Delivering urban energy infrastructure: the capacity of planning and governance networks in the cases of Barcelona, Burlington, Lerwick, London, and Toronto

Sarah E Cary

University College London

Research Degree: PhD, the Bartlett School of Planning

Declaration

I, Sarah E Cary, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

District heating and cooling (DHC) systems are a sound solution to environmental, energy security, climate change, and fuel poverty concerns in cities. As an environmental policy goal not fully controlled by government and subject to complex multi-actor negotiations, building DHC can be understood as requiring network governance patterns of behaviour.

This thesis investigates the role of planning in delivering DHC, employing a conceptual framework of Actor-Centered Institutionalism to unravel the relationships between industry, government, and citizen organizations in governance networks. It contributes to a growing area of study on the intersection of urban development, energy infrastructure, and environmental policy goals. It responds to calls for further practical research on governance patterns of behaviour, applying a recognised network governance approach to the analysis of five international case studies. It also investigates the weight of institutional context and the purported connection between network interaction characteristics and policy outcomes.

The research categorises a range of potential roles for planning organisations and planning interventions in governance networks for DHC. The comparative analysis suggests that planning organisations rarely negotiate for DHC but that planning interventions are regularly used to initiate governance networks for DHC and to shape negotiations by other actors. The findings outline a number of specific institutional factors, actor orientations and capabilities as well as qualities of interaction which affect the capability of governance networks to deliver DHC. The research contributes to the explanatory ambitions of network governance research and expanded understanding of the capacity of planning in building and managing urban energy infrastructure. The findings can potentially be extended to other urban utility infrastructure and environmental policy goals.

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Chapter 1. Introduction

Cities also believe they are the work of the mind or of chance, but neither the one nor the other suffices to hold up their walls. You take delight not in a city's seven or seventy wonders, but in the answer it gives to a question of yours. – Invisible Cities, Italo Calvino

The past decade has witnessed a growing recognition among scientists, politicians, and the media of the importance of cities in two great phenomena of this age: the simultaneous urbanization of humanity and a widespread concern about the environmental impact of human activity on the earth's natural systems.

Cities are both the problem and the solution to achieving a sustainable future. As the human population grows and congregates rapidly, urban areas increasingly become the sources and drivers of pollution, greenhouse gas emissions, overuse of scarce resources, and environmental degradation. However, urban areas can be more efficient in their use of energy, water, and land than suburban and modern rural development. They can provide transportation services in a relatively clean and democratic fashion, as Curitiba and Bogota have shown. Controlled urban densification, used effectively in London and Portland, helps to save natural areas and open space, relieving growth pressures and focusing development in appropriate locations. Urban living can reduce the use of resources per person; density and its accompanying economies of scale conserve scarce resources such as energy, and enable the efficient recycling of waste and water.

An increasing recognition of the importance of cities is affecting the face of politics, business, and urban management. From mega-city mayors, city councillors, and planning policy officers to local energy companies and neighbourhood compost collection schemes, city management is evolving to reflect environmental awareness. These changes are generating a renewed interest in the role of urban planning. A review of planning by UN-HABITAT, *Global Report on Human Settlements 2009: Planning Sustainable Cities,* concluded that "Rapid urbanisation, widespread urban poverty, climate change, resource shortages, and conflict or post-disaster reconstruction are some of the challenges currently existing or emerging globally; essentially they demand state intervention to fundamentally change the nature of cities; and this implies the need for planning" (p. 13).

Within both public policy and academic research on sustainable cities, there is a growing call to understand and improve the human-built infrastructure that manages urban resource use. Alongside the visible streets and buildings, cities are made up of significant systems (both physical and social) which deliver energy, remove waste, and provide and discharge water. The type and management of these systems affects their environmental impact. Particularly, decentralised energy systems such as district heating and cooling (DHC) systems are emerging as a potential solution for increasing energy efficiency within cities. The management or creation

of these infrastructures has been historically understudied in both urban and environmental domains.

Therefore, this thesis focuses on the role of planning systems in delivering a specific urban energy infrastructure: district heating and cooling (DHC). The premise of the research is that the delivery of DHC as an urban environmental policy goal should require the negotiation between multiple actors across space and time, and that planning organisations and processes might have an important role to play in these governance networks. This premise is explored through a qualitative analysis of five DHC systems across four countries, covering both failed attempts and successfully operating DHC systems.

