerators and small power plants using renewable fuels, making it possible for large, non-utility companies to enter the electricity generation market. The 1978 act, along with tax legislation which allowed tax rebates for investments in renewable energy, led to a so-called Californian "wind-rush" in the early 1980s (Est 1999). By the 1990s these "non-utilities" accounted for 10 per cent of total US generation (Joskow 2005: 8).

The progression in energy deregulation stalled in much of the US following the fallout of the Enron scandal in California, where it was revealed rolling blackouts were the result of a poorly designed market system being manipulated by traders. Texas, however, was not phased. The state continued with its plan to open the wholesale electricity market, initially started in 1995, enhanced in 1999, and with retail completion in 2002 (Zarnikau 2005). One reason why deregulation has proceeded at such a pace is the isolation of the Texas grid. As a result of its isolation, as Texas officials describe it, "the utilities within ERCOT are exempt from most federal regulation, making the Texas energy market a straightforward market in which to do business" (Perry 2012). This has allowed the creation of an "intra-state" market with little federal oversight and has permitted the Texas market to adopt policies and market features that diverge from other markets (Zarnikau 2011). Today the Texas market is one of the most competitive in the world.

As part of the restructuring process Texas adopted a Renewable Portfolio Standard (RPS) to encourage renewable generation in 1999. The original goals were modest, initially calling for the installation of 400MW of renewable capacity by 2003, rising to 2,000MW by 2009. This goal was met in 2005 and today total renewable generation (mainly wind) is more than 10,000MW – a target that was not due to be met until 2025. Under the Texas scheme, utilities are mandated by law to buy and use certain levels of renewable energy from the competitive open market. This mandate created an immediate demand for renewable generation although suppliers were not guaranteed monopoly power. They had to compete with each on price. At the time a number of studies suggested investment in renewables would "decrease retail electricity rates over time by reducing natural gas demand" (Byrne, Hughes et al. 2007: 4568) and therefore renewable generation was incorporated into the newly deregulated energy market right from the outset. However wind power in the state

proved so inexpensive that demand quickly exceeded what the law required, fuelling a voluntary market in renewable energy that is now larger than the mandated market (Hurlbut 2008). The system has been so successful in creating a market for renewables lawmakers are discussing removing the mandate entirely by 2015. Today the main problem in further growth of wind power is the lack of transmission lines to get the energy from sparsely populated West Texas to the main population centres in the east (Upham 2010). In 2009 a $5 billion programme to improve transmission was launched. Looking at the huge growth of wind power in Texas Zarnikau argues:

> "…the state's policies must be viewed as a success. Goals have been met and Texas has become the national leader in wind power production. And this success demonstrates that goals for renewable energy development efficiency can be successfully achieved within a competitive electricity market structure" (Zarnikau 2011: 3912).

2.3.4) Resource Exploitation for Energy-Based Economic Development

Tied in with the success of the deregulation of the energy market to allow renewables to flourish, the Texas energy discourse revolves around a pro-wind yet anti-environment theme. As one opinion writer argued this fact:

> "…flies in the face of conventional logic. How is a state steeped in oil and gas, and run by climate-change denying politicians, spearheading some of the largest renewable energy developments in the US?" (Head 2011).

One key reason for the huge growth in wind power is down to how proponents of renewable energy have adapted their strategies to cope with the anti-environmental beliefs that exist in large areas of Texas. Rather than promoting wind power as being beneficial for the environment and to reduce carbon emissions, tactics have switched to highlighting the financial benefits for various stakeholders. West Texas has vast tracts of scrub land that are unsuitable for agriculture, isolated from large population centres yet with some of the best known wind resources in the world – the ideal location for wind turbines. One respondent described it as:

> "…a place where you can put a few cattle on the land and not much else. And unless you have oil, and even if you do have oil, the wind doesn't detract from that. It's just cash to them. There are different sales tactics to that group of people" (Interview, University of Texas professor).

Another respondent, who was involved in the spread of wind power in West Texas, added:

> "…the state legislature is conservative and dominated by the rural areas, but you suddenly got the ranchers and farmers to realise that there was money out there, so they convinced them to, you know, we can make a buck out of this, and I don't care about the environmental issues, and we are suddenly a national leader now… environmental groups are trying to do the same with energy efficiency. In Kansas for instance, there is a strong energy efficiency organisation, but they never mention climate change or the environmental benefits or anything. It's you can save X number of dollars if you change your light bulbs" (Interview, former Austin Energy executive).

Texas discourse on energy and environmental issues is largely what Carley et al describe as "energy-based economic development". Policy makers have been hugely successful in shifting the debate away from environmental concerns and towards economic ones. As Carley et al note:

> "…framing energy reform on economic development grounds makes energy policy inherently less partisan and more politically feasible—rarely do policymakers contend that economic development is an ill-advised objective, but energy for the sake of climate change mitigation or reduced dependence on foreign fossil fuels is not as universally accepted. Furthermore, efforts framed in economic development discourse obviate the need for policymakers and their constituents to agree on which of the many energy or climate change challenges are most threatening; such framing instead provides a platform for energy reform that has the potential to address multiple issues simultaneously, but with the least political tension" (Carley, Lawrence et al. 2011: 285).

This partly explains how some of the most prominent anti-environmental politicians in the country are overseeing the greatest renewable success story in the US. What should be a contradiction has become possible because of the views that wind energy development equates to economic development. While discussions surrounding environmental benefits are largely dropped from wind projects, their financial impacts are brought to the fore. One report suggests 4,100 full-time jobs were supported during the construction phase of several wind farms in four counties of Texas – 58% of the total jobs created. The report claims the total economic benefits reach more than $1.8 billion, or $1.3 million for each installed MW (Slattery, Lantz et al. 2011). A New York Times article on a quirk in Texas tax law sums up the energy-based economic development discourse perfectly:

> "Behind the 1930s-era facade of the Blackwell school 30 miles south of Sweetwater looms a distinctly 21st-century sight: a wind turbine. Energy development capitalizing on the high winds in the area — which quickly turned sunshine to chill rain one afternoon in late October — has injected sluggish rural communities with new economic lifeblood. More than one local resident has called it the "windfall," and it has bestowed hundreds of millions of dollars on West Texas schools. By the 2018-19 school year, Mr. Gott's district will have received about $35 million from a deal it brokered with a wind farm company in 2005. On the school grounds, $15 million from a combination of bond and wind farm revenue has paid for a new football stadium and academic complex attached to the original school building. About $28 million sits in a foundation earmarked for scholarships; graduates receive $3,000 for each year they have spent in the district, which they can put toward any type of professional advancement, from a beauty school certificate to a bachelor's degree. The influx of wealth has also enabled the district to buy an iPad for every student, starting in the seventh grade" (Smith 2011).

No mention is made of the environmental impacts, whether on local pollution or on global climate change. This energy-based economic development discourse extends to the development of smart grids in Texas. As I will outline in chapter 3 a key objective of the PSP is for economic growth within the city of Austin. The project is seen as a way to attract international finance to invest in the city. But smart grids in the state are also seen as a way to expand and capitalise on the local development of wind power. Some of the larger wind farms are in the isolated areas of west Texas – far from the major urban centres. The upgrading of the grid infrastructure is needed to connect this resource to the major markets. Wind is also not a stable or reliable source of energy and with so much of it being generated in Texas – wind can now generate a quarter of all Texas' energy needs (Marshall 2012) – the new storage and demand response technologies offered by smart grid proponents become an attractive proposition. Yet the discourse surrounding smart grids is still focused on economic terms,

rather than environmental. This shift away from concerns over the environment is deliberate and largely a response to the extreme politics in Texas. As Marshall (2012) argues Texas is:

> "A state where attitudes to climate change are a mark of cultural identity, where the political economy is still inextricably bound to fossil fuels and yet there is a raw economic drive that offers the hope of a rapid transition to new fuels. There is no shortage of concern about climate change in the liberal enclaves of Austin, or outright denial in the Republican heartlands. One old lady, coming out of a Baptist church in Houston, told me that she had "prayed for wisdom" and now knew that climate change is 'a Marxist plot by the Muslim terrorist Obama to impose one world government'" (Marshall 2012).

Large parts of Texas remain sceptical about climate change and are suspicious of attempts to switch to renewable energy use for environmental reasons. A series of studies have found that landowners with turbines on their land reject any attempt to label them as "green". Jepson et al found these wind producers actively rejected attempts to describe themselves as promoters of green technology:

> "Even though many respondents were pivotal in bringing wind energy to Nolan County, most respondents did not want to be associated with the label of being environmentalists" (Jepson, Brannstrom et al. 2012: 855).

Instead they "rejected the pledge" of going green and saw wind power in terms of the economic benefits only, either through federal subsidies to promote wind power or through land rents paid by the utilities. Even though many large landowners may reap economic benefits from siting large wind farms on their land, they still take pride in driving their SUVs and care little about global climate change. As a BBC reporter noted from Sweetwater – one of the largest wind farms in Texas – in late 2009 on the eve of the Cancun climate talks "the people at the heart of one of the largest ever booms in clean energy see plenty of benefits – except the one of avoiding greenhouse gasses" (Jepson, Brannstrom et al. 2012: 851). A second study examining energy discourses in Texas and Iowa found that:

> "…arguing for more renewable sources of energy based on reducing our carbon footprint (and, by extension, mitigating against climate change) would be far less persuasive in these communities than simply approaching it from the perspective of wind being a clean and safe source of energy" (Slattery, Johnson et al. 2012: 3697).

The environment is an important issue for just 1% of Texans (University of Texas 2013). Yet to one University of Texas professor this ambivalence about adopting technologies to reduce greenhouse emissions is almost a good thing. As he noted "you can put green technologies in Texas because we care so little about the environment" (Interview). Wind is seen as a resource which can be exploited by Texans, similar to oil and gas. Promoters of wind energy have used this discourse well. As one respondent outlined:

> "…if you look at the public discourse here, particularly in Texas, and this is the one thing that makes wind particularly bizarre, is that if you used greenhouse as an argument to the policy makers, to encourage wind, not only will you get nowhere, they would prevent it happening. So wind has been sold as rural development, it's helping these West Texas farmers, it's being sold as apparently cheap energy – it's cheap because they get federal subsidies for it – whatever, but not on the basis of greenhouse" (Interview, former Austin Energy executive).

A study on discourses surrounding Carbon Capture and Storage technologies found respondents were mainly motivated by the political and economic justifications, with little interest in any environmental benefits (Feldpausch-Parker, Chaudhry et al. 2011). Any environmental benefits are seen simply as an added benefit rather than a key driver. Yet within these rollouts and the development of wind power there is a glimpse of an environmental narrative being seeded into the existing discourse framework. According to Hajer's theory on discourse coalitions actors with diverse motivations and beliefs who engage on one level can come to a discursive agreement on another level "even despite potential incoherence and incongruence between specific disciplinary discourses" (Elgert 2012: 297). While many farmers may support the development of wind power for financial reasons, they have to also engage, albeit even subconsciously, in the environmental debate. As one environmentally aware interviewee described:

> "…you don't have to convince them to do the right thing for your reason. And the way I like to do it… I do it for environmental reasons; we have the word environment in our name. So let's do these things for these reasons, here are the benefits, oh and by the way, at no additional cost you get low carbon electricity. There was a pilot for smart grid work in Oklahoma that I really like, that used both the personal economic argument and the environmental argument to get people to sign up. And the total is greater than the sum of the parts. More people signed up for purely economic reasons than environmental, but together… getting both was more than the two added together. And so what they did was, we guarantee if you do this programme you will save money, and by the way we won't build a coal plant. So you can be selfish but also part of a community simultaneously" (Interview, Environment Defense Fund representative).

While most customers are signing up for economic reasons there is a belief that environmental concerns do play a part and by subtly introducing people to reduce their energy use and become aware of their consumption there is a hope that people will start to become further embedded into wider environmental and community goals. Although Texans may care little about global climate change, or even deny the science behind it, they do care about *local* environmental pollution. A 2010 study in northern Texas found that although just 33.8% of people believed the use of fossil fuels is detrimental to the environment and 58.4% had concerns over global climate change, more than 93% of respondents felt protection of the environment was very important with water conservation important for 95.4%. The "results show an overall concern for the environment but less concern with issues related to climate change and use of fossil fuels" (Swofford and Slattery 2010: 2518). Economic factors were also important for respondents with only 34.5% of people willing to support renewable energy if it cost more than fossil fuels.

2.3.5) The Growth of Smart Meters – A Cash Register for Electricity

The success of wind power is largely a result of financial arguments based on an energy-based economic development discourse. Strategies to promote smart meters in the state have followed the same model. While some cities and states in the US have seen a huge backlash from customers opposed to the new meters – concerns vary from health scares, to rocketing energy bills, and issues around privacy – customers in Texas have been more compliant. One respondent put this down to the framing of the debate:

> "…I think it was articulated in Texas better that this was a cash register for electricity. And I think just by labelling it like that, you head off some of the, I suspect, privacy-based concerns that might have been in place in California. Those privacy-based concerns might have been bigger in California though, but I think that by emphasising this is a 21st century cash register for electricity it is easier to sell" (Interview, University of Texas professor).

In Texas there is deep animosity towards the federal government. In June 2012 the Republican Party released their party platform, promising "protection from extreme environmentalists," protecting health care from "government intrusion" and the promotion of "life origins and environmental change" being "taught as challengeable scientific theories subject to change as new data is produced" in schools (Republican Party of Texas 2012). As a result the debate over smart technologies fits into the same discourse – this is not about saving the environment, this is about economic development. Similar to wind development, smart meter rollout has been relatively successful with little backlash from consumers. Oncor Electric Delivery has rolled out three million smart meters across North Texas. CPS Energy has 40,000 in San Antonio, Houston-based Centerpoint Energy has two million and Austin Energy has rolled out around 400,000 meters. Yet the only privacy issues raised by consumers are by those with animosity towards any type of government interference. As one respondent said:

> "You have to think about what America is made up of. It's full of people who were all immigrants who wanted to break away from some system and seek their own path. They all thought, I don't want to be a part of this, I want to get away. And so a lot of that mentality still persists. I don't want to conform to government standards. So it's somewhat wired into the way America is built" (Interview, PSP architect)

Another respondent expressed surprise when questioned about the lack of anger over privacy issues:

> "I think that's true. That's a true assessment. Now exactly how they managed to do that I don't know, because you would usually expert Texans to be more unhappy about a mandated thing" (Interview, University of Texas professor).

In summary, Texas is a state with an anti-federal political discourse. It is highly energy dependent with huge reserves of oil and gas. Its grid is one of the most deregulated in the world. The infrastructure is separated from the rest of the US allowing relatively easy access to new market entrants and creating opportunities for experimentation. The regulatory system, as well as the shift from an environmental discourse over renewable energy towards energy-based economic development has seen huge growth in wind generation, while the introduction of smart meters has been easy and successful. Within this we have the city of Austin and the development of the PSP. Although politically more liberal than Texas, Austin is still influenced by the pro-market, anti-federalist stance of its surrounding neighbours. Views on energy still revolve around cost and the promotion of smart grids has adopted this as a strategy. However it is more environmentally aware and the energy discourse, while still seeing energy as a resource, gravitates more towards ecological modernism, which I will explore below.

2.4) Austin – An Island of Blue in a Sea of Red

While Texas as a whole seems to be deeply Republican with politicians doubting the science of climate change and any form of state intervention the state capital Austin seems to have more in common with coastal Democrat cities than with the surrounding state. It has a Democratic mayor, a burgeoning high-tech economy and a young population. In many ways it can be described as the polar opposite of its surrounding state.

2.4.1) Austin as a "Unique Animal"

Several interview respondents spoke about how they felt Austin was a "unique animal" which was isolated from its surrounding Republican neighbours. They felt there was an open-mindedness amongst residents who were more willing to adopt green technologies and embrace the need for energy reduction. As one respondent captured it:

> "Austin is this weird little city in Texas that is actually almost completely opposite to how the rest of the state functions. It's a very tight knit community. Politically its very left leaning, one way the people refer to Austin in a political sense is it's the blue island in the sea of red. It's really unique in that sense. Here in Austin we have all these tag lines that we have given ourselves. We have one that says 'Keep Austin Weird' because it's kind of a weird interesting place with different types of people, different walks of life. It's really a melting pot of people. I think what really drives it is the University of Texas, which has brought a lot of talent and students and researchers and all different types of stuff to the city and a lot of people end up staying here, so we end up getting a lot of people from California, a lot of people from Asia and Europe, all coming to Austin. And then also it's the capital of the state so all the politicians from across the state, whether conservative or liberal, Democrat or Republican, they all have homes here. So that makes Austin a very unique animal" (Interview, Austin Chamber of Commerce Representative).

Respondents felt Austin differed in how residents were open to new projects and green issues compared to the rest of Texas. In describing the Mueller district one respondent said:

> "…the type of people and the families that are living at Mueller are kind of a different type of people, or people that think differently. These are typically younger families, a lot of them work in the high-tech industry. The vast majority of them are early adopters of technology. They are very open to opening up their house and giving us access and helping us test out all these technologies" (Interview, PSP executive).

Part of the willingness to participate comes from the visibility of various green schemes and conservation programmes in the city. Along one of the busiest road networks, the I-35, a public art team has built an array of 15 "solar sunflowers" (figure 7) that not only offers clean solar energy to a nearby retail park, but also provides shade for passers-by in the hot summer sun.

Figure 7 - "Solar Sunflowers" located at a retail park in the Mueller Development, Austin

The developers describe the work as “an icon for the sustainable, LEED certified Mueller Development and a highly visible metaphor for the energy conscious City of Austin” (Schwartz 2009). Other schemes include a “car2go” rental scheme which charges members by the minute and provides them with access to 200 cars placed around the city, helping to reduce congestion, which “fits the Austin lifestyle as perfectly as live music or a jog around the lake”(Car2Go 2012). Car2go points are clearly visible to anyone walking or driving downtown (figure 8).

Figure 8 - A Cars2Go Hotspot in downtown Austin

Residents have also faced the threat of electricity blackouts. One respondent described a key aim of the PSP being to reduce rolling blackouts in the city.

"…we actually had a period of rolling blackouts, not this winter but last winter, because they had a lot of plants down for maintenance, and we had a 200 year record cold snap. Even in Austin we had I think five continuous days under 30 degrees F. The high was less than 30 degrees F. So that's cold for us. That's really cold for us. There were a lot of frozen pipes and we do not deal with that well. We just do not have the infrastructure. So they did have rolling blackouts, because there were a lot of plants offline, and a couple of plants that hadn't been weatherised correctly to deal with that cold and then the internal safety mechanisms tripped, and we did have rolling blackouts" (Interview, PSP engineer).

Further visual indicators highlighting the need for conservation come from the water sector. Austin gets much of its water from the nearby Lake Travis, a recreational beauty spot which is nearing historic lows in its water level. As one interviewee said:

[I] "…as of last fall it had dropped down to pretty much 30 per cent, pretty much historic lows. It had been only as low as that in one period since the dams were built that created the lakes.

[AM] So it's pretty visible.

[I] Yes, very visible. It's just on the outskirts of town. It's big recreational area, people see it, they understand that 'ok, it's low'. With that as such a visual cue to people, they are like 'oh jeez, yes this is our water supply, we are responsible for saving that'. So everybody gets the idea that it's a community thing we all need to do together" (Interview, Austin Water executive)

The visibility of these issues – from black-outs in the energy sector to severe droughts in the water sector – enable policy makers to garner support for their conservation projects. Austin does not have a history of oil or gas extraction and Austinites see the environment as something to live in rather than to exploit:

"By the 1970s the predominant economic activity in Austin was centered around white-collar occupations in government, education, and an emerging technology industry. This kind of economy created a social and class structure that included a relatively high degree of educated middle-class white-collar workers, rather than a large pool of labourers or working class. The economy was not dependent on industry or resource extraction, so people did not need to think about taking from the environment for their livelihood. They could see the environment as something to live in rather than work from or pollute with factory smoke" (Swearingen 2010: 42).

Hajer describes his argumentative approach to discourse formation as "a struggle for discursive hegemony in which actors try to secure support for their definition of reality" (Hajer 1995: 59). He argues the "dynamics of this argumentative game is determined by three factors: credibility, acceptability and trust." In Austin residents can see and physically experience the effects of rolling energy black-outs and lack of water supply, covering Hajer's credibility. Coupled with an acceptance to become engaged in innovative conservation schemes and the cumulative effect of projects such as the solar sunflowers and public transportation schemes, people are willing to accept that their behaviour could be responsible for the problems. This visibility of energy and water usage and the day-to-day experience of residents within Austin place conservation efforts into the energy discourse. The socio-technical landscape is slowly being influenced by these visible efforts, allowing for the emergence of a project such as the PSP. Although the PSP may still be in a niche phase, the growth of its visibility, along with the growth in usage of renewable technologies, is pushing the new technologies towards acceptance. The diverse range of conservation and energy efficient schemes

within Austin, along with the Mueller district having the highest concentration of elective vehicles, make it a good place for a smart grid to evolve.