Understanding the role of planning from this international perspective requires the research to give consideration to the formal structures and informal context of planning systems and their relationship with other urban policy processes and organisations. The research's focus also requires examination of the way in which modern urban policy is formed and enacted through collaboration and negotiation between the public sector, civic society, and private business; and the ability of such patterns of governance to organise and construct capital intensive infrastructure.

This chapter introduces the context and focus of this thesis: the relationship between planning systems and urban energy infrastructure, and the network governance patterns of policy creation and delivery. DHC systems are explored as a solution to urban energy demands and positioned as a policy solution to multiple concerns of an environmental, energy security, climate change, and fuel-poverty nature which require local government coordination. The chapter ends by developing three research questions which structure the thesis.

1.1 Urban Energy Infrastructure: District Heating and Cooling

What is district heating and cooling (DHC)?

A DHC system is a technology for the local generation and provision of hot or cold water, and the heating or cooling of multiple buildings. It can bring cost efficiencies and environmental benefits when compared to individual building heating or cooling systems. A 2001 World Bank study defined DHC as follows.

> A district heating system is a concept in which heat is produced centrally in precise location(s), from where heat is distributed to the consumers located in different buildings, in the form of hot water or steam circulating in a distribution piping network. Often, heat is also used not only to heat buildings but also to provide domestic hot water and for industrial purposes, such as process heat.
>
> A district cooling system is a concept in which the production of cooling is centralized in precise location(s), from where cold is distributed to the consumers located in different buildings, in the form of chilled water circulating in a distribution piping network. Alternatively, cold can be produced from heated water circulating in the network by using absorption technology, which enables the co-existence of DH and DC. (Gochenour, 1994, p. 1)

DHC should be distinguished from similar but distinct classifications of energy generation: 'decentralised', 'distributed' and 'combined heat and power'. Decentralised energy is a term which refers to energy which is generated close to where it is used, to minimise transmission losses associated with 'centralised' systems. It can also imply that the energy system is 'off the grid' and not dependant on traditional energy generation and supply networks. The term can apply to a wide range of energy systems operating at different scales; solar thermal panels and biomass boilers are both examples of decentralised energy (The Government Office for Science, 2008; Woodman & Baker, 2008). DHC can be considered a form of decentralised energy, although more often decentralised energy refers to multiple units of generation which serve a smaller physical area than a DHC system (The Government Office for Science, 2008). Distributed energy is a loosely defined concept which is generally used to refer to situations where activities rely upon small scale electricity generation, such as individual wind turbines powering several rural needs or a small scale gas-fired generator in an industrial application (Pepermansa, Driesenb, Haeseldonckxc, Belmansc, & D'haeseleer, 2005; Karger & Hennings, 2009). Combined Heat and Power is a type of generation which uses an energy fuel input to simultaneously create both heat and electrical power, resulting in an efficient input to energy output. "CHP plants generally convert 75-80% of the fuel source into useful energy, while modern CHP plants reach efficiencies of 90% or more" (Moomaw & Moreira, 2001, p. 293). CHP is often associated with DHC, but DHC can be fuelled by a range of generation types (International Energy Agency, 2008).

DHC systems are found around the world. They are particularly common in eastern European and former Soviet countries, having been the dominant technology for the supply of heating and hot water during that era. Examples of DHC systems currently in use include the Con-Edison district heating system in Manhattan, NYC, initiated in 1882, which runs on steam; the Copenhagen district heating system installed in the 1980s, which utilizes hot water produced by a waste incineration plant; and a district cooling system using electrical chillers serving the Dubai metro system, initiated in 2009 (Gochenour, 1994; Hope, 2009).

Why is DHC used?

There are a number of drivers for the use of DHC in urban areas to share energy. Historically the main driver has been cost efficiency, although more recently environmental concerns have also been cited as reasons for implementing DHC. Cost efficiencies and associated energy efficiencies are realised with DHC in two main ways: primarily, because it enables the re-use of 'waste' heat from electrical generation or incineration and therefore reduces the overall amount of fuel consumed. This becomes more effective at larger scales, supporting a district approach. Secondly, efficiencies are achieved through economies of scale and the purchase and generation of the heat or cooling in bulk, rather than by individual boiler or chillers customers (Mancarella, 2013). Cost savings are linked to the density of heat or cooling load, as the cost of installing DHC increases at lower densities through additional pipework and transmission losses (TCPA, 2008; Gochenour, 1994; DTI, 2007). Proponents of DHC, such as the International District Energy Association, also contend that DHC systems are more reliable than other

heating systems and reduce development costs for individual buildings (International District Energy Association, 2009). Other efficiency benefits, such as the fuel efficiencies gained from fewer boilers at full load versus multiple boilers at part load, depend on the size and type of the system and on existing electricity and heat sources (Roberts, 2008; Carbon Trust, 2007; Mancarella, 2013).