2.4.2 The Role of the City's Public Sector

It is Hajer's idea of "trust" that is a key issue in relation to the future development and potential upscaling of the PSP. While residents of Austin may have more confidence in the public sector and governmental structures than surrounding parts of Texas, it remains the *belief* of key players within the PSP that the smart grid cannot be seen to be a part of government interference in people's homes. There is a fear that this will be seen as a drive to invade the personal space and cause privacy concerns. As one interviewee said of smart meters:

> "If we connect it up to the internet and a virus gets in and it hacks us, that's our problem. I mean maybe the product manager, but you know what, even though Microsoft builds software which has seen viruses, you don't go up to them with pitch forks right? Whereas if that happened in the meter, the local utility would be vilified" (Interview, PSP engineer).

Partly because of the anti-federalist stance of many Texas residents the publically-owned Austin Energy is reluctant to roll out smart grid technologies on a large scale, hence the creation of the PSP. This is an attempt to create an arms-length entity that is (on paper) separate from the controls and influence of the state. The hope is to get the private sector to come in, develop and test new technologies and then they themselves can start the creation of a smart grid. It will be a voluntary choice for consumers if they wish to adopt smart technologies. One interviewee outlined it as:

> "…the people who live in Mueller are environmentally conscious and so want to participate. So it's not forcing it down their necks, and its volunteers amongst them anyway. But my belief is that this will grow into something, the commercial products will be for sale by someone who is selling to an individual homeowner, not to a utility entity" (Interview, University of Texas professor).

The discourse of anti-state politics in Texas creates a situation in which the publically-owned energy utility is reluctant to roll-out mandated smart technologies to reduce energy consumption. Instead the issue becomes one of voluntary choice, only to those consumers who want them. This could create a splintering of the energy network as described in the splintering urbanism thesis. If the tools needed for energy efficiency and user control are only provided by the free market then they are likely to be purchased only by those who can afford them. Lower socio-economic groups who may be unable to afford the new tools, or who do not feel they are necessary, are likely to become bypassed in the smart grid. They will not participate in programmes to roll out solar panels, or reduce energy consumption, leaving them with higher fuel bills and less control over their energy usage. It is an irony of the PSP that this free market within a smart grid is being created by a publically-owned utility. Elsewhere in the US many privately-owned energy utilities are undertaking mandated smart meter rollouts and charging customers extra if they wish to opt-out.

2.4.3) Going Green and Boosting the Economy – Ecological Modernism as Policy

This combination of highly visible environmental issues, a well-educated workforce and a large high-tech sector has created an energy discourse of "ecological modernism", which as Hajer describes is a discourse that "recognizes the structural character of the environmental problematique but none the less assumes that existing political, economic and social institutions can internalize the care for the environment" (Hajer 1995: 25). At the core of this belief is the idea that "pollution prevention pays". It is important economically for the city of Austin to reduce environmental impacts and to try and direct urban growth away from ecologically sensitive areas. While "cities may be drivers of economic growth, they are also great consumers of resources and creators of environmental waste" (Hollands 2008: 310). Ecological modernism is not simply about lessening environmental impacts but reducing them while at the same time as pursuing policies for economic development. Development in green issues and improved technology efficiencies can help reduce pollution in tandem. Proponents of ecological modernism argue that "economic development and ecological crisis can be reconciled to form a new model of development for capitalist economies" (Gibbs 2000: 10). As Laidley describes "while these two logics seem at first blush to be ideologically and materially antagonistic, the politics of growth and the politics of the environment have become important correlates in the development politics of urban regions," yet "the literature critically examining the pitfalls of ecological modernisation has already deftly demonstrated that such ''win–win'' approaches to urban problems subsume environmental issues under neoliberalised concerns of ''efficiency, competitiveness, marketability, flexibility and development''(Laidley 2007: 261). The PSP forms part of this energy discourse. The objective is to develop new industries and test out new gadgets that can reduce environmental impacts yet at the same time spur economic development by bringing green growth and development to Austin. For a city with such a high-tech sector "the cultivation of environmental amenities and an ecological image" becomes "part and parcel of a strategy to spur economic development because these have been shown to attract and retain educated and highly skilled workers, and promote industrial development in innovative sectors such as renewable energy" (Tretter 2013: 2). Within this discourse the storyline of a "smart grid", or the energy network of the future, can emerge.

2.4.4) Conclusion

The PSP therefore has emerged in a unique set of circumstances. It's location within Texas on an isolated and highly deregulated energy grid allows for experimentation. The growth of renewable energy, particularly wind, has highlighted the need for upgrades to the infrastructure network. This has provided the raison d'etre to experiment with smart technologies and for environmentalists to push for higher energy efficiency and decentralised generation. In cities such as Austin the high visibility of conservation efforts has created consumer demand for green power. These factors can only partially explain the emergence of the PSP. The promotion of smart grid technologies has been tailored to fit the unique energy discourse of Texas. Rather than promote the environmental benefits proponents have focused almost entirely on economics and have attempted to alter their strategies to fit the local socio-economic framework. Smart meters are cash registers, wind turbines can provide employment and an alternative source of income, and consumers have the choice of becoming involved rather than battling against a mandate. The growth of wind power in Texas, the

lack of public opposition to smart meters and a willingness of consumers to become engaged with the PSP suggests this strategy has been largely successful.

While proponents of the smart grid may have altered their strategies to fit with the socio-technical framework within Texas, the growth of the PSP itself is following on from the public-private partnership (PPP) structure that was enthusiastically adopted by the city in the 1980s. Its structure is not radically different from the organisations that went before it. It has stimulus money from the federal government, it has a large research-intensive university providing students, professorships, land, and funding, and it has private companies paying so they can test new technologies. The growth in PPP forms a key part of the splintering urbanism theory and will be examined in the next chapter.

Chapter 3 - State-driven Economic Development, International Capital and new Energy Markets

3.1) Introduction

One key concept underlining the splintering urbanism thesis is that of neoliberalism. While classical liberalism sees markets as naturally occurring phenomenon, neoliberalism "is premised on the idea that the conditions can be created that will encourage people to act in a more marketlike fashion" (Larner 2009: 2). Splintering urbanism involves a shift away from the modern infrastructural ideal of universality of service provision and towards a form of "infrastructural consumerism" (Graham 2000). The theory suggests this has happened within a range of infrastructure networks in countries around the world, including within energy networks. Welfare provision and state regulation are replaced through policies of privatization and deregulation. While I do not wish to engage in an extensive debate about the many nuances of neoliberal thought it is important to examine its impact on networks and the creation of free markets. It is difficult to examine splintering urbanism within the PSP without examining how neoliberalism influences current thought in Austin. In this chapter I will examine how the PSP is being used as part of a wider economic development strategy within the city of Austin; how Austin Energy is devising business models to create a new energy marketplace; and how consumers are being given new "choices" about how they consumer and generate their

own energy. The aim of all these policies is to make Austin an attractive investment opportunity for outside private investment and to give Austin an ability to compete internationally within the newly developing smart grid industry, but it could also lead to splintering of the energy network and a tailoring of smart spaces towards higher income groups.

In this chapter I will outline the neoliberalism that lies behind the splintering urbanism thesis. I will explore how Austin has adapted its policies in line with this thinking, looking at the history of public-private-partnerships that have been used for economic development and to create new markets and industries.

3.2) Neoliberalism – Urban Spaces and International Private Capital

David Harvey defines neoliberalism as a theory of creating strong private property rights, free markets and free trade, in order to advance human well-being by "liberating" entrepreneurial freedom and skills. Neoliberalism sees the state as nothing more than an institutional framework to create the conditions for free markets, such as guaranteeing the integrity of money, providing defence and strong legal structures. Harvey argues:

> "…if markets do not exist (in areas such as land, water, education, health care, social security, or environmental pollution) then they must be created, by state action if necessary. But beyond these tasks the state should not venture. State interventions in markets (once created) must be kept to a bare minimum because, according to the theory, the state cannot possibly possess enough information to second-guess market signals (prices) and because powerful interest groups will inevitably distort and bias state interventions (particularly in democracies) for their own benefit" (Harvey 2005: 2).

We can see clear evidence of neoliberal thought within Texas. It can be argued that, historically at least, a reluctance to interfere in private property hindered the growth of a universal, state-controlled energy sector leading to a mix of uneven energy development. Paradoxically the same recognition of private land rights has allowed for the huge growth in wind farm development with objectors reluctant to raise concerns about what neighbours do with their own land. As a state Texas is opposed to state intervention beyond what is entirely necessary – the state's energy sector is one of the most deregulated in the world. Yet neoliberalism does allow for state intervention to *create* markets if they do not exist and in recent years the city of Austin has excelled at using state apparatus to create markets without becoming directly involved within the marketplace. The PSP is an example of a state creating market conditions to attract international capital, create jobs and develop the tax base, all within a neoliberal framework. The PSP does not simply represent a desire to move towards a low carbon smart grid, but it also aims to encourage economic development and to create a new decentralised energy marketplace where consumers can make their own informed choices about how to behave.

David Harvey's definition of neoliberalism allows for highly flexible free markets, minimal state interference and an emphasis on individual choice (Larner 2009). In terms of cities and states around the world, instead of directly creating employment through the public sector and regulating existing industries, the neoliberal idea focuses instead on developing competitive advantages to attract

private capital from elsewhere. Leitner and Sheppard (2002), citing work by Michael Porter, outline the theory:

> "…the key to urban prosperity lies in developing a competitive advantage, and that the key to competitive advantage is to be found in clusters of firms forming industrial districts, networking with one another in ways that promote dynamic external economies, innovation, and growth. These clusters should be in leading-edge industries that take advantage of a locality's strengths. In principle, every location can identify such a cluster and rely on it to generate good (high-wage and interesting) jobs and an improved physical environment. Porter envisages a role for the state, but one confined to helping cities identify their appropriate competitive advantage and to correcting market imperfections" (Leitner and Sheppard 2002: 500)

Neoliberalism envisages the state moving away from huge, overarching plans for large infrastructure networks to provide universal provision for residents, away from involvement in the minutia of market management and regulation, and towards a modern model of being facilitators for private enterprise. In a globalised world cities compete with each other to attract international capital, hoping to attract industry and jobs to boost their own economies at the expense of others. Free markets and competition, according to the theory, is the key.

One way for cities to achieve this is with public-private partnerships (PPP) and the use of these entities has mushroomed over the past 30 years. Around the world, between 1985 and 2009, more than 950 transportation facilities alone were newly built, upgraded or operated from PPPs worth over US$550 billion (Siemiatycki 2011). Supporters contend that PPPs provide additional private capital to fund investments in infrastructures of new facilities, stimulate design innovations that save money and transfer risks to the private sector (Siemiatycki 2012). However, as argued by Graham and Marvin (2001) PPP investments are often guided by market forces and may exacerbate unequal urban development with private finance flowing to new "premium network" connections in high value locations that offer high returns while less profitable regions are bypassed. Any windfall profits for private sector partners often come at the expense of users and taxpayers. Recent concerns have also been expressed over the potential to use PPPs to transfer public assets into private hands, such as debates over the reconstruction of large areas of New York after Hurricane Sandy (Klein 2012).

Public-private partnerships are nothing new and have been around for centuries (Savas 2005) yet they have become more common over the past few decades. While much of the literature defines PPPs as risk-sharing relationships based on a shared aspiration between the public sector and one or more partners from the private and/or voluntary sectors to deliver a publicly agreed outcome and/or public service (Grimsey and Lewis 2004), as Siemiatycki argues this definition is broad enough to cover relationships that include "contracting out the management and operations of existing facilities, and concession agreements where the private partner designs, builds, finances and operates a facility over a long-term concession period" (Siemiatycki 2012).

In Austin I argue the PPP relationships are slightly different. The city has a history of public-private collaboration with several projects being successfully rolled out since the 1980s. However, while they do share an aspiration for publicly agreed outcomes many of the PPPs in Austin have been used for wider economic development purposes, creating niche high-tech industries to further attract outside investment rather than focusing on individual infrastructure agreements or one-off projects. While many PPPs around the world have been used to transfer risk from the public to the private

sector and to finance new highways, hospitals or small-scale infrastructure projects, Austin has followed Michael Porter's original advice to use PPPs for economic development purposes, to create high-tech industries to bring in outside investment and to "kick-start" local business start-ups. Austin provides an excellent example of Porter's competitive cities thesis and this public sector push to develop the private sector has been largely successful. Today's Pecan Street Project is the latest of a long line of PPPs in Austin.

3.2.1) 1980s Austin –The Public Push for Private Economic Development

In the late 1970s Japan emerged as a major producer of semiconductors, with spectacular success in DRAMS. Between 1978 and 1986 the US share of this market plummeted from 70% to 20%, while the Japanese share jumped from 30% to about 75% (Irwin 1996). To compete, in late 1982 several US computer and semiconductor manufacturers banded together and formed the Microelectronics and Computer Technology Corporation (MCC) in Austin – the first computer industry research and development consortia in the US. This was followed by Sematech in 1986. In reality, these two entities were public-private partnerships and represented a major public-sector push to attract private technology companies to relocate to Austin. Both consortia were non-profit research and development organisations and worked in partnership with a diverse range of actors, including state and federal government officials, research institutions, business representatives and manufacturers. The Austin-based University of Texas provided land for the initial MCC building as well as several endowed professorships seconded to the board. Home-grown companies such as Dell and Tracor, were joined by international corporations such as Motorola, AMD and Samsung. Both MCC and Sematech were successful in developing the high-tech industry in Austin. One interviewee outlined:

> "A lot of people like to compare Pecan Street to MCC. MCC was instrumental in building out the Austin software and computer industries. I mean the IT industry exploded after the MCC consortium, and decided to locate in Austin. And then if you fast forward seven or eight years another research consortium established itself in Austin called Sematech. That was a big global research consortium for the semiconductor industry… Sematech was an opportunity for the US to capture some of that market and some of that knowledge and expertise and thought leadership. So because of Sematech, which came to Austin in the late 80s, and that is what launched Austin into the semiconductor industry, we now have companies like Freescale Semiconductors headquartered in Austin. They have a big manufacturing facility here for semiconductor chips, Samsung has… they have invested close to 10 billion dollars in Austin in semiconductors" (Interview, Austin Chamber of Commerce representative)

For Austin these PPPs were very successful. As Smilor et al (1989) argues:

> "In early 1988, after a national competition, the main players in the US semiconductor industry chose to locate the industry's new research consortium of 13 member companies (Sematech) in Austin. Austin and Texas were outbid by several other contending cities and states in terms of financial incentives. However, Sematech officials cited as a main reason for choosing Austin the synergy among business, academic, governmental and community entities." (Smilor, Gibson et al. 1989: 52).

In the late 1980s Austin was praised worldwide for its approach to economic development:

> "Austin made headlines in the New York Times, the Wall Street Journal and the world press as the next great "Silicon Valley". Nicknamed "Silicon Prairie", "Silicon Gulch", and "Silicon Hills", the area experienced an unprecedented wave of enthusiasm because of the perception that it had suddenly become a major technology centre" (Smilor, Gibson et al. 1989:52).

Smilor et al argue the city was successful because of the cooperation between various actors active within economic life within Austin. Their "Technopolis Wheel" (figure 9) highlights the links between seven major organisations in the city that helped boost private development.

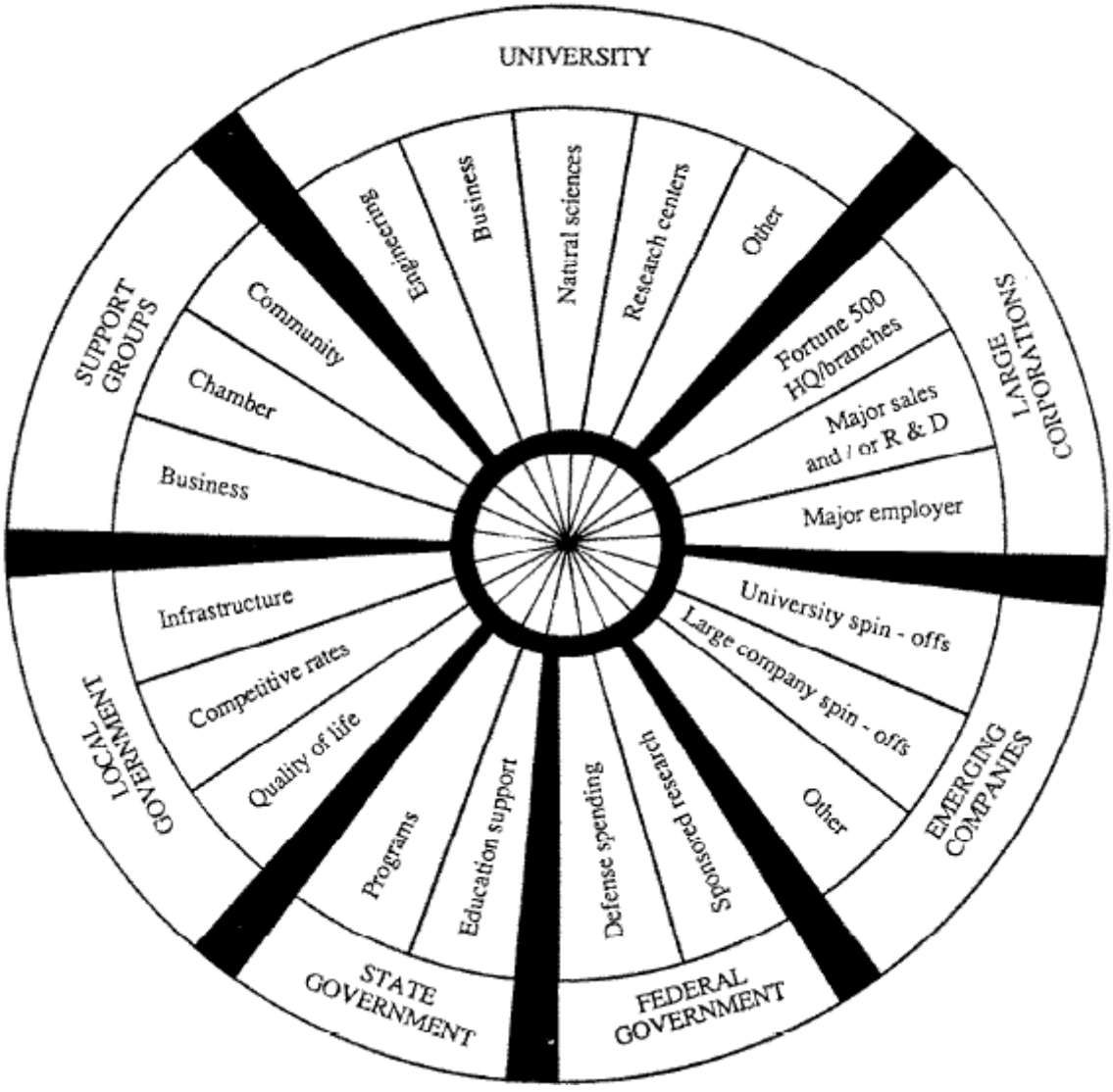

Figure 9 - The Technopolis Wheel (Smilor, Gibson et al. 1989: 51)

The concept of Austin as a "technopolis" has two assumptions – "techno", reflecting the emphasis on technology, and "polis", the Greek work for city-state, reflecting the balance between the public and private sectors in spurring economic development and promoting technology diversification. Smilor et al argue:

> "The nucleus in the development of the technopolis is the university segment. The research university plays a key role in the fostering of research and development activities; the attraction of key scholars and talented graduate students; the spinoffs of new companies; the attraction of major technology-based

> firms; as a magnet for federal and private sector funding; and as a general source of ideas, employees, and consultants for high-technology as well as infrastructure companies" (Smilor, Gibson et al. 1989: 53).

The idea of a "technopolis" captures the idea of the public and private sectors within Austin working together. The University of Texas was heavily involved in the creation of MCC and Sematech, providing land, staff and students for the new consortium. Austin is the state capital of Texas, offering easy access to both state and city policymakers. The Chamber of Commerce is very proactive in encouraging economic development and had seats on the board of both MCC and Sematech. Smilor et al also highlight the quality of life of Austin – cited as one advantage to entice workers and businesses from elsewhere within the US – with the city seen as a good place to live and work, providing a good climate, low crime rates and a vibrant service sector. The coming together of the public and private sectors within Austin in the 1980s may seem to contrast with the idea of neoliberalism as practised by the Regan administration, with a rolling back of the public sector leaving a reduced and limited government. Yet neoliberalism is not simply about a reduction of the state (although this is a key part). As Harvey argues, neoliberal thought requires the state to *create* markets where they do not exist, to act as a catalyst for private industry and then take a step back. Harvey also calls for a growing emphasis on local action (such as the proactive development policies of the City of Austin) to promote economic development, replacing the declining power of the nation-state to control multimodal flows of capital (Harvey 1989). While nationally the US was reducing state involvement in many areas of economic life, locally very different groups of diverse actors were stepping in and using public institutions to direct investment towards their own localities. Neoliberalism as defined by Harvey therefore is not just the rollback of the nation-state. It is about smaller local groups using the state apparatus and their local advantages to create markets tailored to their own regional needs. State institutions are used to direct private finance into specified pockets of urban life, rather than simply being pushed out of the way to allow private industry to flourish naturally. This is not the state picking the winners and losers between various companies in a competing marketplace, but the state creating the conditions for new private actors to emerge. In many ways what happened in Austin during the 1980s pre-empted the later policies of the Clinton and Blair administrations in the 1990s. As Holifield (2004) argues:

> "…this was (at least apparently) a "kinder, gentler" neoliberalism. If the neoliberalism of Reagan and Thatcher - what Peck and Tickell (2002) call "roll-back neoliberalism" - sent out bulldozers to raze the Keynesian welfare state, the "roll-out" neoliberalism of Clinton and Blair sent out construction teams to build new institutions, designed to embed the neoliberal project more deeply in civil society (Jessop 2002)" (Holifield 2004: 285).

Within Austin the state was being used to direct markets in its own favour to attract industries from elsewhere, to increase urban development and to boost the city's tax intake. Markusen (1996) develops and expands on the idea of Austin as a "technopolis" with her description of the city as a "state-anchored industrial district". Such areas use the state facilities present – in Austin's case the large research university and the significant political and economic resources that come with being the state capital – to attract international finance and spur economic growth (figure 10). As Markusen argues outlines:

> "In state-anchored industrial districts, long-term growth prospects depend on two factors: the prospects for the facility at the core of the region, and the extent to which the facility encourages growth within the

region by spawning local suppliers, spinning off new businesses, or supplying labour or other factors of production to the local economy" (Markusen 1996: 307).

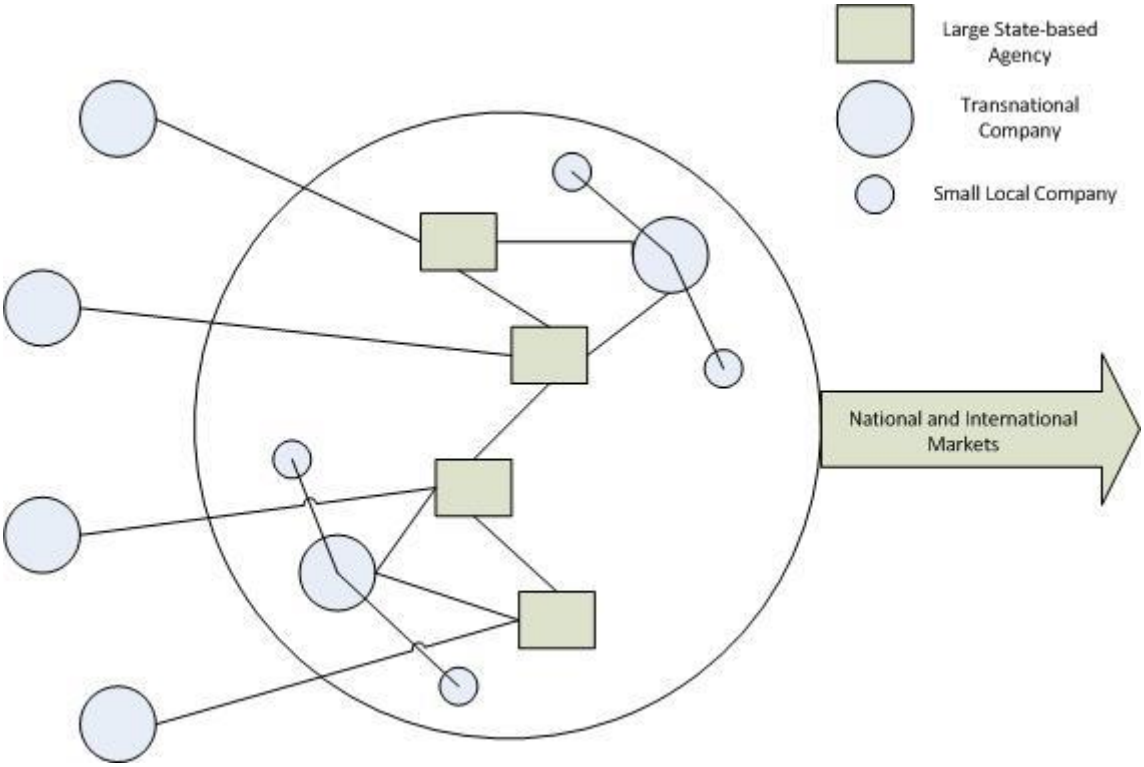

Figure 10 - The State-Anchored Industrial District, adapted from Markusen 1996

As Carley et al argue Austin has used the vehicle of PPPs to focus heavily on specialisation – in this case the high-tech industry – following the economics advanced by Michael Porter (Carley, Lawrence et al. 2011). As stated by one interviewee above MCC and Sematech not only attracted multi-national companies from around the world which continue to invest in Austin (such as Samsung's expansion of its manufacturing plant and the base of Freescale Semiconductors, which has annual revenues in excess of $1 billion) but also allowed for the creation and expansion of local high-tech industries.

This specialisation came at a cost. Some 22% of all employment within Austin lies within the government sector (figure 11) with 18% in trade, transportation and utilities, creating an ideal mix for a state-backed PPP seeking to develop a smart grid.

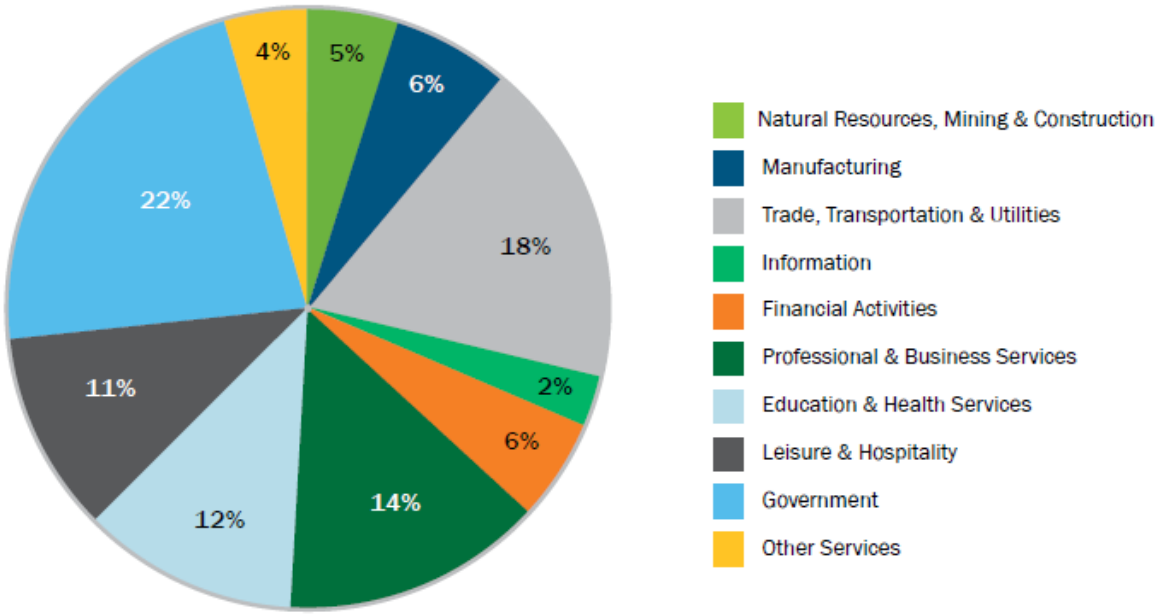

Figure 11 - Employment By Industry in Austin (Imagine Austin 2012)

However, while only 6% of workers are involved in manufacturing, Austin's over-reliance on high-tech companies was revealed after the dot-com bubble burst in the early 2000s. As one respondent outlined:

> "High tech industry started here in the late 60s, it grew through the 70s and 80s, and it exploded in the 90s with the dot-com boom. We had all kinds of dot-com start-ups and software companies emerge. But then in 2000 when the bubble burst, Austin actually got hit really hard economically. We lost somewhere around 40,000 jobs in a matter of six months. We got hit real hard. It really sent Austin into a downward spiral economically" (Interview, Austin Chamber of Commerce representative).

3.2.2) The Pecan Street Project – A Clean Energy Research Consortium

The organisation and structure of the PSP is very similar to those of MCC and Sematech. One of the objectives is to attract companies to Austin and to encourage local start-ups – exactly the same aims as MCC and Sematech. While Austin already has an existing high-tech sector the recession of the early 2000s has encouraged city planners to focus resources on diversifying the local economy towards the burgeoning clean energy sector. An economic development strategy drawn up by officials outlines the key issues:

> "Austin's traditional high-tech base is being forced to move into other sectors. As "offshoring" continues to affect the manufacturing and electronics base, the city is refocusing on other high-tech industries such as medical and life sciences; clean energy, which includes sustainable design and building, smart grid technologies, and solar energy; creative industries such as gaming, digital media, film, post-production; data centres; and professional services and corporate headquarters" (Imagine Austin 2012: 31).

The PSP is an attempt to diversify the local economy towards the clean energy sector. It is hoped the project can achieve the same level of success in developing private industry as MCC and Sematech.

Economic development was one of the main reasons the city's Chamber of Commerce became involved. One representative said:

> "[We looked at] the opportunity to create a research consortium that could act as a magnet to bring companies and to bring jobs to Austin. That was actually one of the original motivations for the chamber being engaged and involved in Pecan Street" (Interview, Austin Chamber of Commerce representative).

The interviewee continued:

> "The opportunity to attract these types of consortium members was one of our top priorities. But also, Pecan Street creates an opportunity for local companies, for existing companies. A good example is the home energy monitoring systems we are using, they are actually being provided by an early stage start-up. A company called Incenergy. And Incenergy is at a very early stage. So it is providing opportunities for start-ups, and Incenergy as a result, because we are proving out their technology in a real world testing environment, they are raising more money, they are growing, they are adding jobs, so it's helping local companies. But also it's also creating opportunities for some of these established companies that are multi-national, global companies. And you're right, they could be anywhere they want. Based on the understanding that there are a lot of values in having your presence in Austin, so you are already seeing companies like Sony for example, adding more research staff to their Austin office, and, a lot of these other companies are also looking to do the same thing. Best Buy is looking at adding more of its research and development functions to Austin. It's a company that is not even based in Texas, you know, and because of Pecan Street we are starting to draw these companies in, and over time that's kind of one of the indirect benefits of research consortia."

Even members of the more environmentally-aware groups that are involved in Pecan Street see the project in economic terms. Several respondents, when asked about the main aims for the PSP, replied:

> "…the initial thought… this was before any stimulus money, it was can we use the utility as a driver for economic development generally, but to make Austin a clean energy hub, thinking that we were going to have a boom in clean energy?" (Interview, Environmental Defense Fund representative).

> "…a lot of our work is on how you can get the market right, so people can make a lot of money in doing the right thing in cleaning up the environment" (Interview, Environmental Defense Fund representative).

> "…our idea is that using a public utility and a large public research university to figure out ways to launch private entrepreneurs, to clean the environment for all of us is what we should be thinking about" (Interview, Austin Energy executive).

Like the previous PPPs before it the PSP has a mix of government interests (federal, state and local), private (corporate and local), environmental and university interests, all using the project for economic development purposes. The project has other similarities with the research consortia from the 1980s. Two of the board members who have been involved in the PSP since its inception were involved in the development of MCC and Sematech in the 1980s, and saw the PSP as an extension of the same ideals. As one respondent said of a colleague:

> "…he basically had been involved with an organisation called MCC back in the 80s, so that was actually an attempt… a consortium for and by a lot of the products companies, the computer companies, to build the fifth generation supercomputer to compete with the Japanese, funded a lot by the federal government but also by these companies that came in" (Interview, University of Texas professor).

The experience of previous economic development projects offers a key advantage to the PSP. Staff members have knowledge about how to use the state to direct private investment into desired areas. They have experience in drawing together a range of diverse interests, and they are aware of the many motivations of the actors involved. One respondent described further advantages of such a setup, describing the PSP as almost an arms-length organisation:

> "For a politician you can imagine, 'well give me a briefing I have got to do a press conference'. It's a good mechanism for an NGO because they get huge leverage into organisations that they would otherwise have to fight their way into. It's a real world filter on academic things, because academics tend to get all balled up in their research and reality is a mess to academics a lot of the time. So they can get a ground trothing as we say here, a reference point in the real world through the organisation, they can get connections to the people that they want to have. So everybody had their own selfish theories, so John Locke I think called it rational hedonism. Everybody has their own hedonistic objectives for wanting a seat and for wanting to go forward and it's the right combination of that" (Interview, Austin Energy executive).

3.2.3) The Smart Grid as a Sandbox for Public and Private Sector Experimentation.

For private investors joining the Pecan Street has clear advantages. Within the splintering urbanism thesis international finance is highly mobile and flows to high-value districts with competitive advantages. So why would international companies choose to invest in the PSP? There are four clear advantages for outside interests – public relations, gaining direct access into the homes of customers, developing early market share and experimentation.

Simply being on the board of the Pecan Street provides a gold standard badge, which can demonstrate how forward-thinking, clean and green the company is. It can be a huge public relations boost for a company to be able to tell customers how they are a progressive, forward thinking company. Smart grids are seen as the future of electricity networks and companies are keen to get involved early to get their brands known and to highlight the work they carry out on research and development. One respondent outlined how the privately-owned Texas Gas Service was using the Pecan Street organisation to comply with various agreements they have with the City of Austin.

> "…part of their franchise agreement to operate within the city limits of Austin requires that they have a conservation programme. So this is, I'm sure, part of them checking that box saying, 'look we are doing it'. It's interesting to look at my bill last month from them, and one flyer is all about conserving, and another is 'oh yeah, ask us about all these different things that you can put in your back yard, you can put a gas heater there, and this great big new gas grill, about three other ways of using gas. And it's ok'. They are definitely selling their product. On one side, you are buying more gas, on the other, 'here conserve it'. The flyer they had for the conservation side was offering five or six times as much money on a rebate than they normally do for putting in a gas dryer. Granted they are hoping they will get people who will transfer from an electric drier to a gas drier, and therefore sell more gas, but that will be offset by people replacing less efficient gas driers with more efficient ones. I'm sure doing the conservation programme benefits their public relations. 'Gee we're not just an energy company that's trying to pollute the environment and do all that stuff, see we're doing conservation too. We are the good guys'. And natural gas being less polluting that the oil companies, they are not Exxon, so hey. But they certainly have different motivations than we do" (Interview, Austin Water executive).

While it could be argued that the Texas Gas Service is using the PSP to surreptitiously sell more gas other companies are using the opportunity to gain direct access into people's homes to see how they use new technologies. This data is hugely valuable for companies to investigate how consumers use their products, how they can be improved and how gadgets can be tweaked. Sony, which is testing out home energy monitoring systems, has created its own test bed house within the Mueller development, with researchers shipped in from Tokyo to evaluate their gadgets in a real world working environment. Best Buy is training its staff on how to install the gadgets and how to use the software in the hope they will become the main provider and installer of new home technology in the future. The company wants to develop the knowledge before its competitors in an attempt to monopolise the market for home installations and to make Best Buy the go-to store when a consumer wants to develop a "smart" home. The PSP has made it easy for board members to engage with consumers and has opened the grid network up fully for private and public researchers. Here we can see the city of Austin adopting features similar to other high-tech cities around the world making "intensive efforts to configure built space and infrastructure needs in parallel to the detailed desires and wants of manufacturing inward investors" (Graham and Marvin 2001: 339). Both the utility and outside companies see this as a key advantage to the structure. One respondent said:

> "… those companies can pay to be members of the technology board of advisors to help us suggest which experiments that need to be done, because they don't know which experiments need to be done, and they can help design the experiments and then they get to watch or even possibly participate in the experiments, and we don't care, because there is nothing secret going on. I mean we all want to find out does this experiment work" (Interview, Austin Energy executive).

For the energy utility the creation of a PPP does allow them to have an arms-length involvement and offers a "sandbox" for them to test new products and services without fear of a consumer and regulatory backlash. They can test devices that they would otherwise have to roll out city-wide. Because the energy utility is a municipally-owned utility mangers are aware of the ideal of "universality", of providing the same level of service (or at least trying to) to all consumers within the city. Creating an arms-length public private partnership, such as the PSP, allows them to develop new business models without fear of criticism from other areas of the city, or without fear of the consequences if things go wrong. As one respondent described the setup as a non-profit research consortium:

> [I] "…it's a place, it's sort of a safe sandbox, you know, as regulated entities, utilities are often resistant of the idea doing one thing because they will have to do it for everyone, because it's a public business. You have the universality that you are trying to address, and so there is… and that's sort of what slows it down, in for a penny in for a pound kind of thing. They can't… most of these people can't imagine doing things a little bit, and at the same time they also have this infinite demand to pilot everything, every utility, no matter how many times it has been done somewhere else, they want to pilot it too. So it's very convenient to have a sandbox, a safe sandbox, a politically secure sandbox, you know, in which they can play, and when the mood strikes, the people from the utility can get more or less involved. So in that regard it sort of distributes risk, it mediates cyclical upheavals, it acts as a way for some of the work to continue, it gives a place for some of the people who are interested in the future of the utility to engage, even though there are no points in their current annual performance exam for thinking about the future. It's always about getting today's work done. So I find a certain level of excitement in some people, going 'I think I want to have a play around with this'. The volunteers are the best, because they want to hang around with this because they think this is where it's going and they have genuine enthusiasm. Most of the people, the poo

pooers are saying 'I don't care, go ahead because I'm not going to waste my time with this'. So it's a pretty cool kind of instrument to build into the ecosystem.

[AM] So if something goes wrong…

[I] Right, it doesn't come back to you. Deniability, it was part of the experiment. Putting all your mutations over in a safe petri dish" (Interview, Austin Energy executive).

He added:

"We don't care if Pecan Street succeeds or fails over in the Mueller area, it's an experimental place."

This is a key bonus for private partners. Access to this petri dish is a highly desirable asset and the utility has been very welcoming to private partners:

"So what Austin Energy has provided the energy industry and the clean tech industry with is sort of a platform, a laboratory so to speak, to play around and test out new technologies. The utility has been very open in partnering with the private sector in the past. There are examples of how the utilities worked with the private sector going all the way back to the 80s. Austin Energy funds the clean energy programme here in the chamber, which is my role and my main role is to try and recruit and attract new clean energy industry to the Austin region. The utility also funds a programme at the University of Texas called the Austin Tech Incubator, which is focused on helping early stage clean tech start-ups grow and develop and raise funding. So AE is very instrumental. In my opinion it's one of the unique aspects to Austin and how we have been able to grow this clean tech industry" (Interview, Austin Chamber of Commerce representative).

The Pecan Street has evolved from the research consortia of the 1980s to combine the strengths of the public and private sectors. There is no sense of "private good, public bad", or vice versa. All respondents felt a mix of both sectors was vital to create a viable market for goods within a strong regulatory environment, not a laissez faire structure. One respondent summed up the feelings of many within the PSP and criticised calls for further state rollback and deregulation:

"There has been in this country, and probably around the world, I know that the UK did this when they got into their deregulation and all that stuff and so did Europe and all that stuff, a domination of the market by the economists and the theory that we are all responsive to price signals and stuff. It was actually kind of wishful thinking, you know, a sort of Reagan, Thatcher, Bush-esq kind of idea that free markets are more efficient than governments, and then if it is a free market, free markets respond to price signals, that's what ultimately drives them, guns and butter and all that crap. And the means of production will be adjusted to meet the level of demand, and all of that. And it's just stages of wishful thinking that don't bear out" (Interview, Austin Energy executive).

While the fieldwork for this thesis was being undertaken campaigners were preparing for the 2012 US presidential elections. In a discussion focused on the libertarian candidate Ron Paul, who called for the government to provide national defense, a court system for civil disputes, a criminal justice system for acts of force and fraud, and little else one respondent criticised the view of limited government:

"In this country there is still some romantic view about limited government. And it goes back to Thomas Jefferson. But fundamentally that argument essentially rejects modernism. You are not growing your own food. You're not building your own roads, you're buying food from some distant place and you need a way to get it there, to get it public, you need a way to make sure it's safe. And we have a million gadgets, a million chemicals. We have an economy that is interconnected. Our economy is too complicated to

> regulate it like it's 1770. In the end that is folly, true folly, to think we are not going to have a government that's the size of our economy, or as complex as our economy. I'm sorry" (Interview, Environmental Defense Fund representative).

Members involved in the PSP have a strong sense that it was the role of public sector organisations to create, regulate and work with markets, rather than simply step back and let markets evolve naturally. One respondent said:

> "I can remember one time someone was going to do a paper Markets or Mandates, and of course it's a silly question. The answer is Markets *and* Mandates" (Interview, Austin Energy executive).