A separate driver for DHC adoption is energy security through the flexibility and resilience of the system over time, as DHC systems can be coupled with a range of fuels and heat generating technologies such as gas or biomass fuelled CHP, waste-to-energy, geothermal sources, or other heat sources such as bakeries, solar thermal arrays, or even sewage (Carbon Trust, 2007; Gochenour, 1994; Mancarella, 2013). The choice of fuel source, size of network, and type of generation plant varies significantly between different DHC systems, and can influence the efficiency of DHC significantly. For example, in Iceland relatively cheap access to geothermal heat results in district heating supplying 99% of the capital Reykjavik (Gunnlaugsson, Frimannson, & Sverrisson, 2000; Randburg, 2010).

DHC also has a number of environmental advantages compared to individual boilers or chillers; some of these are linked to the fuel source used although a DHC system has environmental benefits in its own right. The centralisation of boilers or chillers often results in better air quality, as aggregation of generation plant enables better control of the emitted pollutants, emissions, and chemicals such as refrigerant used in heating and cooling systems. The same aggregation enables better possibilities for noise insulation compared to building-level chillers and boilers. Thermal efficiency of the larger heat or cooling generators used by DHC systems is usually better than multiple small building–level boilers, resulting in further reductions in fuel consumption, reduced emissions to impact air quality, and fewer carbon emissions (Gochenour, 1994; International District Energy Association, 2009). When a gas fired CHP generation plant is combined with DHC, fuel use efficiencies of over 80% are possible, reducing energy consumption and CO_2 emissions by approx 20-30%, compared with multiple individual gas CHP plant (International Energy Agency, 2005; Difs & Trygg, 2009).

Why is DHC not a more commonly applied technology?

Tom Kerr, a senior energy analyst at the International Energy Agency identifies three main barriers to the widespread application of DHC: a lack of information about DHC, difficulty in recognising the benefits in the current framing of energy regulation, and a lack of strategic heat resource planning which is necessary to identify appropriate locations (Kerr, 2009).

Additionally, the cost savings from the use of DHC vary significantly across implementations. A key factor is the density of heating (or cooling) demand which is influenced by the density of human activity and by external climate factors. To be the most efficient, the system should be in demand all day and night; therefore a diversity of heating or cooling demand is preferred, with a mix of building uses connected. Cities with temperate climates (e.g. Rome or San Francisco), or areas of lower-density heat demands (e.g. suburban housing, with low people densities and where heating is only needed during part of the day) are unlikely to realise significant cost

savings through DHC alone. This is reflected in the current spread of DHC systems, which tend to be concentrated in northern countries (for heating) or equatorial countries (for cooling) (Gochenour, 1994; International Energy Agency, 2008).

DHC can have high establishment costs early in the project lifecycle (International Energy Agency, 2005; Mancarella, 2013). A 2009 report commissioned by the United Kingdom government illustrated this by calculating that a district heating system equivalent to Vienna's (serving 270,000 households) would cost £1.5 billion to establish in the UK (Poyry Energy Consulting, 2009). The pipe network installation forms a significant part of the cost and this must be built at the outset (International Energy Agency, 2005).

Two further barriers to DHC which are not often mentioned by technical energy journals or International Energy Agency publications, but which are identified in industry reports (TCPA, 2008; London First, 2008; Woodman & Baker, 2008; Roberts, 2008), are concerns about consumer protection and associated competition regulations, and the multi-actor coordination required for delivery of DHC. Regarding the first point, as a fixed infrastructure, DHC requires carefully constructed administration and charging to avoid acting as a monopoly. Competition regulation and utility regulation can have perverse effects on the administrative organisations which operate DHC systems. For example, currently in the United Kingdom each DHC project must negotiate bespoke service and pricing level agreements between the energy company and the consumer; there is no standard approach (Woodman & Baker, 2008). Each project must consider competition law, allowing other suppliers access to customers and vice versa. Complex structures with separate generation and transmission companies often result, creating additional administrative burden and bringing a higher level of risk to financial investment in either company (London First, 2008). A summary of the strengths, weaknesses, opportunities, and threats of DHC is provided in Table 1 (P indicatives potential). The barrier of multi-actor coordination is addressed below.