While the public sector should be willing to work with private companies, there was a sense that private companies also had to be willing to engage with the state and federal governments, rather than trying to bypass them. Companies interested in investing in the smart grid have to work with the government, the energy utility *and* everyday consumers. One respondent outlined the thinking well:

> "…this stuff doesn't work without the utility. The utility owns the price differential between daytime and nighttime power, between expensive and cheap power, the utility owns that. And the utility converts that difference into an average price that delivers a public good at an affordable rate. The myth… there are a couple of important myths about smart grids that are fundamental. One is that somehow this difference between on-peak and off-peak prices is available to anybody who wants to capture it. It's why we had such spectacular failures… like I got my Microsoft Hohm email today saying they have suspended all support for the service, it's why Google got out of the meter thing, because they were stupid enough to think they could sell 300 dollar meters to customers as individual tech devices, where the maximum savings they get for reducing their consumption on peak would be the average cents per KWh. It's insane. It's 10 cents. But why would you do anything? We know the utility is paying more, but the utility is not offering that bounty up. Google thought they could come in and bypass the utility, it's a huge stupid mistake thinking you could come in and just displace them, it's like they thought… I don't know what they thought. But for them to not have rolled out with a utility partner every single place they rolled out, was, you know, it was clear, I remember saying, this is going to flop, a lot. So you have to engage with the utility in some regard" (Interview, Austin Energy executive).

3.3) The Potential for a Private Sector Smart Grid

While the PSP acts like a safe petri dish for smart grid technologies, many respondents feel that Austin Energy's role should be to kick-start private sector investment and then rely on other entities to roll it out, rather than providing a universal smart grid design for the whole city. Austin Energy's roll would be to create the free market and then take a step back under a neoliberal framework. While the public sector (here in the form of Austin Energy) should be used to create a market, or at least create the conditions for a marketplace to emerge (as in Clinton and Blair's construction teams), it should do no more than that. Interviewees all felt the private sector should take the lead in smart grid development, not the publically-owned utility. While it is essential for private companies to work with Austin Energy to develop smart grid technologies, the actual products themselves should be rolled out by the private sector. Customers should be able to choose want kind of smart television they have or what kind of home energy monitoring system they should have.

It is Austin Energy's role (as a publically-owned utility) to enable the private sector to develop their own products which will then be sold to consumers in an open marketplace. One reason for this is with the concept of universality. Austin Energy is reluctant and nervous to roll out a large smart grid partly due to fear of being burdened with an expensive failure if take-up is poor. Other cities across the US have faced consumer backlash and negative publicity relating to mandated roll outs of smart meters. While many of these roll outs have been by private utilities, Austin Energy, as a municipally-owned utility, has to face the voters if things go wrong.

Another issue is that of consumer "choice". The belief is it should be a consumer's choice whether to install a smart meter, or a home energy management system, or electric vehicles or solar panels. This follows on from the discourse outlined in the last chapter about the reluctance and general opposition to mandated governmental programmes. The University of Texas and Austin Energy are simply allowing their own resources to be used by the private sector to develop products and services that create choice within a smart grid market. Several respondents summed up the feeling:

> "… it's a bunch of consumer orientated, mostly consumer orientated companies that are trying to figure out how this thing is going to play out in terms of the private sector, and how is the private sector going to really… the utility doesn't drive anything, in my opinion, they probably told you that, but we figured out that they have a role to play, but they are not going to get beyond sending stuff into the distribution system, and presumably matching up with people's demands, but all the other stuff around this, which can include demand response and other things, it's unclear what the utilities are going to be doing with this. Everything is going to be dealt with by the private sector, I think, when we get to that side" (Interview, University of Texas professor).

> "…but my belief is that this will grow into something, the commercial products will be for sale by someone who is selling to an individual homeowner, not to a utility entity (Interview, University of Texas professor).

> "We are trying to literally show that the public structure of the utility can enable these private innovations. The utility doesn't want to get into the business of designing demand response technologies. That's not what they do" (Interview, Austin Energy executive).

One problem with a utility-led smart grid project is that ultimately the utility is trying to make consumers use less of its product. If all consumers adopt highly efficient gadgets and do as much as possible to reduce energy consumption, then what will happen to the energy utility? The utility is by the City of Austin, which means:

> "...literally policemen are laid off if this utility doesn't make a profit. Parks close, libraries close. You know… So the utility making a profit is a big deal. The utility doesn't have to worry so much about this quarter or reporting to Wall Street but it does have to every year give a substantial profit to the city to run the city" (Interview, Environmental Defense Fund).

To solve this dilemma the PSP is looking at two future business models for a utility to exist within a smart grid.

3.3.1) Future Business Models

While the Texas Gas Service is signed up to the PSP and is rolling out high-efficiency gas products, they are doing so while promoting more gas-powered products to consumers. As one respondent argued this creates difficulty in developing a viable business model for an energy utility:

> "One of the things that concern the utilities is, if your programme really works you put us out of business" (Interview, Austin Chamber of Commerce representative).

One solution is for the energy utility to change its business model to cope with selling less of its product. The PSP is examining two future models (table 3).

	Business Model One	Business Model Two
Idea	Energy utility moving from a commodity provider to a service provider	Energy utility becoming a hardware platform for distributed generation.
Explanation	Utility will charge a set fee to customers, who can use as much electricity as they want. However the utility can install and take ownership of distrusted generation within each home.	Utility will open up the grid network and, for a fixed fee, provide a software platform for homes and business to manage their own energy generation. Utility provides generation only as a backup. Grid becomes a two-way flow of energy, and the utility operates as a market broker.
Issues	Customer loses control over what is installed in their home. A fixed fee for customers means the utility takes the hit if there are wide variations in fuel price (eg if gas prices shoot up) "Jevons Paradox". As more gadgets are installed, little incentive for customer to reduce energy use. No motivation for roll out of electric cars (which would severely increase grid use and be a huge expense to the utility)	Homes retain control of their installed technologies, yet for a fee do not have to constantly monitor their own generation. Current financial incentives for solar panels allow no provision for the cost use the grid. Grid is a long way from providing the sophistication needed.

Table 3 - Two Business Models Being Explored by The Pecan Street

The first model envisages a switch by the utility away from a commodity provider and towards a service provider. This is described as:

> "…customers could sign up for a service plan for a fixed cost per month. For that fee, they get all the power they need, within a tested and predetermined range. In exchange for the predictable flat fee, they would agree to become energy partners – not just customers – with Austin Energy. They'd make their rooftops available to solar equipment owned by Austin Energy. They'd agree to reduced-cost appliance upgrades such as solar water heaters. They'd participate in Austin Energy's demand response program, which might cycle off their air conditioners in 15-minute increments on the city's hottest days. They'd agree to limit their peak use of non-essential appliances in favour of off-peak use. They would never be denied power when they need it. But they would agree that using energy at certain times – outside their

service plan – would be "pay as you go," just like tossing more garbage than will fit in your city-issued trash can is "pay as you throw"" (Pecan Street Inc 2010: 16).

One interviewee expanded on the ideas behind this business model:

"We are trying a couple of things. One is how do you make money in this world. And one of the things we are testing is a flat rate… the idea is can we drive down the system cost faster than the utility loses revenue. Because if you are the Austin utility and you have net profit that goes to pay for police and fire and other city services, you don't care about the gross revenue. All you care about is net revenue, because that is what is passed on to the city. We have done a few back of the envelope calculations, if we can reduce cost to the system by 40 per cent, but we only end up with a 30 per cent loss in revenue, we are doing OK or at worst stay even. And we are going to test that out in lots of ways and see if that is possible. So far we don't know" (Interview, Environmental Defense Fund representative).

While this may seem an attractive model there are a number of problems. Another interviewee highlighted issues associated with charging a fixed fee for each customer:

"The problem with that model is, first, setting what that point is. Second is the variation in the price of the fuels and commodities on the part of the utility. I mean historically gas prices have shot up, you might be using the same amount of energy but I will take the hit if I can't pass that on. The third problem is Jevons Paradox, I'm going to have to say 'OK, at your current energy use of your current appliances and so forth, I will just charge you a flat fee and you can use what you want, but if you buy an electric car, the deal is off. You buy two plasma TVs, well I don't know what to do with that" (Interview, former Austin Energy executive).

Jevons Paradox refers to a situation in which increases in efficiency lead to a net increase in energy consumption (Polimeni and Polimeni 2006). While technological improvements have led to more efficient tools such as refrigerators and televisions, instead of energy consumption reducing people buy bigger refrigerators and televisions for each room. If cars become more efficient people compensate the reduction in energy use by driving further, resulting in a net increase in overall energy consumption. Despite this several respondents saw clear advantages with the fixed fee model:

"…and the other thing I like about the flat rate, is you… to make the system work… you use less KWh and to make some of that you have got to increase the rate that you charge per KWh, but rather than getting beat up by your customers or by people who are opposed to this kind of stuff and want to say you are just raising rates… well you get away from rates, you are just simply… you are lowering people's bills and you don't have to explain how… it was 10 cents a KWh, now it's 15, but overall you are saying, well you were paying 100, now you are paying 90" (Interview, Environmental Defense Fund representative).

Moving away from a system of selling electricity in units such as Kilowatt Hours could solve many problems but if customers are all on a flat fee then the utility would suffer if energy consumption starts to rise. Could it lead to a situation where customers need their electronic purchases approved by the utility before they are made? For the utility if wholesale energy prices fluctuate widely then they will be unable to pass the costs on. Also are consumers willing to switch to a system where they are charged a flat fee but then lose control over how and when they can use their own air conditioning unit? One respondent outlined the fear over handing control of air conditioning units to software controlled by the utility:

"One thing we have a feeling is not going to work for a consumer, because frankly nobody is going to sign up for it, is 'I'm going to sign up for a rate programme that somehow makes me hotter and charges me more'. Well, sign me up! But you see a lot of these articles and if you really read between the lines of demand response, it's kind of how it works out. I'm not going to do it. No way am I going to do it. There is no way I would sign up for an Austin Energy thermostat, radio controlled to turn off my AC. I have just saved the utility thousands and thousands of dollars, but somehow I ended up paying for it and I'm less comfortable. Now if I can somehow reap some of that financial benefit… sign me up. We are looking for more novel solutions such as that rather than just charge the customer more and make them hotter" (Interview, PSP engineer).

The second business model being explored, and one which is much more likely to be adopted long term, sees the utility as a hardware platform, rather than an energy provider. One respondent described this system as the utility being the infrastructure itself, and nothing more:

[I] "…this is more on the node for distribution companies, the utility will become a platform that everything operates on. And more and more energy is going to be distributed through distributed generation and onsite, not only generation but energy storage onsite as well as energy consumption. I, as a utility operator, am going to be a sophisticated platform that provides energy one way when you need it, takes the energy the other way when you don't need it, monitors the storage and the plug-in and brokers all this distributed onsite generation storage and consumption.

[AM] So the utility literally becomes the infrastructure itself

[I] I become the infrastructure, and I take a little fee for transactions for monitoring all this" (Interview, former Austin Energy executive).

In this model Austin Energy would become a brokerage platform and provide an energy marketplace for consumers within the city. If I have solar panels on my roof, a wind turbine in my back garden and an electric vehicle to store additional energy whilst not in use, then I can sell excess energy back to the grid when I am generating too much and buy electricity from Austin Energy when I am not generating enough for my own needs. In this model each individual home becomes a decentralised generator. However it is unlikely that consumers will keep a continuous eye on their energy usage, managing their own market transactions individually and selling energy to others when they have an excess. Instead Austin Energy would charge to provide the automated software and the tools to manage transactions independently, taking control away from the consumer. Any transactions on this marketplace would be automatic with minimal user input. As one respondent outlined the reasoning:

"10 years from now I don't think anybody will be logging onto a website and looking at their energy usage. It just doesn't sound right, that people would want to be doing that" (Interview, PSP engineer).

Another expanded on elasticity within the marketplace:

[I] "…we might respond in the short term a little bit, you know, but it settles down real fast. If I raised your rates today by 50 per cent you might run around your house and adjust your thermostat a little bit, or you will turn off a light or whatever, but I guarantee you within a month or two you are going to slip back into your old habits.

[AM] A customer may spend an hour looking at…

[I] …and then you're done. The way I put that is customer want choices but they hate making decisions. So in the end the only product or service that is ever going to work… is one that allows them to make a choice but does not require them to make a decision. So if I make a choice to participate in a programme that will automatically cut off my air conditioner or my electric car charger when my air conditioner wants to cycle, and you throw me 25 dollars for the cost of it, or 10 dollars, or you give me a sticker to put in my window or a bumper sticker to put on my car, I probably will do it, I will see relatively no interruption in my service as far as I can tell, and as long as I don't have to push the damn button every time I want to get my dollar, or whatever, just take care of it. And this was all played out by the guys that did the… it's not freakonomics, but the other stuff, all those studies that have been done by economists that are about how people react to incentives and choices and opportunities. So that, in a sense , is what you see manifest in the smart grid, stuff about all the 'choices' we are going to give to customers, and they are right, sort of, at some level giving all these 'choices' to customers are good, but they don't discern between the choices and decisions that the customers will have to make. What I really like I think, what we would all really like, is to come into my house and it's 30 per cent more efficient than any other house because it's already choosing to do things….

[AM] …and that develops the idea of a smart house.

[I] Yeah and you will get ultimately to sort of the nirvana of this stuff, with buildings talking to buildings and the utility and the people aren't involved. So I watch… I see all the fun people out at Mueller and they get all excited about the idea that 'oh wow I have all these devices in my home', and you talk to a couple of them, but they're not ordinary. I mean one of the things we like about Mueller is that they are not ordinary" (Interview, Austin Energy executive).

This business model fits well into the neoliberal ideology. The state (in this case the public utility) creates all the necessary essentials and provides backup for the marketplace to take shape. Consumers can choose how much input they want to have in their day to day energy usage. A market in home energy management software is created on top of the huge variety of home gadgets. People are free to choose their own consumption patterns. They could generate their own energy and became beneficiaries themselves. All the utility is providing is the infrastructure for these transactions to take place. The state will roll back from becoming the main player in the energy network, preferring to take a more hands-off role. In its place a variety of small economic actors will take control. Although this model may not be too favourable to private utilities that make their money from selling their own generated power, for state-controlled utilities it is a way of encouraging the large-scale adoption of renewable generation by householders while still operating within a neoliberal framework of minimal state intervention. The state is being used to create the market and private actors then take over.

3.3.2) Market Segmentation of Energy Consumers

This business model does create some problems, related to the concept of splintering urbanism. If future energy networks consist of consumers choosing their own smart gadgets and energy efficient tools to manage their consumption what will happen to groups who cannot afford to upgrade? A key foundation of the splintering urbanism thesis is a shift towards "infrastructural consumerism" which is clearly evident in the direction of the PSP within the neoliberal concept of "choice" – i.e.

consumers *choosing* to become more active with their energy consumption through the gadgets they buy and the solar panels or wind turbines they install. However:

> "…such infrastructural 'choice' tends to be limited to certain social and spatial groups within the city. The ability to access competing providers is dependent on wealth, location, skills and how lucrative one is to serve." (Graham 2000: 193)

While accepting that the PSP is a "sandbox" being used to test new technologies and products, several respondents hinted at the direction the utility wanted to take. I accept that the project is a research consortium and has been given access to a unique urban landscape as part of a wider redevelopment project, and as such managers have not had to worry about the concepts of universality, or the effect of the smart grid on the wider population or less economically active groups. Nevertheless, directions within the PSP can be seen as the start of the splintering of the energy network. Recent reports from elsewhere have suggested that different smart technologies are being offered to different consumers based on their suggested market segmentation. In January 2012 The Smart Grid Consumer Collaborative produced a State of the Consumer report, splitting consumers into a number of market groups such as 'concerned greens' ("protective of the environment and supportive of smart grid initiatives… highly likely to participate in energy management programs") and 'DIY and save' ("consumers are frugal and have a do-it-yourself lifestyle. Their biggest concern is providing for their family, not global environmental issues" (Smart Grid Consumer Collaborative 2012)). This is true within the PSP as well. Several respondents highlighted the suitability of the Mueller development for the research describing them as "early adopters" and "homogenous as hell", people perfect for a test audience. One respondent, referencing a 1960s political satire song describing the urban sprawl of middle class suburbia as "ticky-tacky", said:

> "In Mueller we can at least get to measure the house as it is at a fairly… I mean God, those guys are all homogenous as hell, they all look the same, I can't tell any of them apart at a senior citizens meeting up there. They are just all the same. They are all made of ticky-tacky" (Interview, Austin Energy executive).

Middle class suburban Americans are the target audience most likely to purchase the gadgets developed for this kind of a smart grid. Lower economic groups may not be able to afford a home energy management system if it is not rolled out by the utility itself. The models under development envisage these systems all being sold on the open market rather than rolled out universally. Lower-economic groups are more likely to be unemployed or underemployed and as such more likely to spend more of their time in the home leading to higher energy consumption – especially with air conditioning usage in the sun belt of America. One respondent, being interviewed in a highly air-conditioned office, outlined this scenario at length:

> "…but going to the universality thing, it's not yet a myth… well it is a myth, but in the regulatory world as in most of the world, it turns out that discrimination is not illegal. Only illegal discrimination is illegal. What I mean is that if my wife and I are both working full time, and we have no kids at home, we are able to set the thermostat off every day, because we are not in the house and we will just cool it down when we come home. Putting extra insulation or putting a thermostat time-of-use controller on my house is a joke. Paying me is even worse, because I'm not there, I'm not making a choice, and I'm not giving up much of anything. On the other hand, trying to get this office to cycle its energy use on the hottest afternoons is a smart strategy, because we are all in here. So it's perfectly appropriate in an information-rich world for the utility to say 'I'm going to design a programme that goes after the opportunity in the office building and not

necessarily the opportunity that lies in upper middle class homes in the suburbs'. It's just perfectly reasonable, and it's discriminatory as hell, but it's not illegal discrimination" (Interview, Austin Energy executive).

New smart technologies will make it easier for companies and utilities to target their products towards affluent consumers. The Austin Energy executive added this could lead to highly specialised products being designed for target audiences:

"…we might actually be on the threshold of a word we used to use in the early days, of 'customerisation'. We might actually get to the place where this technology enables the utility to say 'these are stay-at-home moms who keep their air conditioner running and run the dishwasher and have the TV running and a couple of other appliances, and we really ought to figure out a way to keep all of them from being on-peak at the same time'. Go to their house, put these controls in place, stop them from quadrupling their peak for a few minutes at a time, because it's not worth building a system to serve that when it's so cheap to control the wavelength. But in my house where my wife and I are both gone all day, don't deploy the hardware, unless you can charge me an arm and a leg for it, because then you will get pure revenue without any cost. So there might be some possibility here, I would say that it's probably going to be better for us to segment our customers before we try to deploy this crap to every single person. I mean, we don't need every appliance in America under control. We don't need everyone with a cell phone app to control it, we don't need those terabyte, petabyte, whatever it is sort of warehouses of data about the differences between your consumption and my consumption. You're gone all damn day, I don't care about your appliances, and when you come home I want you to turn them all on so I can make some damn money from you. But I don't need the sophistication of all this" (Interview, Austin Energy executive).

There are several features of splintering urbanism within this idea. There is the concept of neoliberal consumer "choice". People can choose if they want these gadgets. They can choose if they want to become energy efficient. They can choose if they want to install solar panels. At no point is there any suggestion of a mandate from the state to influence consumer behaviour or force people to buy electric cars. There is also the concept of market segmentation with consumers being grouped into stay-at-home moms or office workers. There is also recognition that the very basis of this model is discriminatory against lower income groups (albeit not illegal discrimination). The neoliberal concept of choice has extended into utility itself. In an information rich world the utility will be tailoring specific gadgets, products and services to relevant consumers. Universality seems to be disappearing from the lexicon. While families at work all day will see very little disruption in their energy services and may benefit from lower costs and improved efficiencies, stay-at-home moms or the unemployed could be forced to install time-of-use pricing structures or load controllable washing machines, handing control over their energy consumption to external entities. Discussing the benefits of the new smart grid gadgets another respondent said:

"…I wouldn't want to force this on the lower socio-economic, lower income people because fundamentally it's not going to save money in the short term. It's a big capital outlay. Now, once manufacturing volumes increase, once we get all these technologies laid out, once every consumer product has this sort of HEMS capability built in, now I think we're talking. But that's years down the line. Down the track, when that stuff becomes trivial, when there is an app built into your iPhone so we can do it, or there is something built into the next TV that you can buy so you can get it, then that's a different game. Once all the appliances have these capabilities, but for now I would observe that retrofitting these capabilities into an existing appliance would be a very expensive thing" (Interview, University of Texas professor).

Although this is a valid point, and rolling the technologies out universally will be prohibitively expensive, there was no mention of consumers who would not be able to afford the latest iPhone and a new television set. The respondent continued:

> "…this is not suitable as first generation for someone who is low income. It is suitable for someone for whom those dollars aren't the point. It's very similar to the Tesla. The dollars aren't the point. It's the image. Now, along the way that's going to spur some technological development, going to build up knowledge about these things, manufacture base builds up, and maybe then that facilitates getting us to the cheaper. But it doesn't make sense to force everybody to do it in the first generation" (Interview, University of Texas professor).

It is possible that the utility could combine the two business models outlined above. Homeowners with the time and resources could upgrade their gadgets to improve efficiency, install their own solar panels and wind turbines and then pay Austin Energy to manage their consumption and generation. Those who cannot afford these new technologies will be stuck on fixed-rate tariffs, having solar panels and wind turbines installed in their homes, but with ownership remaining with Austin Energy, and losing some control over how they use their energy. They will have to charge their electric cars at certain times of the day and will face losing control of their air conditioning units so Austin Energy can manage their energy peaks. They could also face higher charges. As one interviewee stated:

> [I] "…it's choices and control as opposed to giving the utility or government control. So you can decide how much you are paying because depending on how you programme all your appliances, you pay more or less. You get to decide if these gadgets make sense for you. You get to control automatically when the defroster runs on your freezer, when your swimming pool pump runs. If you don't want it to run at the inexpensive time that's your choice.
>
> [AM] So it's an expansion of consumer choice.
>
> [I] You just pay a lot more because you are going to pay the real cost to the system, and the environmental cost" (Interview, Environmental Defense Fund representative).