	Strengths	Weaknesses	Opportunities	Threats
Economic	• Reliability • Fuel flexibility	• Installation costs	• Cost efficiency(P) • Phaseable	• Monopolistic (P)
Environmental	• Fuel efficiency (P) • Reduced air pollution • Suitable for urban areas	• Requires strategic planning • Performance related to density	• Reduced carbon emissions (P) • Can apply to existing areas	• Lack of information

Table 1: Summary of DHC strengths, weaknesses, opportunities, and threats

Why are multiple governments promoting DHC?

As the introduction describes, society is increasingly aware of the growing impact of human activity on the earth's limited resources and natural environment. In response, governments have been actively seeking ways to address resource use, and energy use particularly. There has been substantial discussion and literature on how both national and local governments could both regulate and incentivise business and industry to address resource challenges, particularly encouraging technological solutions. Over the past five to eight years, there has

been an increase in both national and local governments promoting specific renewable and local carbon technologies as a solution (UN-HABITAT, 2009; Lamia & Robert, 2009) in company with demand-side market interventions such as 'accurate pricing' of the environmental impact of fuel use through taxes. Sweden and Finland provide examples of a straightforward fossil fuel tax, and the UK has a similar tax on private businesses – the Climate Change Levy. Germany, Spain, and the UK provide examples of governments promoting specific technologies through direct financial support or financial mechanisms such as a Feed-In-Tariff or Renewable Heat Incentive.

Within this discussion, DHC is supported alongside a range of efficient or renewable technologies and wider considerations of national energy generation and distribution systems. Particularly when looking at an urban area, the use of currently available low/zero carbon (LZC) or renewable technologies are limited by physical constraints, (London Renewables, 2004; Wiginton, Nguyen, & Pearce, 2010; Mark, Parnell, & Sullivan, 2006) particularly in refurbishment or retrofit scenarios as summarised in Table 2. As a LZC technology, DHC emerges as a strong energy efficiency contender for cities because of the benefits outlined above, its ability to retrofit to existing buildings through a phased approach (Lamia & Robert, 2009), and its ability to operate at 'scale' across whole city districts (Mancarella, 2013).

Technology	Renewable or LZC	New Develop.	Retrofit	Technical constraints
Solar Hot Water	R	Yes	Yes	Limited by external surface area and over-shading; low grade hot water
Heat Pumps	LZC	Yes	Depends	Depends on energy demand and limited by ground or air conditions
Wind Turbines	R	No	No	Wind interference reduces capacity
Local CHP	LZC	Yes	Yes	Depends on energy demand profile
Photovoltaics	R	Yes	Yes	Limited by external surface area and over-shading
District heating and cooling	LZC	Yes	Yes	More efficient at district scale; environ. benefits dependant on fuel source
Geothermal	R	Yes	No	Limited by geology
Biomass	R	Yes	No	Air quality issues; depends on fuel source availability

Table 2: Current renewable, low carbon technologies - technical viability in urban areas

(compiled from (London First, 2008; Lamia & Robert, 2009; TCPA, 2008; London Renewables, 2004; Mark, Parnell, & Sullivan, 2006; Wiginton, Nguyen, & Pearce, 2010; London South Bank University, 2007; Jennings, 2013; Pantaleo, Shah, & Kierstead, 2013).)

A range of motivations and mechanisms for implementing DHC exist. Two examples of municipal governments promoting DHC primarily because of environmental benefits illustrate the reasons and methods of promotion. In 2008 the Hamburg city government updated a 1997 *Climate Protection Act* to include the formulation of energy regulations within the scope of urban land use planning. In 2007, it passed a *Strategy for Climate Protection*, as well as a *Climate Protection Ordinance*, which specified heat insulation and energy-saving systems requirements for buildings, surpassing German Federal law standards (Local Government Association, 2009).