Highlighting the reality of the choices consumers will face he added:

> "I think ultimately what you do is give people options. You take this option, this is how much you pay. You don't, then you are going to pay more. Because you are making the system cost more."

3.4) Conclusion

A key plank of the splintering urbanism thesis is that of neoliberalism. Cities and urban spaces are adapting their policies to attract highly mobile international finance in efforts to create jobs, provide services and increase the tax intake. For the past 30 years in Austin efforts have been made to use the state as a tool to direct external investment towards chosen economic sectors. The city has used its base as the state capital, the university has offered up land and research resources and urban areas of the city have been opened up to provide experimental workshops for private investors. These efforts have largely been successful. The early work of MCC and Sematech were examples of how public private partnerships could work well. However the history also shows what can happen

to urban environments when specialisation goes too far. In the dot.com crash the city was hit hard, with 40,000 jobs being lost in just a few months, as the highly mobile international capital flowed elsewhere. Yet Austin is now using the same tools and policy devices it used in the 80s to attract finance back towards a different sector – that of clean energy. The companies involved are huge multinationals – Sony, Whirlpool, Motorola, Freescale – demonstrating the attractiveness of such strategies. But the experience in Austin provides an example of how splintering urbanism is continuing within infrastructure networks. The grid itself is now being opened up to private interests. A future marketplace could soon be created in which individual homeowners communicate with each other in order to generate and consume power using the utility only as a provider of the infrastructure rather than a universal service guarantor. If this scenario is played out, then it is likely we will find a new splintering within urban life between those who can afford to generate their own energy – through the installation of solar panels and electric batteries – and those who cannot afford the high initial outlay so will be forced to accept minimum standards from a highly reduced public utility. These low-end consumers may even be forced to change their consumption habits and use energy only at times set by the utility, signing away control over their own home. The experience in Austin gives a very good example of splintering urbanism in action at an early stage.

The PSP is also an example of a technological niche in development within Geels' work on system innovations. The desire of Austin Energy to find a new business model to survive in smart grid is pushing new technologies towards acceptance. Smart meters, solar panels and electric cars are being concentrated within the Mueller district of Austin and are making consumers aware of their energy usage and the cost of doing nothing. The growth in renewable generation such as wind across Texas has created a window of opportunity for the smart grid to emerge. If consumers are willing to engage further in the concept of choice within the energy infrastructure then the smart grid could become the new socio-technical regime.

Chapter 4 - The Mueller District – Splintered Urbanism or a Model for Future Sustainability

4.1) Introduction

So far this thesis has examined the PSP in relation to the changing dynamics *within* the infrastructure system itself – how smart technologies are allowing new markets to be created on the existing grid, the technologies being developed to allow for customer choice and how decentralised generation is changing the relationship between the utility and consumer. So far I have not examined what effect the PSP will have outside of the infrastructure, such as on urban environments in a real, physical sense. While examining the infrastructure system is important, the existing grid is not a theoretical construct and exists in the real world. The growth of wind power in Texas is being constrained by the physical size of the landscape and the need for expensive cable connections, necessitated by the vast distances on the geographical landscape. The socio-technical system outlined by Geels (2002) operates in a real world environment and has a multitude of interactions with diverse actors. In Austin the smart grid is being developed in a fully functioning and real urban area – it is not being developed solely in a lab, but a range of actors and organisations are fully engaged in the project in a real world physical environment. This chapter will look at the Mueller district. First, I will briefly outline the history of urban development in Austin which led to the Mueller redevelopment. Second, I will discuss how Mueller was developed to be a green and sustainable community, and in turn how this led to it being chosen as a test bed for the PSP. Finally, I will explore what impact, if any, the PSP has had on the community.

4.2) Austin Urban Development – Growth Machine versus the Green Machine

The emergence of Austin as a major centre of technology research and development in the 1970s resulted in peripheral development of offices, hotels, and other high-rise buildings. Throughout the 1980s and 1990s development in Austin continued to rise with its continued dominance in the area of technology research as well as general population growth – in 2011 the population of the city was more than 820,000. Development in Austin has been a continuous battle between environmentalists and the developers (Swearingen 2010). From the 1960s until the 1990s the debate on urban development was between the "green machine" and the "growth machine" with activists viewing most developments through a prism of profit or environmental protection. It was either unfettered development on pristine greenfield sites to provide growth or no development at all.

Austin has a long history of environmentally-conscious residents. Early city planners and private developers saw Austin in terms of the high quality of life it could offer migrants and workers. The early city was relatively small and surrounded by wildlife, stunning vistas and natural formations. The inner city offered a rich nightlife, vibrant music scene and low crime. Quality of life became an important asset for the burgeoning high-tech business industry hoping to attract well-educated

workers. Concerns for the environment were tied to this. The first greenbelts were created in the 1960s with environmental issues being written into the planning code. However the main aim was not to protect the environment for its own sake, but:

> "…they were seen by the business and civic leaders of the time as ways to increase the attractiveness of the city to future residents and businesses. In order to continue attracting white-collar workers and jobs, the plan emphasized a pleasant-looking, residential city, defined by its neighbourhoods rather than by industry." (Swearingen 2010: 44).

In the 1960s and 1970s the economy was centred on white-collar occupations in government, education and the emerging high-tech industry. Very few businesses and residents had any dependence on resource extraction or exploitation of the city's natural resources so the environment was seen as "something to live in rather than work from or pollute with factory smoke" (Swearingen 2010: 42). Yet despite the city having a vocal environmental community, environmental concerns were seen as lesser than those of growth and development. Quality of life, wildlife, and the scenery were seen as pull factors for attracting businesses and workers from elsewhere. Elected politicians and business leaders did not see them as issues which should take priority in themselves – they were merely added benefits when selling the city to others. The city also had a number of wealthy West Austinites with business and political ties to the authority being opposed to any kind of government regulation. These groups:

> "…did not experience the degradation of creeks and the river because they did not use them for their own recreation… instead of using their neighbourhood creeks or river, they drove out of town to private, undeveloped land on the weekends. They did not have to think about preserving Austin's natural environment because they owned their own 'nature' outside of town." (Swearingen 2010: 74)

Susan Owens, citing Cotgrove and Duff, suggests this situation was not typical to Austin with groups on "the 'periphery' of corporate capitalism, such as academics, planners and other public employees, more likely to hold environmental values than those at the 'centre', including central government, the major corporations and the trade unions" (Owens 1986: 91). In Austin although environmentalists did win some major concessions these were largely due to the connections and motivations of wealthy Austinites themselves. People in lower socio-economic groups in the east of the city saw very little of the environmental benefits. On a city-wide scale when the growth machine came up against the green machine it was usually business interests that prevailed. The city's Chamber of Commerce favoured growth at any cost while elected politicians neglected funding for environmental projects in favour of large infrastructure schemes. The animosity between planners within the City of Austin and the Texas legislature continued until the late 1990s when the state pulled out of providing an anchor tenant on the Mueller development. As outlined in chapter 2, as a state Texas is overwhelmingly in favour of private property rights and "devoted almost wholly to the pursuit of profit… Texas legislatures were not at all impressed by what they considered a bunch of liberals and hippies telling a developer what he could do with his land" (Swearingen 2010: 140).

Things began to change in the late 1990s when a new influx of high-tech businesses and well-educated workers began to change the discourse. Although many people still believed in the "growth at any cost" philosophy, new high-tech companies began to reconnect with the idea of quality of life for workers, including strong standards for environmental protection. These people were not *against* growth but were *for* the environment that provided that growth. The debate

between the green machine and the growth machine changed into simply growth itself, albeit in a more controlled and environmentally aware manner. The development at Mueller is a result of this change in emphasis and the adoption of an ecological modernism discourse surrounding the environment. Rather than allowing unfettered development wherever the market takes it, the city wanted to control it and direct it into specified zones. New urban development, especially the shift to high-density zones like Mueller, is "seen by many as a way to decrease the suburban sprawl that causes most environmental problems" (Swearingen 2010: 186). The history of the battle between developers and environmental activists and then the coming together of the "growth machine" with the "green machine" was one factor that led to the development of Mueller. Ecological modernisation provided an argument that economic development should be encouraged *for* environmental protection purposes. The new district of green homes and environmentally conscious residents would help protect the environment, developing new forms of sustainable living.

4.3) Mueller – A Template for Future Urban Planning

The Mueller development represented a shift in urban design within Austin in the late 1990s with the rediscovery of the importance of the city's quality of life in attracting businesses and workers. The city's Chamber of Commerce became involved in promoting environmental issues and understood that protecting the environmental landscape was itself a pull factor attracting workers and businesses from elsewhere. A new breed of environmentalists now became active in the city who were no longer against any forms of development, but believed in ecological modernisation. Recognising that development within the city was inevitable they focused their concerns on ensuring development was confined to specific districts and away from environmentally sensitive areas. However, early battles between the state apparatus within Austin and private developers had created a situation in which developers seemed to be able to circumvent their way around Austin's planning laws and develop where they saw fit.

4.3.1) Mueller History

Mueller was designed from the outset to be different. The neighbourhood is three miles from downtown Austin, separated from the centre of the city by Interstate 35 (figure 12).

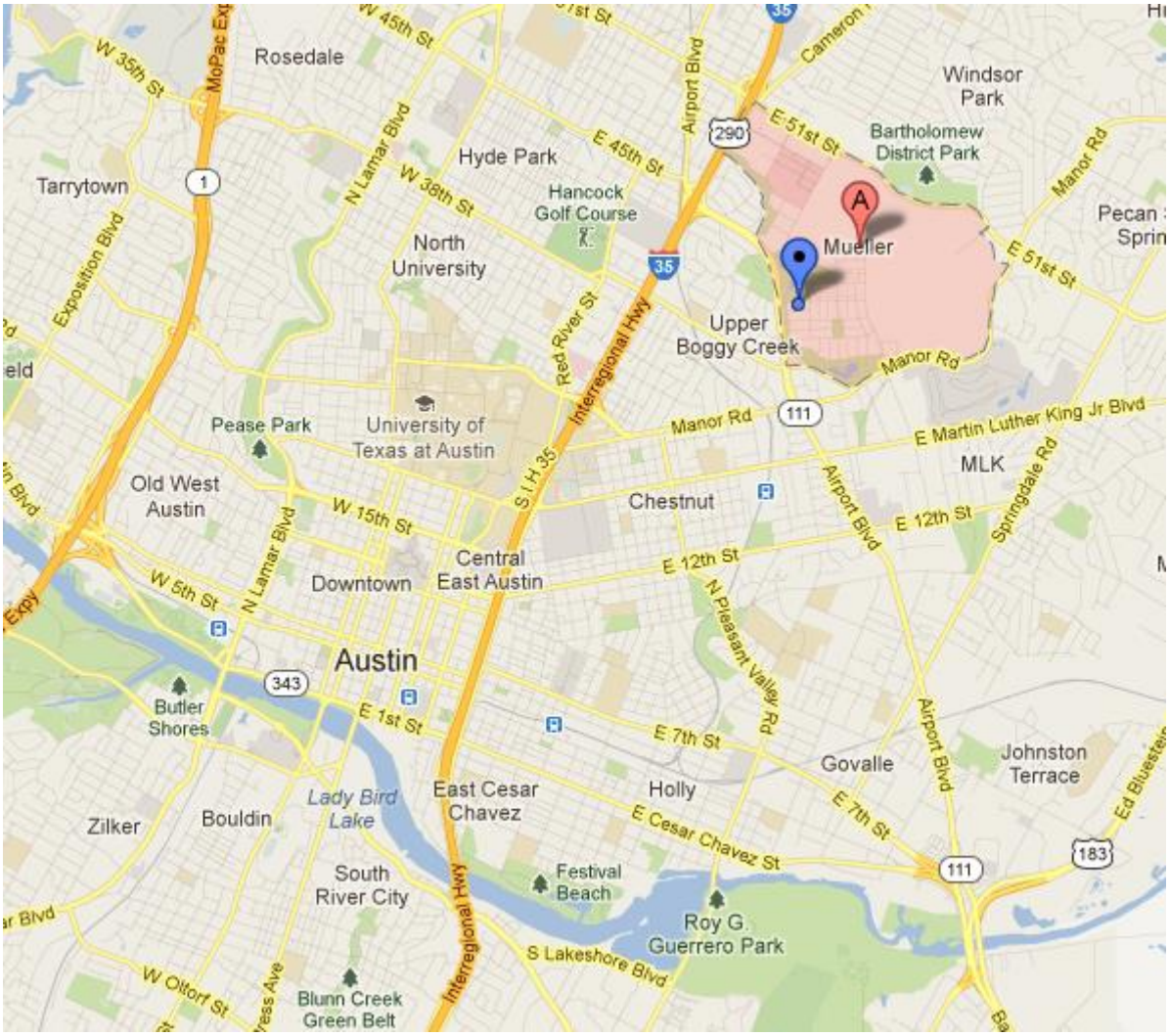

Figure 12 - Mueller (marked A) in relation to downtown Austin (Source: Google Maps (2012))

The development sits on the 711-acre site of the former Robert Mueller Municipal Airport – which was opened in 1936 but relocated south to the decommissioned Bergstrom Air Force Base in 1999. This was a prime brownfield site ready for redevelopment with the land still owned by the city. Instead of selling the land off in a single large chunk to one developer or dividing it up into smaller zones on a piecemeal basis, the city wanted to keep some control over what was developed. A vocal community surrounding the land made their voices heard and informed city planners on a weekly basis about what they wanted. As one planner said:

> [I] "… in the case of Mueller there were years and years of public input on what… when it was clear the airport was going to move, and even before the airport was going to move, there was a lot of interest in what should occur there. When I was here during the planning stages I would get weekly letters, 'let us put a racetrack in', 'let's do this, 'let's put a waterpark in'.
>
> [AM] From the residents?
>
> [I] Yeah, from the whole city mostly" (Interview, Austin City planner).

From the beginning community representatives had an input. Although relocation of the airport was discussed as earlier as the 1970s nothing concrete was achieved until the creation of the RMMA (Robert Mueller Municipal Airport) Redevelopment Process and Goals Task Force in 1996. The task group was enthusiastically backed by residents living nearby. As an editorial in the Austin Chronicle argues:

> "The Goals Task Force was dominated by local neighborhood leaders (several of whom are architects) who had fought to move Mueller for years, and who as far back as 1987 -- in the Manor era -- had crafted a planning vision for the site. In fact, the chair of the Goals Task Force, Girard Kinney, has since been hired by the city to watchdog the current process and make sure the goals are honoured" (Clark-Madison 1997).

Nearby community leaders drew up a list of social goals they wanted to be incorporated into any new development. In 1997, to act as a kick-start for the new development, the state of Texas said it would buy 282 acres of land for its own use to act as an anchor tenant and the Roma Design Group was contracted by the City of Austin to draw up a development plan. As the Austin Chronicle outlined in 2000 the company was contracted to turn "the local task force's goals and recommendations into an actual buildable plan for a Smart Grown, mixed-use, transit-oriented, pedestrian-friendly, you-know-the-rest urban village – which is what the neighbours wanted all along" (Clark-Madison 2000). The Roma Group incorporated the original social goals drawn up by nearby residents into a set of clear policies to be adhered to (table 4).

Fiscal Responsibility	Redevelopment must create a positive revenue stream that will fund on-site infrastructure and increase the City's tax base for the benefit of all citizens.
Economic Development	The project should serve to reinforce Austin's role in an increasingly global marketplace and create a wide range of employment opportunities for a diversity of the community's citizens.
East Austin Revitalisation	The project must promote economic development opportunities within East Austin, giving local residents a direct stake in redevelopment.
Compatibility with Surrounding Neighbourhoods	Development must maintain and enhance the quality of life in adjacent neighbourhoods, providing complementary linkages, land uses and transportation patterns.
Diversity and Affordability	Redevelopment must offer a wide range of housing choices in order to create a new community of socially and economically diverse residents
Sustainability	Development should be planned in a way that promotes energy and water efficiency, resource protection, reduced auto dependency, watershed protection and green space preservation

Table 4 - Goals of Mueller (Mueller Austin 2012).

Early phases of the work involved an "opportunities and constraints" phase involving economic development officers and planners holding focus groups across the city of Austin, not just in the surrounding neighbourhoods of Mueller. A key goal of the task force was sustainable development. As the recommendations highlight it was to be "a model for responsible urban development and influence the form and pattern of growth as it enters the new millennium" or as Clark-Madison described it "the New Mueller was Smart Growth when Smart Growth wasn't cool" (Clark-Madison 1999). He further detailed steps the state and community had taken to become involved in how the new Mueller district would be developed:

> "Even if they had been heathens, though, Roma has been both aided and shadowed by a City Council subcommittee, a focus group of neighborhood reps (including this reporter), a council-appointed advisory group chaired by architect Jim Robertson, and city-contracted ombudsman Girard Kinney, the architect and longtime Mueller neighbor who led that neighborhood effort of 15 years ago, chaired the Process and Goals Task Force, and has generally been the sage of the New Mueller" (Clark-Madison 1999).

The cost for the whole project was estimated to be around $2.2 billion from both public and private sources. However problems emerged in 1999 when the state of Texas dropped out of the project, handing back its 282 acres and forcing the city of Austin to come up with the money itself.

In 2002, Catellus Development was selected as the development partner to work to the previously developed Master Development Plan. Commercial development of the site (including SEDL, the Dell Children's Medical Centre, and retail shops) became operational in 2007, with single-family home construction beginning in the same year. Between 2008 and 2009 single-family homes along the first three completed streets were completed as well as the Mosaic multi-family site. The eventual plans for Mueller include 4,900 single and multi-family homes (including an allotment of at least 25% affordable housing), a retail town centre, and additional scientific and technological research sites including the University of Texas Medical Research Campus, Austin Film Studios, and additional retail and office space. The completed development will eventually house around 10,000 people and 10,000 permanent workers, including 1,100 affordable homes and 140 acres of open public space. It is also set to receive parks, trails, a hospital, doctor's clinic, school, offices and light rail links to the wider city. It is essentially a new community being built on the outskirts of Austin.

4.3.2) Incremental Changes and the Push Factor

Similar to previous public-private partnerships within Austin outlined in chapter 3, the development of Mueller could be argued to fit within the splintering urbanism thesis, although only partially. The City of Austin is fearful of losing competitive advantage to other areas and rather than have development leaking out of the city into other districts – and therefore losing any benefit from increased taxes – Austin wants to bring urban development back into its own zones of control. The city wants to generate growth "by courting the private sector and cultivating economic enterprise across the urban landscape" (MacLeod 2011: 2444). Similar to the examples of neoliberalism explained in chapter 3 the aim is to use the state apparatus to attract private interests. Rather than have the state design, build and sell the homes, the aim is to contract the process at arms-length yet

still be able to have an input and be able to direct the process. The setup allows the city to maintain control yet spread the risk of failure. The splintering urbanism thesis describes this as an intensive effort "to configure built space and infrastructure needs in parallel to the detailed desires and wants of manufacturing inward investors" (Graham and Marvin 2001: 339). Yet unlike other examples examined in the splintering urbanism literature the city of Austin and community representatives were able to keep some level of control over the development, promoting social and environmental goals and tailoring construction so it links with the rest of the city. While the private sector was brought on board, it did so with clear and strict guidance from the state.

A key element in using the vehicle of a public-private-partnership for developments such as Mueller is a shift worldwide away from cities as managerial authorities and towards entrepreneurialism. The attempt is to bring in the "dynamism" and efficiencies of the private sector to drive growth while reducing any unnecessary bureaucratic oversight. For smart cities the literature highlights the emphasis on "business-led urban development" (Hollands 2008: 308). One component of the splintering urbanism thesis is "the growing influence of the private sector and business interests in convening urban politics and in shaping the nature of urban policy, whether analysed in the form of growth coalitions, regimes or public–private partnerships" (MacLeod 2011: 2444). One example within Mueller is how planners and developers were able to collaborate with other city departments in order to change Austin's planning codes and ordinances in favour of the development. The high-density housing within Mueller – unlike many US suburban developments – meant several changes to the planning codes were needed and interviewees felt their colleagues were more open to the changes than if the requests had come from an external actor:

> [I] "...although some of them were kind of grumpy about it. What we did was, during the fact-finding two years, I just pulled staff in, because I used to work in planning review for two years, it was really valuable to me, I worked there before I moved into this position, and I knew people. I would invite staff in and say 'look, council told us we have to do this, and can you help us', so we got them to help us identify the things that needed to be changed, because our codes are real complex. So we asked them to help us and they knew that council wanted us to do it, so yes they did help us.
>
> [AM] So that's one advantage, you can just grab someone down the hall and say 'we need this changed, how can we do it?'
>
> [I] Yeah, help us make the list of what we need and someone will come up with ideas, 'you might want to do this', and then they were also aware of it when it came around, they already had seen those things in their area and they made sense. We had almost no pushback on the zoning, it was very strange. I worked on the zoning with the zoning guy. Everyone knew council wanted them to do it so people were less inclined to pick it apart and say 'why do you need this' because it was such a big effort" (Interview, Austin city planner).

Some of the codes were changed to accommodate the requirements for affordable housing, as the interviewee stressed the private developer was struggling to make a profit on the construction. The planning codes were also being changed to accommodate the emerging ecological modernisation discourse. Geels' three interrelated analytic dimensions (figure 1) demonstrate how human actors and organisations can influence rules and regulations. In Mueller the codes were being changed on an incremental basis when they needed to be. The new discourse is shaping development on the ground, winning the hearts and minds of planners and city officials, before becoming normalised within the law. The niche vehicle of a public-private-partnership, focusing on one high-profile urban

development project, fostered enthusiasm in city workers changing the planning codes, which in turn influences other future developments. Another respondent argued:

> [AM] "So you have the city, Austin Energy, the water, the planning, all working together towards the same thing. So were they more helpful knowing other departments were involved?
>
> [I] Yes, that's my belief. They never specifically said that. There wasn't that sort of physical connection, as they are in separate buildings, and they certainly didn't know the names of anyone else working on the project. It's certainly too large of a city for that. But I think understanding that it was a project being funded by a government grant and being something that was very unique, I think they gave us the benefit of the doubt" (Interview, PSP architect).

Because city officials knew the importance of the Mueller development there were few dissenting voices:

> "…so we worked for two years because council said go do that, but every code said, 'it's against the code'. So we basically had to sit down and figure out… we basically made a giant list of all the things that had to change the code... Zoning and site development standards, sub-division, everything. It's kind of the development section of our ordinances. So we did this huge look at that. We had an engineer, we still had our planner, and basically we didn't have opposing planners, opposing engineers – we had one engineer, one planner, one pro forma, a financial consultant that we had originally. And it was just transparent, and we were just trying to make it work like a business deal. So they worked on that until it was right side up and then we figured out all the things that needed to change, and the city processed that in the zoning code" (Interview, Austin city planner).

Other respondents felt the city bureaucracy slowed the project down immensely. One interviewee described the problem as there being "too many cooks":

> "Having the city involved did slow things down tremendously. To be fair, sometimes that friction is good, as it forces you to think about your decisions a bit longer. But at other times it's not fruitful at all. It's just…. There are so many cooks in the kitchen. If it had been developed privately it would have been a much more streamlined approach. But it's a necessarily evil. Because the government had put forth the funds for us to do this, but there were strings attached, we had to follow all these different types of rules and to work with everyone, and everyone has to be happy. For me it was a necessary evil in and of itself" (Interview, Chamber of Commerce representative)

4.3.3) Green Developments Attract Green Residents

The high level of input from the community, the city and from developers changed the rules and regulations of the socio-economic landscape, contributing to the adoption of strict environmentally and social goals for Mueller. The discourse of ecological modernisation that had developed in Austin in the late 90s was now having a real and physical impact on urban development, and in turn this type of development attracted a certain kind of resident. In the previous chapter it was suggested by one interviewee that residents within Mueller today are not "ordinary" people. Many are classed as early adopters, ready to try out new technologies without fully understanding the benefits. Early residents who moved in to Mueller had to sign up for a lottery before any houses were built, yet they were happy to pay a deposit and sign up based on what they believed would be developed.

These early adopters examined the goals behind Mueller and signed up based on the potential. One resident said:

> [I] …before we moved in there was nothing here, there was dirt. You had to enter a lottery to get a house here, because there was such demand for it.
>
> [AM] This was before it was even built?
>
> [I] Before the houses were built, before there was a road, anything. So we entered the lottery, and our number got drawn, and said you had to go in, pull your number, put your money down, sign your contract, or walk away. Frankly the people who moved in at the beginning had to be people who kind of knew what was going on, because you had to know about the lottery, kind of be tuned in, and had to be really for this concept because you were signing your paper and putting your money down and nothing was here, so you had to have trust. So that first group was very engaged and knew what the principles were. The more it goes on, the less of that you see, because it is just general open sales, and so not everybody is as informed as the first group. And so, I haven't seen any issues from that yet, but I'm just saying it would be interesting to see how that sort of evolves as we move forward" (Interview, Mueller resident).

By their very nature these residents are more socially and environmentally aware than others, and this helped Mueller progress further as a green community. Part of the energy infrastructure is powered by a CHP power station provided by Austin Energy, which also provides cooled water for some of the buildings. The buildings within the development are designed to share heating and air conditioning systems, reducing heating and cooling costs and environmental impact. There is evidence of the effect the development is having on the discourse within Austin. Members of the Mueller community largely identify themselves as progressive, Democratic voters, and are happy with the variety of people moving in. One resident suggested the social goals of the development are influencing the residents in their day to day lives:

> "Every once in a while you will hear people in places kind of start to talk that way a little bit. Like you will hear people in a meeting make a comment or something like, I don't know, 'there's too much trash in our parks, we shouldn't have so many people'. And they very quickly get kind of nicely shut down, like 'no, no, no, our parks are open and everyone should go to them'. And that's how we all want it to be. Very quickly people are starting to say that kind of stuff" (Interview, Mueller resident).

The social goals adopted for the development become the new rules of the socio-technical landscape and become self-enforcing. The residents who have moved into Mueller are adopting the same sense of community. Human actors are now being influenced by the changes and are reinforcing the same rules and regulations. One resident, when describing the development goals, said:

> "…this is a petty small thing, but the pool can never be this private pool that only we can go to, because part of our theory and principle is that everything has to be open to everyone. There is a fee that goes to outside people because the way the structure is set up, but it is not going to be like 'no, no this is our pool, this is our pool'. It can't be that way. And it kind of sets up that framework" (Interview, Mueller resident).

This extends beyond the lives of individual residents to the participation of private businesses and multinational companies operating within Mueller. Interviewees suggested the strict rules on environmental building standards were spreading beyond the district into other areas of the city and even beyond into wider Texas. To gain planning permission to build in Mueller, private chain stores had to provide designs showing how their buildings would look if they were to have solar panels

installed at a later date. One interviewee argued that although installing solar panels were optional, the fact that developers had to think about the issue influenced the design:

> "…It's not an actual requirement. It's just to make the builders think about it. It's not normally in their way of thinking. There are a few cases… all the buildings have to meet certain requirements, such as Best Buy for example had to meet certain requirements. And because we made them do that, they have learned some stuff from that and they have changed the base design for all of their stores in the region. So they won't necessarily do everything that we made them do here, but they learned 'oh, well these five things were easy, and they saved us money, and these five things were crappy and we don't want to do them, they were a pain in the ass.' You will see that a few times too even with some of the city stuff. They will kind of give you push back and stuff, and you say 'no, no, we want this and this and this,' and they will come up with the possible things that we can do, and then they will start showcasing it as a success story for them, and you are like 'see?' Sometimes it takes somebody pressuring them" (Interviewee, Mueller resident).

4.4) The Pecan Street Project Within Mueller

There were three reasons why Mueller was chosen as a test bed for the PSP. Firstly, the adoption of ecological modernisation as a discourse within Mueller created an urban area that was a perfect fit for a project such as the PSP. The PSP did not *need* the Mueller development, in that it could have chosen a different site to use as a demonstration. But Mueller has environmental goals and standards that are similar to the PSP's. The PSP is about using new technologies to avert environmental crises and reducing energy demand by using demand response and decentralised generation technologies. As one interviewee argued Mueller was "an obvious place to test things", adding:

> "… you had this hub of homes that already met certain criteria, because we had to adhere to certain green building principles as part of the development agreement. We were very well communicated with each other, kind of a very good network to communicate; houses were easy to work on, it was an easy kind of plug in for them to test stuff. It was a perfect… plus the city has some sort of control out here" (Interview, Mueller resident).

The homes within the Mueller district were built to strict environmental specifications. Since the 1980s Austin Energy has had its own ranking system for environmental standards and the residential homes within Mueller were all built to a three star minimum (out of a five star scale). One interviewee argued that one star signified higher standards than an average American home, adding:

> "…these are extremely energy efficient homes, so it was a great location to do this demonstration project. The people who live in Mueller are environmentally conscious and so want to participate. So it's not forcing it down their necks, and it's volunteers amongst them anyway" (Interview, Chamber of Commerce representative).

Mueller was developed under a smart growth initiative in the late 1990s – more than a decade before the PSP was created. Many interviewees felt the goals of Mueller matched the objectives of the PSP, and the community was a "self-selecting group of people living in a green community" (Interview, Austin Energy executive). Eventually the project will involve 1,000 residents as volunteer

participants within the PSP, allowing the project to install smart technologies and to monitor energy use. The district already has the densest concentration of electric cars in the United States, with 100 Chevrolet Volts, allowing the project to research effects on the grid infrastructure.

The second reason why Mueller was chosen was due to the homogenized nature of the building stock. All homes were built within a few years of each other, meaning all were fitted with similar appliances and all had similar energy efficiencies. This is an important consideration for a project studying energy usage. One interviewee argued:

> "…it's a great test audience, because I don't have to deal with differentials between housing stock, for example. The diversity of housing stock climbs probably almost exponentially as the housing unit gets older, because five years from now your air conditioner breaks and you get an update, and seven years from now 25 people's break, and they get replacements. And your diversity goes screaming through, and now you don't know what you are measuring. Am I measuring behaviour or expiration of stock, or am I measuring that he just got an inheritance when his mother passed? Am I measuring that he is planning to sell the home? I don't know what I'm measuring right? In Mueller we can at least get to measure sort of the house as it is" (Interview, Austin Energy executive).

The third reason why Mueller was chosen was due it still being under construction. One benefit to the PSP was the ability to build an experimental research lab in the centre of the residential area. Mueller not only offered the space for this type of development, it also offered the PSP members access to the city's planners:

> "…with the city involved we had access to the planning department. We knew that, for example we are building a new research laboratory out there…we are basically building a commercial scale research lab in the middle of a residential neighbourhood. There are some zoning changes and variances that we had to get approved. Basically the laboratory is going to have the same amount of electric infrastructure that is equivalent to I think five regular residential homes. So the power infrastructure that we are building in the lab is significantly more, and none of that would have been possible if we did not have the city on the board, directly engaged with the project, and willing to work with us on further developing the project" (Interview, Chamber of Commerce representative).

These three factors made the Mueller district an ideal place for the PSP to operate. A representative from the city's Chamber of Commerce felt that if somewhere else had been chosen as a test site, the PSP may not have got funding from the federal government and the project would not have been launched.

4.5) The Potential Impacts of the Smart Grid Within Mueller

The impact of the PSP is difficult to evaluate at this stage, mainly because it is still early in development. The novelty factor associated with the gadgets and technologies may not yet have expired, making it difficult to draw firm conclusions at this stage. Yet there are some important points to be made about the potential of the PSP.

Firstly, it must be noted that Mueller is an experimental lab where various technological seeds can be planted. Researchers are trying out many different gadgets and policy techniques within this

district, seeing what works and what does not, and then hoping the successful projects will be rolled out elsewhere. For the PSP it does not necessarily matter if residents do not fully adopt certain technologies, or if ways of consuming and generating power between homes become problematic. Mueller is:

> "…a safe place to play this out, an appropriate base, you can take advantage, you are not worried about cherry picking because it's a lab setting. You are not worried about social equity because it's a lab setting, you are not worried about all the messy things that are associated with deployment, but you get to kick the tyres as we say, to check it out before you have to work through all the rest of that stuff. And it satisfies the people who don't want to do anything. Because they don't have to" (Interview, Austin Energy executive)."

Mueller has become the physical embodiment of Geels' niche with many different technologies being tested and scaled back depending on how well they fit together as a seamless web. Some of these technologies could become embedded across the landscape, most likely will not. But Mueller is a test bed for reducing the failure rate. It is a place where researchers can fine tune and develop their technologies in a real, physical world. One Austin Energy executive argued "we don't care if Pecan Street succeeds or fails over the Mueller area, it's an experimental place."

Secondly, as highlighted in the last chapter, one aim of the PSP is to turn residents into active energy participants, rather than passive consumers. Once residents see how smart technologies work, once they understand how they can reduce their energy consumption, save them money and reduce the impact on the environment, then it is hoped more of them will be likely to adopt them. This stretches not only to low-tech gadgets and techniques such as using harvested rainwater to irrigate lawns, but also to high-tech gadgets such as solar panels and electric vehicles. One architect argued this well:

> "…this particular project is about trying to create awareness as well… it's evolved. My hope is always that this has been something to encourage this particular community to really engage both in those more generic principles… let's just say with the high tech and the low tech. Actually seeing the different technologies that are out there right now, and getting a sense of 'oh, now I see what there is', and to break down the fear factor of all of that, to get people to engage so they want to experiment in their own houses in terms of how they can begin to live differently. So it's this idea of becoming quite active. Instead of just doing the least harm, or which is the intent… we are trying to have a very small footprint, literally… but also trying to get people to actively engage with the built environment" (Interview, PSP architect).

Similar to a previous quote about residents loving choices but hating decisions, the aim is to provide residents the opportunity to become green and environmental *if they choose to become so*. There is no mandated push from outside. The hope is residents, if given the opportunity, will see the benefits themselves and change their own behaviour. The neoliberal agenda of free markets and choice stretches to the designs of the homes and buildings within Mueller. This is evidenced by the PSP being a volunteer only project. Only people who want to take part are doing so.

If these types of technologies are to be incorporated into the sider socio-economic landscape, as defined by Geels, then will be adopted on a piecemeal, incremental basis. Technologies will rolled out slowly and to only those who want them. However the software and tools that allow consumers to become more active in energy decisions will become more prevalent and cheaper over time. One interviewee argued this was the motivation:

> "…once manufacturing volumes increase, once we get all these technologies laid out, once every consumer product has this sort of HEMS capability built in, now I think we're talking. But that's years down the line. Down the track, when that stuff becomes trivial, when there is an app built into your iPhone so we can do it, or there is something built into the next TV that you can buy so you can get it, then that's a different game. Now, along the way that's going to spur some technological development, going to build up knowledge about these things, manufacture base builds up, and maybe then that facilitates getting us to the cheaper" (Interview, Austin University professor).

The impact will only arrive when a critical mass of people are participating in the new socio-economic landscape, and this point will only arrive when the software and technologies are cheap enough to be rolled out on a large scale.

A third impact relates to how people visualise their energy usage. Energy consumption and generation is to become a visual part of the geographical landscape in order to make residents think about how they consume energy in relation to each other and the wider city.

> "…a smart grid as being a way you can begin to conceptually think of my energy use… I'm dependent upon a grid, I know there is a grid there, and I can now be interested in my relationship with that grid. I can understand how much I am pulling from that grid or how much I am selling or giving back to the grid from my energy harvesting, from solar panels. And that sense as well as being a community, instead of just having your own house that is removed and using the energy in whatever way. Now you can understand in relative terms, and understanding how much your neighbours are using relative to yourself and where you stand. So, for me there is no singular definition of sustainability of any type. In this project it certainly isn't. It spans scales, from a very large scale to a very small scale, and it spans from the physical to the more mental associations" (Interview, PSP architect).

Solar panels and electric vehicles are highly visible components of the energy infrastructure. Similar to the solar sunflowers car rental schemes outlined in chapter 2, by making energy usage more visible it is hoped the issue will become a key topic in the city's discourse.

The fourth, and arguably most important, potential impact revolves around creating sustainable communities in terms of human relations, not just in energy consumption. Proactive human relationships and neighbourhood collaboration have been cited throughout the Mueller documentation, rather than having each individual home isolated from its wider environment. Planners wanted to create ways to encourage residents to link up with each other to link them with the rest of the city.

> "…there are the sustainable elements in terms of actually trying to create a sustainable community, and instead of this isolationist idea that a lot of American houses have, where you are fenced off and you have your own world, we are actually creating this positive…. having this strong energy, with each house and shop having a presence on the street, so it's a place which you would actually want to stay, a development that would continue to thrive and be sustainable in that sense, and it wouldn't be some trend that would just die off, with people moving on to the next development. It would be something that would begin to develop its own… life of its own and its own character and create a sense of community in a generic sense. In some ways so that people are actually forced to meet their neighbours" (Interview, PSP architect)

Not all features of Mueller have been a success in this regard. The design of some of the affordable housing has itself created problems within Mueller. As Robert Hollands describes, "one of the key elements which stands out in the smart (intelligent) city literature is the utilization of networked

infrastructures to improve economic and political efficiency and enable social, cultural and urban development" (Hollands 2008: 307). Smart cities are "wired cities" and ICTs are a main economic driving force in urban areas. Yet in Mueller, because of the design of several of the apartment blocks reserved for affordable housing (very few of which will make the developer a profit) very few residents within these blocks can participate in car sharing schemes. During a public meeting attended in Mueller a start-up business was advertising a car rental scheme whereby anyone can cheaply rent an electric car for a few hours or a few days. While several residents expressed their interest very few could sign up because they did not have any provision for parking facilities to store the vehicle. Because of lack of space and a desire to create high-density housing some residents were unable to sign up for a Chevrolet Volt from the PSP, or even rent transport over short periods. Instead these benefits went to those living in the larger homes elsewhere within the estate. This could potentially put at risk plans to improve integration and social cohesion within the development. One of the major questions is whether formation of community in a real sense will be possible in Mueller. Clarke argues:

> "…under the banner of New Urbanism, the marketing of community is inherently exclusionary. These developments, produced with mandated aesthetics, proffer a vernacular image of community for the social relations and personal identification of place" (Clarke 2005: 43)

Lower-income groups within Mueller, within the affordable housing schemes, could find themselves excluded from the benefits of a smart growth driven future. While the designs for these buildings were completed long before the PSP was created, the usage of space within Mueller has already created problems with social cohesion. If, as is likely, a smart future allows for residents to retain their desire for personal transport (although electric cars instead of gasoline cars) then those without the means or space to utilise cars will remain isolated socially and economically. Any benefits low carbon vehicles may bring to urban spaces will bypass them. Although they are not living physically isolated within gated communities they remain walled off from the smart future, being ignored in a shift towards "infrastructural consumerism". If residents are left to exercise choice in how they interact with energy networks, this will limit the benefits to "certain social and spatial groups within the city. The ability to access competing providers is dependent on wealth, location, skills and how lucrative one is to serve" (Graham 2000: 193). Even within the Mueller district, which is designed to be an example of a cohesive society and relinking of space within the city, we can see examples of premium networked spaces for those who can afford them and the very basic services for those who cannot.

4.6) Conclusion

The Mueller development has come about as a result of decades of battles between city planners, environmentalists and private developers. The idea of a "new urbanism" and changing discourses within the city of Austin has led to a coming together of the main antagonists, and the vehicle of public-private-partnerships has been used to secure funding and social goals for the development. The green goals and sustainable objectives of Mueller provided a neat fit with the aims of the PSP and now the district provides a real world experimental lab for researchers to try out new technologies. Mueller itself is the niche described by Geels.

Within this community we can see the furthering of neoliberalism, and similar to how the PSP wishes to create an individual market for energy, in Mueller residents are being given choices to make their own decisions about how they live, how they consume energy and how to interact with each other. However one danger is that those without the financial, political or physical means to make those choices (such as those in affordable housing without parking provision) are being bypassed, isolated from the emerging smart market.

Chapter 5 – Conclusion

5.1) Answering the Research Questions.

In this thesis I have attempted to examine the socio-technical conditions that exist within an urban area that allows a smart grid project to emerge. My initial overarching research theme outlined in Chapter 1 was:

> What are the socio-economic conditions present in an urban area that allow for a smart grid experiment to emerge?

This was framed in such a way so I could identify what conditions are already present within Austin that allows the PSP to emerge, almost in a natural evolutionary form. Why does a project in Austin have a higher chance of success than one in Boulder, Colorado? Rather than examine how the projects themselves differ – such as in the technologies that are being used, the different forms of consumer interfaces or cost differentials between energy prices – I wanted to look at the base conditions of the urban environments themselves that (could) allow a smart grid to evolve and to succeed. I did not want to look at how projects are trying to persuade or force consumers to adopt smart technologies against their will. I also did not want to focus on the individual technologies are being rolled out. Many of the technologies being deployed in smart grid projects have been around for decades. Solar panels and wind turbines are not *that* revolutionary. Electric vehicles also have a long history. The problem to identify is why they have not been deployed on a large scale, and what can be done to further encourage their use. In this thesis I wanted to examine the wider socio-technical landscape that surrounds the smart grid and what it is that is directing consumers to choose to participate, without any coercion from outside. Then we can look at how this can affect the future evolution of the infrastructure. In Austin the smart grid project appears to emerge as a natural evolution of the existing system because of the socio-economic conditions that are already present. There are five factors in this case study that I believe that have allowed this to happen.

5.1.1) The Energy Discourse of Texas.

As outlined in Chapter 2 the discourse surrounding energy is largely focused on using resources for energy-based economic development. Oil and gas are seen as resources to be extracted and exploited and the development of wind fits well into this discourse. Wind power is not seen as a way to reduce climate change emissions (Texans "reject the pledge" of being green). Instead it is a way to make money, while smart meters have been successfully promoted as "cash registers" for energy. Within this energy-based economic development discourse smart grids are not ways to reduce carbon emissions or ways to boost revenue for utilities – at least they are not presented in this way. They are instead seen as ways to enhance individual choice with a strong expression of profit. In Austin residents can have solar panels or electric vehicles if they want them. They can buy their power from wind generated in West Texas only if they want to. Wind and renewable energy as a whole have become just resources to be extracted, similar to oil and gas. The PSP is designed to

provide consumers with the tools needed to make these choices. However green issues are much more visible in Austin than oil and gas extraction. Green and renewable schemes are dotted around the landscape with solar sunflowers situated next to one of the busiest commuter routes in the city. Austin is more environmentally aware than Texas as a whole. The discourse of ecological modernism – that of using new technologies and green growth schemes to reduce or prevent environmental damage – gives legitimacy to the PSP's goals. We can reduce harmful emissions with new technologies, yet at the same time provide jobs and growth to improve the economic prospects for residents.

5.1.2) The Availability of an "Experimental Lab".

A second key socio-technical component of the PSP is the availability of a physical and regulatory space that allows experimentation. This applies to Texas as a whole and to the Mueller district within Austin. The unique setup of the Texas electricity grid allows for experimentation both with regulations and with new technologies. Companies and utilities do not have to worry about inter-state federal oversight. Being wholly within Texas the ERCOT model allows for tweaks or large-scale transitions relatively easily compared to the cross-border negotiations needed elsewhere in the US. Wind power has been so successful in Texas because of the highly deregulated market and the ability to experiment. The niche within Geels' landscape requires an area to experiment, to try out new technologies and new ways of doing things. Texas as a whole offers an excellent sandbox for energy researchers and this niche could allow future breakthroughs into the wider socio-economic regime. As one respondent highlighted in Chapter 3 when discussing the partners of the PSP:

> "…and at the same time they also have this infinite demand to pilot everything, every utility, no matter how many times it has been done somewhere else, they want to pilot it too. So it's very convenient to have a sandbox, a safe sandbox, a politically secure sandbox…"(Interview, Austin Energy executive).

While the wider regulatory landscape of the Texas electricity market allows for experimentation it is the Mueller district within Austin that provides the PSP with its physical space. Mueller is an excellent place for a test bed for new technologies. The homes are generally the same age, it is largely isolated from wider Austin and there are a large proportion of early adopters. The isolation of the Texas grid and the physical space of Mueller both allow technologies to be developed and refined in a niche.

5.1.3) The "Technopolis Wheel".

In Chapter 3 I discussed Smilor et al's idea of the "technopolis wheel" – "techno", reflecting the emphasis on technology, and "polis", the Greek work for city-state, reflecting the balance between the public and private sectors in spurring economic development and promoting technology diversification. As Smilor et al outline:

> "The nucleus in the development of the technopolis is the university segment. The research university plays a key role in the fostering of research and development activities; the attraction of key scholars and talented graduate students; the spinoffs of new companies; the attraction of major technology-based firms; as a magnet for federal and private sector funding; and as a general source of ideas, employees, and consultants for high-technology as well as infrastructure companies" (Smilor, Gibson et al. 1989: 53)

All of this is present within the PSP in Austin. But there is one thing present in Austin that is overlooked by Smilor – the existing social relationships between key actors and the history of public-private development in the city. Austin has a long history of using state apparatus to kickstart economic development going back to the 1980s and 1990s with the development of MMC and Sematech. Both of these organisations helped foster an entrepreneurial spirit within the city and a focus on high-tech industries. But they also created strong social networks of workers and politicians. Two of the founding members of the PSP were involved in the development of MCC in the 1980s. Since then they have stayed in Austin and built up strong relationships with executives within Austin's energy and water utilities and with officers and politicians within the city authority. It is the knowledge, connections and existing networks of the founding members that has allowed for the creation of the PSP and they were able to utilise the knowledge and experience they gained from being involved in previous public-private partnerships. As Thomas Hughes described technologies are never autonomous agents within societies but are reliant upon cultural, social, political and economic forces to become accepted. For the PSP it is the interplay between the board members, the city authorities and the utility companies that has led the evolution of the smart grid. This manifests itself as "a set of social, cultural, economic, and political interests fused together with technology, rather than a 'black box' of generators" (Sovacool 2009: 4501).

5.1.4) A Neoliberal Economic Model.

Fourthly there is the role that economic neoliberalism plays within the PSP – a key component of the splintering urbanism thesis. As outlined in Chapter 3 public-private partnerships in Austin have not historically been used by central planners for large-scale development purposes, but instead to act as a kickstart for additional private sector development. Many officials within the City of Austin want to create a distinct competitive advantage to attract international private finance from elsewhere. In Leitner and Sheppard's words:

> "…the key to urban prosperity lies in developing a competitive advantage, and that the key to competitive advantage is to be found in clusters of firms forming industrial districts, networking with one another in ways that promote dynamic external economies, innovation, and growth." (Leitner and Sheppard 2002: 500)

This is a key *raison d'etre* for the Pecan Street Project. The project is not about the publically-owned utility gaining or keeping control of the energy network. A large driver is the motivation to attract multi-national companies from elsewhere. It is to provide a space for international finance to invest in Austin, for companies to create jobs and increase the tax take of the city. This is a key component of the splintering urbanism theory. Officials within Austin are no longer central planners but as Rutherford (2008) describes they are now "market managers" creating and nurturing the conditions most advantageous for international finance in competition with other cities around the world. The

desire to attract and create a highly skilled workforce has allowed the City of Austin and the state components of the technopolis wheel (the university, the state capital) to use public-private partnerships to *create* markets under the banner of neoliberalism. Austin did not strictly follow the Regan-Thatcher economic policies of the 1980s and remove all state interference in the markets. As described by Holifield Austin followed policies that much more resembled the economics of the late 1990s:

> "…this was (at least apparently) a "kinder, gentler" neoliberalism. If the neoliberalism of Reagan and Thatcher - what Peck and Tickell (2002) call "roll-back neoliberalism" - sent out bulldozers to raze the Keynesian welfare state, the "roll-out" neoliberalism of Clinton and Blair sent out construction teams to build new institutions, designed to embed the neoliberal project more deeply in civil society (Jessop 2002)" (Holifield 2004)

The City of Austin has experience of using state apparatus to generate economic development. It has focused on developing policies and urban spaces that are attractive to international investors. It has opened up its own institutions to private interests and it has largely been successful in driving economic development. Yet the dot.com crash in 2000 demonstrated the dangers in specialising economic growth in this way with Austin losing 40,000 jobs in just six months. The PSP, although having evolved from the same public-private partnerships as developed in the 1980s and 1990s, is an attempt to diversify the local economy towards green energy using the same neoliberal tools that have been used in the past – opening up state institutions and using public government to attract international finance. In many ways the neoliberal desire to attract external investment is similar to the redevelopment of Toronto's waterfront. Laidley's description of that project as a way for Toronto to compete globally in the 21st century by developing in a particular way that "accommodate the needs and desires of the global economy" could be a description of the PSP and Austin's previous public-private partnerships. Laidley adds that Toronto:

> "…has seen a significant neoliberalization of urban policy intertwined with the institutionalization of ecological concerns. Perhaps paradoxically, at the same time that urban entrepreneurialism and competitiveness have taken firm root in Toronto an increasingly environmentally-focused politics has fundamentally shaped the city's political and policy terrain" (Laidley 2007: 206)

In Austin, as in Toronto, ecological modernism is the dominant discourse. Economic growth can be beneficial economically but also environmentally. Environmental issues can be controlled with new technologies and "green" urban growth. Yet the way these issues are being tackled provides strong evidence for the splintering urbanism thesis. Both cities are using the changing roles of the state to attract private capital by using neoliberal tools. A shift has occurred away from centralised planning by city authorities, towards the state accommodating the wishes of private interests. It is now not the state that is trying to prevent pollution or environmental damage. We now have private interests involved in developing the technologies needed to shift towards a clean energy economy. The state, it is believed, cannot develop the technologies and gadgets itself (such as electric cars or solar panels). This has to be left up to the free market and then consumers can pick and choose the green technologies they want. The state creates the markets and private interests then take up their positions within them.

5.1.5) An Initial Catalyst.

One final condition that has allowed the PSP to emerge in Austin is the initial funding boost from the federal government. All of the above conditions were in place within the city before the PSP began. The discourse surrounding energy within Texas and the ideology of ecological modernism; the neoliberal history of public-private partnerships; the technopolis wheel; and the unique positioning of the Texas electricity grid and the availability of the Mueller test bed. All of these factors were already in existence within the socio-technical regime and were "dynamically stable" in the terms of Geels, operating within the urban area (figure 13).

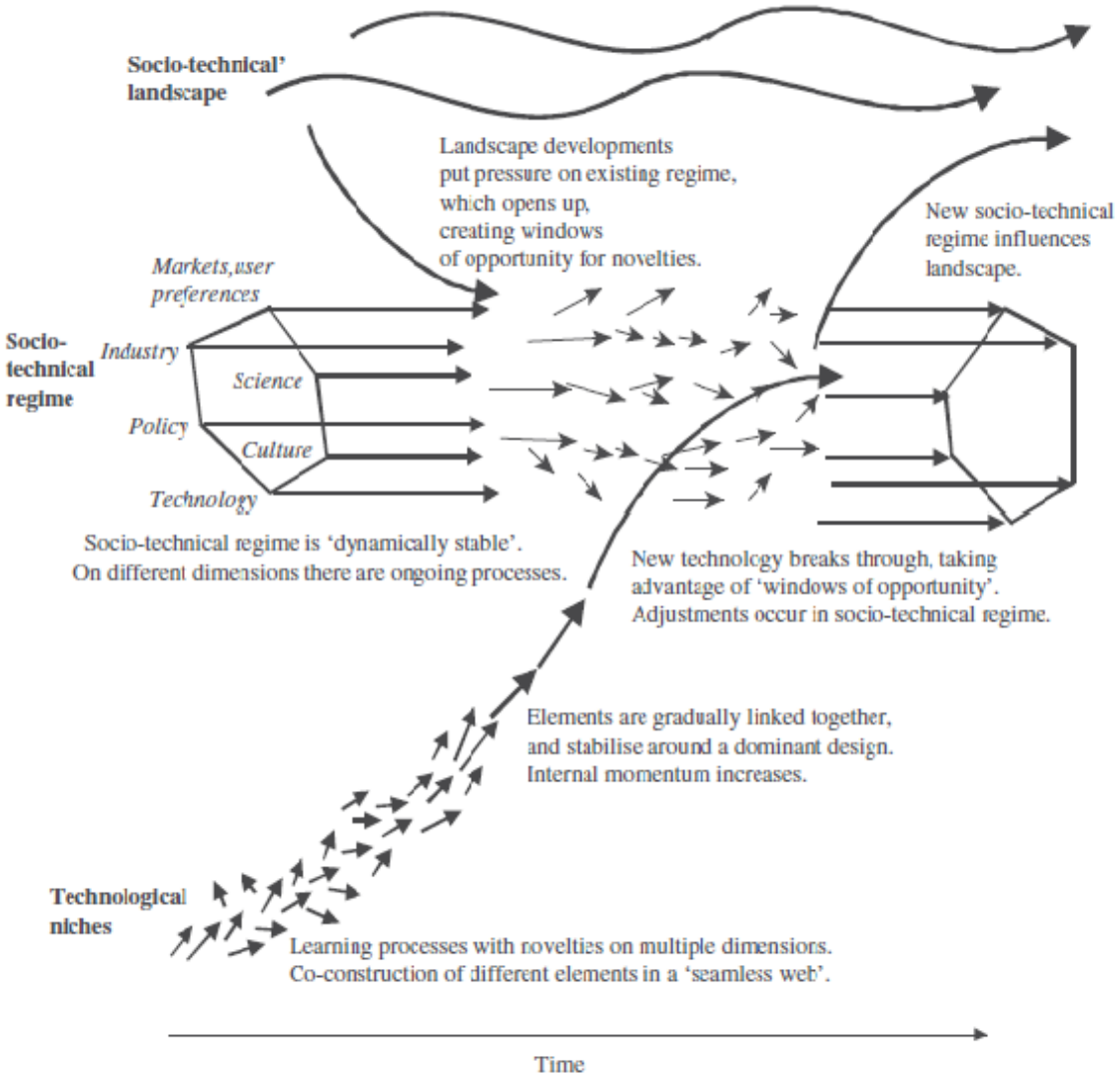

Figure 13 - Geels' Dynamic Multi-Level Perspective (Geels 2002)

What the smart grid needed to get started was an initial external boost. This came in November 2009 in the form of a $10.4 million grant from the US Department of Energy. Looking at Geels' dynamic multi-level perspective it was this funding that provided the window of opportunity for the PSP to emerge. This was the catalyst for the project. The money was not the most important component, as even one respondent outlined – "If anything I don't think we have received as much funding as some as other projects" – but what it offered was the chance to get the PSP up and running. It provided the window of opportunity that was needed to allow the smart grid to develop.

One problem with the MLP is the lack of predictive ability it offers. Using the literature it cannot yet be known whether the Austin version of the smart grid will be the one that breaks through to become the fabric of the new socio-technical landscape. There are too many variables involved to make that sort of prediction. However it is still important to examine what changes could happen if this type of smart grid is widely adopted.

If the PSP becomes the accepted version of the smart grid then it could have major consequences for consumers. One key aim of the PSP is to develop a suite of consumer goods that can be offered to residents on a voluntary basis, and they in turn will use these goods to change their own energy consumption. It is yet another extension of neoliberal choice for the consumer. They can choose to have solar panels installed. They can choose to have smart meters, yet if they choose not to participate, then they will lose out in other ways (such as in control over when they can use certain appliances or with a higher cost of energy). This early direction for the PSP could represent true marketization of the energy market with each homeowner making their own decisions about their generation and consumption with very little involvement from the state. Each home could become a decentralised power plant, buying and selling energy from others as and when needed. The role of the energy utility will be scaled back to become a platform for these transactions to take place. This extends the free market discourse of Texas but it also forms part of the ecological modernization discourse within Austin. Environmental problems can be tackled by using technologies. Problems with the energy infrastructure and reductions in climate emissions can be solved by allowing people to choose to buy more efficient appliances. The free market economics of Texas and the environmental modernisation of Austin have been combined within the PSP to restructure the energy infrastructure. Smart energy technologies are the answer to the crises facing the energy industry, but they will be offered within a neoliberal framework.

If this does happen then the fabric of urban life will be further fragmented, as this vision leads to the ultimate version of infrastructural consumerism. Those who can afford it will find themselves with all the benefits of the new smart grid world. Those who do not participate (or who cannot afford to do so) will find themselves the target of "legal discrimination" as one respondent discussed in Chapter 3:

> "…we might actually be on the threshold of a word we used to use in the early days, of 'customerisation'. We might actually get to the place where this technology enables the utility to say 'these are stay-at-home moms who keep their air conditioner running and run the dishwasher and have the TV running and a couple of other appliances, and we really ought to figure out a way to keep all of them from being on-peak at the same time'. Go to their house, put these controls in place, stop them from quadrupling their peak for a few minutes at a time" (Interview, Austin Energy executive).

Although this may make sense from a utility point of view, it does lead to a splintering of the urban life with some residents actively targeted to reduce their energy use, while others can generate (and even sell) their own.

5.2) Lessons from the Pecan Street Project.

While this thesis has been focused on a single case study in Austin, Texas, the advantage of the case-study method is "it helps to reveal the importance of contingency, and shows tensions that exist within the complex workings of institutions and actors" (Tretter 2013: 2). It is still too early to tell if the PSP will successful become a permanent part of the socio-technical landscape. The initial research phase of the PSP has not yet been completed. It could be argued that the PSP is a unique project in a specific location and it is debateable whether other groups can attempt to deliver the same goals by using the same methods elsewhere. One advantage that Texas has compared to the UK is the strength of local city governance. The UK does not have anything comparable to Austin Energy – an energy utility wholly owned by the city. The UK's power structure is also too centralised towards central government, leaving local authorities with few mechanisms to deliver economic development strategies in the way Austin has. Another unique feature about Texas is the mix between free markets and public mandates. The deregulation of the energy market has been so successful because of the mix of public and private involvement. Public utilities were mandated by law to buy power from small renewable companies, immediately creating a demand and boosting the renewable industry. Public utilities were also prevented from undercutting competitors, leading to large numbers of consumers to switch rapidly to lower-cost suppliers. This does not happen in the UK marketplace. Yet there are lessons to be learned from the PSP.

5.2.1) It is Not Just About the Technologies

One early result from the PSP was the lack of effectiveness in differentiation between the various smart products. While viewing the test home used by the private partners to develop new technologies, there were seven different types of connector in development to charge an electric vehicle, all offering different interfaces and feedback information. What became clear early it the project was that the differences were all minor – a plug socket is a plug socket. It doesn't matter how many flashing lights or how smooth it is made, it essentially does just the one task for the consumer, and that is charge the electric vehicle. Residents also quickly became bored with the various internet-based interfaces offering a myriad of ways to view individual energy consumption. One respondent claimed that residents would spend a few hours early on in the project rating the use of each individual appliance in the home, and then quickly become bored of all the information being offered. The differences between the various products appear to be minor. What is important is the tasks they allow the consumer to do overall.

5.2.2) The Consumer Has To See Some Benefit.

Many smart grid tools being discussed in the literature revolve around how to lower energy consumption to reduce climate change emissions, to lower the load on the network or to save the energy utility money. Very rarely is there any discussion of how the consumer can benefit. As one respondent said:

> "…one thing we have a feeling is not going to work for a consumer, because frankly nobody is going to sign up for it, is "I'm going to sign up for a rate programme that somehow makes me hotter and charges me more". Well, sign me up" But you see a lot of these articles and if you really read between the lines of demand response, it's kind of how it works out. I'm not going to do it. No way am I going to do it. There is no way I would sign up for an Austin Energy thermostat, radio controlled to turn off my AC. But if they said I would pay less?" (Interview, PSP board member).

For consumers to fully engage with the smart grid they have to gain some of the benefits. The consumer must see a difference in their energy bills, or in the longevity of their appliances if they are willing to change how they consume energy. Connecting an electric vehicle to a home to be used as an energy storage device may appear beneficial, but if the consumer if going to lose money by reducing the battery life, they are not going to participate. However if the consumer receives a big enough rebate from the power they are generating and saving themselves, or if they can gain a discount on the cost of a new battery, then that might persuade them to sign up.

5.2.3) Leave Product Design and Development to the Market.

A key advantage of the PSP, which falls nicely into the neoliberal economic theory, is that the public sector is taking on very little risk. Nearly all of the product design and testing is being carried out by private companies – Sony, Best Buy etc. They want to design and sell products that consumers will eventually buy, and they are prepared to take on the risk for doing so. The public sector – the university and in Austin's case the energy utility – are merely providing the space for this to happen. The public sector will not be left with a bill for designing a product that no one wants to buy. Yet the university is able to gain from researching how people are willing to change their lives. The risk is contracted to the private sector, yet the benefits accrue to all partners.

5.3)Research Limitations.

There have been limitations and problems with this thesis, mainly its focus on just a single case study in a highly developed energy marketplace. This was due to the time and cost restraints of this research study. Having one year to research smart grids did not leave adequate time to pick several

case studies to examine. Instead of looking at two or three and comparing them briefly I felt it would be better to examine one project in depth.

I also chose to look at the socio-technical conditions that exist within Austin, rather than researching how consumers react to the new technologies or whether they are willing to engage in a smart grid. My intention was to examine how an urban environment can produce a project such as the PSP, and whether there are any conditions that are useful to having a smart grid project emerge. There are close to a hundred smart grid projects being developed around the world. The PSP stood out because of the interplay between the public and private sectors, and the changing power relations that could result. I believe it is more useful to look at the wider macro arena of society itself, which has the potential to affect thousands and even millions of residents, rather than to focus on the micro by researching the changing energy use of individuals. I hope that I have been successful in outlining what conditions are beneficial for the evolution of the smart grid.

In conclusion, one respondent himself outlined the conditions he felt were necessary for a smart grid project to succeed:

> "…some moments of good timing, some pay off or idealistic volunteer work, a couple of flashes of brilliance associated with organisation and approach, and I guess at some point sort of political will – little 'p' political will – between the leadership of the utility and the leadership of the city, although to be honest with you I think those are derivative of community will. Get yourself a world class tier-one university, if you can get one I would say get yourself an urban infill development, I would say get yourself 10 to 15 million dollars of federal, or you know sort of grant support to start. I'd say give yourself two or three years to incubate it in terms of building up the attention and the concepts, and you can have one too" (Interview, Austin Energy executive).

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Appendix A - Examples of projects progressing with full scale integration.

PROJECT	START DATE	MAIN BACKER	KEY AIMS	TECHNOLOGY USED	COMMENTS
Newcastle, Australia – Smart Grid Smart City	Late 2010	$100 million funded by NSW government.	- To develop a plausible business case for smart grids. - Carbon reduction - Provide consumer incentives	- Smart meters - Electric vehicles - Demand response - Local power generation (wind, solar) - Wireless data transmission - Home energy storage units.	Users have full access to the data to monitor their usage. Volunteers can sign up to a new flexible pricing and incentive system to reduce power use at peak times. Entire system is voluntary only. Eligible households are offered a wide range of smart appliances and in some cases offered a one-off payment to take part in certain schemes, such as installing energy storage systems. More community-based than similar US projects.
Boulder, Colorado - SmartGridCity	2008	Funded by private utility Xcel Energy.	- To update grid infrastructure.	- Smart meters - New fibre-optic network. - Data transmission via Broadband over Powerline (BPL)	- Boulder has become a byword for how not to introduce a smart grid. Plagued by mismanagement, cost overruns and poor public relations. Initial cost was put at $15 million. Latest estimate was $100 million. - Private companies were asked to pay $5 million to take part in the trial. Many declined. The technology was designed around those companies who agreed to pay. -Poor initial research. Costs ballooned when the company had to dig through granite to lay more fibre option cables. - Perception management issues. - Conflict between public regulators and private utility.
Austin, Texas – The Pecan Street Project	March 2009	A non-profit private public partnership.	- A large scale test bed for upcoming smart technologies. To provide a location for private companies to test smart appliances, and to develop a business case for the smart grid.	- Smart meters - Web-based energy system. - Solar panels - electric vehicles, - 100 per cent green-built buildings. - smart home appliances.	Built on 711 acres of an abandoned airport. Smart meters have been rolled out to 100 green built homes, with 11 having rooftop solar cells. Being expanded to a second group of 100 homes that are at least 10 years old to compare usage. Working with Austin Energy and Austin Water to combine two smart utility systems.
Groningen, The Netherlands – Power Matching City	March 2010	EU funded.	- Europe's first smart grid test bed, hopes to become a small scale virtual power plant.	- Homes equipped with micro combined heat and power systems (high efficiency boilers) - hybrid heat pumps - smart meters - solar panels - electric vehicles - smart household appliances	Billed as Europe's first fully integrated smart grid, with 25 homes involved in a virtual power plant. Users can access their energy usage via PC or smart phone, comparing it to the project average. The homes generate their own electricity, store it, and sell excess power back to the grid. Also connected to a 2MW windmill park. Project software is largely automated; however researchers hope to evaluate how consumers exchange comfort for energy flexibility based on financial rewards. All electrical appliances are connected to the internet. Data is available for data mining by researchers.
Jeju Island, South Korea	December 2009	Two-thirds of the start-up cash is from private companies.	- To develop smart grid technologies for export internationally.	- Smart meters - Electric vehicles - Integration of renewable energy - Infrastructure upgrades - Home energy storage.	A town with 3,000 homes serving as a test-bed for renewable energy and for research into smart grid technologies. The government hopes that private companies can use the town to develop smart appliances and related technology, before exporting their products internationally.

Appendix B - Selected projects with smart meter roll-outs

PROJECT	START DATE	MAIN BACKER	KEY AIMS	COMMENTS
San Francisco, USA	March 2009	Private utility Pacific Gas and Electric	Users can view their hourly usage online however PG&E did not roll out in-home displays for cost reasons.	8 million smart meters installed across the region – the largest number in the US. - Massive consumer backlash. Issues over transparency, customer engagement and use of unsuitable smart meters. In May 2011 the company apologised for its poor customer service. Customers who could not get in touch PG&E contacted the press instead, who claimed the meters who making people homeless and forcing them into other states. A class action law suit was launched by users who say their bills skyrocketed. - Claims that 1 per cent of the units are faulty, causing consumer bills to skyrocket.
Texas, USA	Mid 2010	Private utility Oncor.	760,000 smart meters rolled out. Users can view hourly usage online	- Opposition not as organised as San Francisco, although still thousands of complaints about high bills. Same meters seem to have generated the same type of complaints. Smart meters were installed unilaterally, generating hostility.
Maine, USA.	Early 2011.	Private utility Central Main Power.	440,000 smart meters have been installed in homes, with a further 180,000 more planned. Usage information is sent direct to the company, reducing the need for home readings.	- Huge consumer backlash. The latest complaints focus on the use of the 2.4Ghz frequency, which interferes with Wi-Fi systems, garage door openers, security devices and other household appliances. - Various concerns raised by customers over health effects.
San Diego, USA	2010.	Private Utility San Diego Gas and Electric.	A 1.4 million smart meter rollout to provide real-time information on energy use. Customers access their accounts via a web portal.	Customers were encouraged to compete with each other over their energy savings, with the winner receiving a new laptop. Many homes connected with broadband, avoiding public health scares over wireless technology. Special social gaming apps were created for the project. SDG&E also hopes to shift 100MW in peak energy use to off-peak times through a rebate and pricing structure.
Victoria, Australia	Second half of 2011.	Private Utility Orion Energy	5,000 smart meters rolled out.	Bottom-up and very low key approach. The company makes no bold claims about possible savings or benefits. The meters are not designed to incentivise customers or change their behaviour in any way. Instead they are being introduced to see how householders can change their own behaviour depending on what information they have available.
Naperville, Illinois, USA.	Early 2012.	City-owned utility.	End point will be 57,000 smart meters across the city. Data sent to company wirelessly, eliminating the need for manual inspections.	Public concerns raised over health issues and possible hacking. An attempt at proactive public engagement. The project developed a customer bill of rights, created a customer privacy advocacy handbook, and recruited volunteers to serve as "ambassadors". However seems to have minimal customer involvement. An opposition group - The Naperville Smart Meter Awareness – has been created to halt the program and is seeking legal action. Any resident not wanting the new meters has to pay extra each month for manual checks.
New Zealand	Large scale rollout began 2008	Three major utilities – Contact, Genesis, & Meridian – are all installing smart meters throughout New Zealand	Conserve energy and to reduce energy use. Eliminates the need for expensive manual readings.	Issue over the nature of the smart meters installed in homes, how cheap they are and what is needed by consumers. 70 per cent of residents in Christchurch have smart meters – the largest in Australasia. Although the new smart meters have been beneficial for the producers, criticism has focused on the cheap nature of the installed meters, bringing little benefit to consumers. Failure to include upgraded chips on installation meant the meters are "capable" of being smart, but are not yet.
Ontario, Canada	2009	Hydro One. Utility with the Government of Ontario as its single shareholder.	1.3 million customers have smart meters across the province.	A contrast with the health scares over smart meters seen in much of the US. In August 2011 the utility won an excellence award for how it handed the upgrade. Just over 1 million of the utility's customers have shifted to time-of-use pricing. Customers receive bills based on actual consumption, and can access their hourly usage within a one day time delay.

Appendix C - Three projects chosen for further research.

	Funding	Project Partners	Project Aim	Smart Meters	Home Integration	Demand Side Management (DSM)	Wider Network Integration	Pricing	Renewable integration and Electric Vehicles
Newcastle, Sydney and Scone, Australia.	$100 million funding from the New South Wales Government. Project organised via a consortium led by private utility Energy Australia.	NSW Government, Ausgrid, Energy Australia, Sydney Water, Hunter Water, Transgrid, Newcastle City Council, IBM, GE Energy, AGL - integrated renewable energy company.	A shift from the traditional view of supplying as much electricity as possible to a system where consumption of power is controlled to meet the available supply	Volunteers are being given four types of smart meter: Online only Simple IHD Advanced IHD Customer HAN	A home monitor system allows users to track up to 10 appliances in the home, turning them on and off with internet access.	Homes are trialling air conditioner and pool pump cycling. Ausgrid will remotely put the high-energy appliances in a low power mode at peak times using 'ripple' technology.	Sydney Water and Hunter Water installing their own smart meters, creating a hub for power and water use with data transmitted wirelessly. Rural town of Scone will form Australia's first micro-grid virtual power plant, isolating it from the main grid.	Tests of time-based pricing and incentives for households to reduce power use in peak times. 365,000 customers already have time of use pricing.	Solar cells installed on roofs and turbines installed at selected sites around Newcastle. Limited trial of a handful of EV in Sydney.
Austin, Texas. The Pecan Street Project.	Non-profit organisation. Given a federal boost with $10 million under US Government's stimulus programme.	**Research team members** University of Texas, Environmental Defense Fund, Galvin Electricity Initiative, National Renewable Energy Laboratory, Underwriters Laboratories. **Member Companies** Cisco, Dell, Microsoft, Best Buy, Check-It, Freescale, Landis + Gyr, LG Electronics, Oncor, Oracle, Sony, Sun Edison, Texas Gas, Whirlpool	Maintaining the city's revenue stream. To provide a test bed for private companies to develop software and appliances for smart homes. Convergence of water and energy utilities with the Austin city authority. Shift from an energy *provider* to an energy *manager*	Meters rolled out to 100 green built homes and 100 homes that are at least 10 years old.	Aim is for full smart grid integration. Home security, web-based energy management, health care monitoring, home improvement, entertainment and labour-saving services.	Hope to defer construction of 300MW of power through DSM. Trials of various DSM techniques to allow comparison.	The electric, gas and water utilities that serve the test area – Austin Energy, Texas Gas and Austin Water – are each providing meter integration and research support to project researchers and participating companies.	Users pay a fixed amount each month, and agree to allow Austin Energy to install solar PV on their roofs. Any increase in energy use and they will pay extra on a 'pay as you go' basis. Extra power generated by solar PV goes back to Austin Energy.	100 Chevrolet Volts for lease or purchase to participating residents, one of the nation's highest residential concentrations of electric vehicles. (130 homes are signed up). Nearly all of these homes will have low-cost, thin-film solar PV.
Boulder, Colorado. Smart Grid City	Private-utility originally said cost would be $15 million. Latest estimates are three times that, and Xcel is trying to recoup the cost from customers.	Led by private-utility Xcel Energy. Partners include: Accenture, Current, Grid Point, OSISoft, SEL sensing, SmartSynch, Inc, Ventyx.	To update the grid infrastructure, develop more renewable and reduce energy demand.	Smart meters installed across the city, data transmitted with Broadband over Powerline (BPL).	Volunteers received a Home Base display, a Honeywell Wireless Thermostat, two Appliance Sockets, and a Wireless CT sensor.	Promises made that users could have full control over their energy use. Very little progress made.	Most of the upgrades were done to the wider infrastructure. Xcel installed monitoring devices on 4,600 transformers and four substations that serve Boulder. The utility also upgraded 24,000 meters -- or about half of all meters in Boulder -- and installed 200 miles of fiber-optic cable to allow the components of the grid to communicate with one another.	A new pricing structure to charge extra for energy use during peak times. Users saw an annual drop in their bills of just $18.	Xcel wanted 30 per cent of energy developed by renewable. City and customers wanted a more ambitious 50 per cent.

Appendix D

As part of the qualitative research, semi-structured interviews were carried out with the following people:

- Two founding members of the Pecan Street Project.
- Five academics from the University of Texas.
- Senior executive at the Austin Chamber of Commerce.
- Two partner researchers at Best Buy.
- Senior smart grid researcher at Sony.
- Executive at the Environmental Defense Fund.
- Pecan Street Project lead architect.
- Community representative of the Mueller district.
- Former senior executive of Austin Energy.
- Current senior executive of Austin Energy.
- Two senior executives at Austin Water.

Appendix E

Durham University
Durham Energy Institute

Customer-Led Network Revolution

An Introduction

The Customer-Led Network Revolution is the UK's biggest smart grid project - a three year, £54 million scheme to find innovative solutions to network constraints caused by the transition to low-carbon technologies. It involves trials of smart grid solutions on the distribution network as well as the creation of smart-enabled homes to give consumers flexibility over the way they use and generate electricity. The results will help the industry make sure the electricity networks can handle the mass introduction of solar PV panels, electric cars and other low-carbon technologies.

Around 14,000 customers in the North East of England and Yorkshire will have smart meters installed in their homes, bringing to the project the range of both urban and rural geographies and distribution network topologies. This allows the results to be applicable to 80% of the UK's landscape. Around 2,500 customers will be installing solar PV panels, heat pumps or provision for charging electric vehicles. The project will explore the use of new technology on the electricity network and help develop different pricing structures and commercial propositions for the consumers. This will help the electricity industry find the best way to keep down the cost of connecting customers to the grid and minimising the cost of meeting their electricity needs.

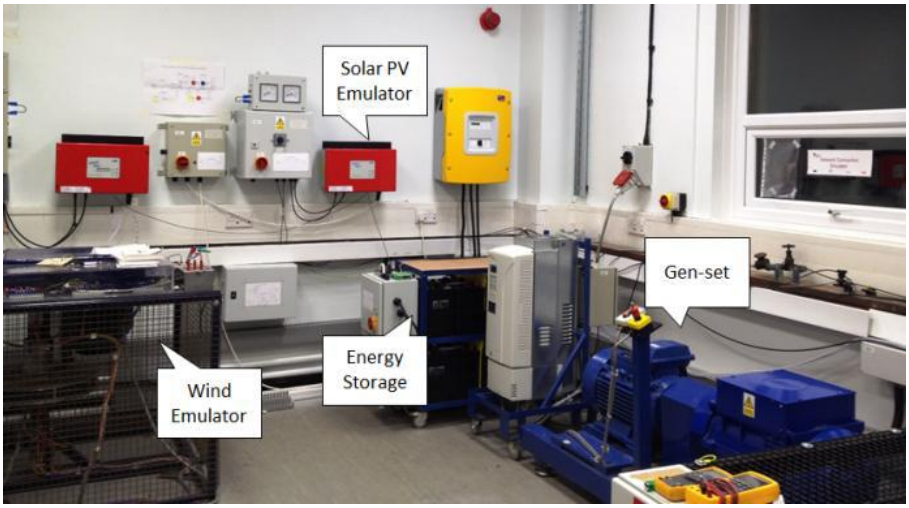
The project is led by Northern Powergrid (formerly CE Electric). The main project partners are British Gas, the Durham Energy Institute, EA Technology, National Energy Action and Sustainability First. It is half-funded by the regulator Ofgem under the Low Carbon Network Fund. The project has been developed to combine engineering perspectives with approaches from the social sciences, delivering a 'social-technical' analysis of the emergence and the implications of the smart grid.

Durham University provides multi-disciplinary support by undertaking technical modelling and simulation, trial analysis, laboratory emulation and social science research in collaboration with British Gas and EA Technology. The project has been designed to deliver five learning outcomes:

Learning Outcome 1	Learning Outcome 2	Learning Outcome 3	Learning Outcome 4	Learning Outcome 5
Monitoring	**Customer Flexibility**	**Network Flexibility**	**Optimum Solutions**	**Effective Delivery**
Establish a greater understanding of current, emerging and possible future load and generation characteristics.	Evaluate the extent to which customers are flexible in their load and generation, and the cost of this flexibility.	Focuses on network technology and evaluates the extent to which the network can be more flexible, and the cost of this flexibility.	What is the optimum solution to resolve network constraints driven by the transition to a low carbon economy?	What are the most effective means to deliver optimal solutions between customer, supplier and distribution network operator?
Involves monitoring the consumption and generation profiles of 11,000 domestic customers (general, heat pumps, PV panels, CHP, electric vehicles) 2,250 small commercial customers, 14,000 industrial and commercial customers and 250 merchant generators.	Testing different customer propositions, such as static and dynamic time of use tariffs and direct control tariffs. We will introduce customer interventions involving 3,450 domestic consumers, 450 small commercial customers, 5 I&C customers and 10 merchant generators.	How can new technology optimise the use of installed network capacity? This will involve trialling the integration of primary and secondary Enhanced Automatic Voltage Control (EAVC), real time thermal rating (RTTR) and storage network equipment and associated monitoring and control systems.	The outputs of the first three learning objectives will be combined with desktop modelling, simulation and emulation to identify combinations not piloted in the field to identify the best solutions.	We will prepare the tools needed to progress from the pilot study towards business as usual. This includes commercial arrangements and the development of policy, guidance and tools for distribution networks.

The main grid network technologies being trialled are Enhanced Automatic Voltage Control, Real Time Thermal Rating, and Energy Storage Systems. In the home various technologies are being introduced, including smart meters, PV panels, heat pumps and a number of smart, load controllable white goods as part of a customer Demand Participation capability for the network.

Durham University also operates an on-site Smart Grid Laboratory allowing real time modelling and analysis. This hosts a low-voltage network and a wide range of low carbon technologies, including



Electrical Energy Storage, Air Source Heat Pump, wind and solar PV emulators, an electric vehicle and a Real Time Digital Simulation system. The laboratory is fully instrumented with a central workstation that monitors and controls the equipment via a high-speed data acquisition network throughout the laboratory. It is designed for investigating the solutions to network constraints in electrical networks.

For further information visit www.networkrevolution.co.uk

CLNR Primary Partners

Northern Powergrid is the electricity distribution business for the northeast, Yorkshire and parts of northern Lincolnshire, delivering electricity on behalf of suppliers from generators, mainly on the national transmission system, to 3.8 million domestic and business customers.

British Gas is the UK's leading energy supplier, providing eight million domestic and commercial customers with gas and electricity. As the UK's largest energy supplier, British Gas will be responsible for recruiting and supporting customers involved in the trial. It will install smart meters into around 14,000 customer homes to capture data from trials. Hundreds of these homes will have solar PV panels, or electric car charging points, or ground-source or air-source heat pumps, or micro combined heat and power systems – boilers which generate electricity while they heat the home.

EA Technology offers a range of consultancy, services and products to assist in the management of electricity networks. EA Technology's role in the Customer-Led Network Revolution project includes developing site-specific network solutions, equipment specifications and providing technical support to the procurement process;
In addition, it has a significant role in turning the outputs into usable / implementable solutions and tools.

The Durham Energy Institute is part of Durham University, one of the world's top 100 universities, and leads in at least five energy disciplines: offshore wind, photovoltaics, carbon capture and storage, electricity transmission and smart grids. Durham University will be providing academic rigour to the project but will also be a customer in the trials.
DEI will use its academic breadth and depth to design the methodology, generate core hypotheses, analyse trial results and draw conclusions, publish academic papers and help design new market structures.

National Energy Action (NEA) is the UK's leading fuel poverty and energy efficiency charity. NEA is advising on aspects of the trials in relation to finding out what determines domestic energy behaviour. NEA will also advise on how to engage and encourage customers to participate in the CLNR, as well as gaining feedback from customers on their experiences with smart meters and smart tariffs. For more information visit www.nea.org.uk

Sustainability First is a UK environmental think-tank with a focus on pratical policy development in areas of sustainable energy, waste and water. They bring significant knowledge and insight in the fields of household energt efficiency, smart metering, smart energy tariffs and demand response. They will bring expertised on commercial, regulatory, policy and consumer issues, as well as advice on tariff design and commercial interactions through the value chain.

Other partners to the CLNR include:

Community Energy Solutions (CES) is a not for profit company operating throughout the north east and Yorkshire, delivering cheaper heating alternatives to communities off the gas main. One of CES's major strategies is the installation of air source heat pumps.

Sunderland City Council is submitting a Smart Homes project for funding through the European Regional Development Fund to improve 65 houses in Sunderland with PV, smart meters or heat pumps.

Gentoo, a social housing provider in Sunderland, delivers core housing management services and maintenance to approximately 70,000 customers in 30,000 homes. It is installing PV as retrofit to the 26 bungalows referred to above, and to 37 new build properties, including exploring zero carbon homes with up to 5kW of PV per house.

Kirklees Council has been awarded funding under the Low Carbon Communities Challenge (LCCC) Fund, as one of 12 winning entries from 300 entrants, to install PV on 42 homes, small businesses and community centres.

Future Transport Systems (FTS)/One North East are installing 240 domestic electric vehicle chargers in connection with the Plugged In Places trial.

North East Chamber of Commerce will be working with the project partners to identify suitable SME candidates, both involving demand and generation, for participation in the project.

Appendix F

Consent Form for Participation in the Customer-Led Network Revolution Project

Examining Smart Grids Internationally

Researcher: Anthony McLean (a.j.mclean@durham.ac.uk)

I confirm that I have read and understand the information sheet for the study and I have had the opportunity to ask questions.

I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.

Although I understand that personal names and contact details will be removed from the final report, it may be necessary for the researcher to provide details about my role and my organisation that may identify me to others. As such, complete anonymity cannot be guaranteed.

Most interviews are designed to be interesting and thought-provoking. If, however, I feel uncomfortable in any way during the interview session, I have the right to decline to answer any question or to end the interview.

Participation involves being interviewed by a researcher from Durham University. Notes will be written during the interview, which will also be recorded electronically. A transcript of the interview will be available upon request.

I understand that the findings of the research may be published at a later date.

This research is subject to Durham University's requirements for ethics and data protection. The Review Ethics Geography Sub-Committee (REGS) has reviewed and approved the research proposal against the guidelines provided by the Economic and Social Research Council, the Natural Environment Research Council and the University's own guidelines interpreting the law on Data Protection.

Your signature below indicates that you have decided to participate voluntarily to this study and have read and understood the information provided above. You will be given a copy of this form to keep.

Participant name (please print): _____

Signature: _____

Date: _____

Researcher name (please print): _____

Signature: _____

Date: _____