The strategy committed Hamburg to reduce CO_2 emissions by 2 million tonnes by 2012; 20% less in comparison to 1990 and a per capita reduction of approximately 25%. The strategy included a catalogue of some 200 individual measures, among which was the extension of existing district heating networks and the conversion of power plants to cogeneration in order to serve the expanded network. In some instances, such as the Kronsberg project, the city mandated connection to the district heating network, using local bylaws, and planning powers (Hamburg, 2010; Institute of Building Services and Energy Design).

The City of Vienna's Climate Protection Programme (KLiP) set a 2020 goal for a reduction in greenhouse gas emissions per capita of 21% when compared to 1990. The KLiP II programmes include a total of 285 individual measures. One specific target is "increasing the share of district heating to 50%" (City of Vienna, 2009, p. 1) by planning and then building pipes to support expansion of the existing district heating network across the city (City of Vienna, 2009). The district heating system is controlled by the municipality through direct ownership and supported by national legislation (Wien Energy, 2008). In addition, the plans for expansion have been developed in collaboration between municipal planners, municipal environmental coordinators, and the district heating utility company (City of Vienna, 2009; City of Vienna, 2007).

Does DHC require municipal planning?

The importance of public sector and local government involvement to the successful implementation of DHC is recognised by industry associations such as the IEA, the World Bank (International Energy Agency, 2008; Poyry Energy Consulting, 2009), and more recently in research on pathways for the transition from centralised to decentralised forms of energy (Rydin Y, Turcu C, Guy S, & Austin P, 2013). Recognition of public sector involvement in existing studies arises from a practical, common-sense understanding of DHC systems, rather than any normative goal about state involvement in energy service provision. The IEA comes from a fiscal perspective, writing "Moreover, due to the highly capital-intensive nature of these systems, DH infrastructure supports a greater level of local government involvement in providing services. As a result, such systems may be communally owned, but funded by public and/or municipal authorities" (International Energy Agency, 2008, p. 15). A UK government report into the costs and benefits of district heating considered that "examples of European countries which have successfully developed extensive district heating systems strongly suggests that a drive to deploy low/no-carbon heat through district heating must be led by the public sector" (Poyry Energy Consulting, 2009). The report cited reasons such as DHC relying upon relevant planning powers and close relationships with social housing, implying both local institutional powers and publicly-managed private energy use was necessary.

Two aspects of DHC which suggest the necessity of involvement of local government is the scale at which it is used, and the link between DHC and energy density. Individual DHC systems are rarely large enough to be a national concern in the way that road or rail infrastructure is. However, they are most efficient at district scales beyond a small number of buildings, and this suggests the need for coordination among multiple property owners and occupiers. They are also more efficient when high energy demands are concentrated together;

creating new DHC in cities requires an understanding of land use. Both these elements suggest that local government and their associated spatial planning organisations and powers could play a role in delivery of new DHC systems. Industry publications recognise that spatial planning practices and organisations could be involved: “Energy planning at town and city scale needs a strategic approach supported by strong planning polices and complementary enabling mechanisms.” (TCPA, 2008, p. 6). The International District Energy Association calls for energy plans, which identify and map out consumers of heat or cooling in relation to fuel sources, energy generation locations, and potential pipe connection routes, as they provide a focus for investment, enabling evaluation of cost, opportunities, barriers, and benefits (2009).

The challenge of DHC: Implications for the research

There is a valid technical argument for the use of DHC as one policy solution to multiple concerns of an environmental, energy security, climate change, and fuel poverty nature. DHC is a potential retrofit solution to existing urban areas. Existing buildings in urban areas are estimated to generate one quarter carbon dioxide emissions globally (B. Metz, 2007), and were featured as a potential focus for energy and carbon reductions in the run up to the 2009 climate negotiations in Copenhagen (United Nations Environment Programme, 2009).

Preparing for and installing DHC in urban areas appears to need spatial coordination by a recognised authority or organisation with specific technical capabilities. DHC can be applied at many scales, but by definition it involves connections between individual buildings through shared infrastructure. This implicitly places some level of responsibility on the relevant municipal or local government authorities to coordinate DHC delivery. Chapter 2 explores in greater detail how local authorities have supported DHC.

Existing literature on DHC is primarily from energy industry sources and aimed at a political or wider audience, often with a campaigning tone. These are accompanied by a limited number of planning and engineering publications which review energy efficiency and renewable energy technologies and establish DHC as a robust and viable technology. Both the academic research as well as the industry literature is poorly developed with regards to policy implications. There is a particular gap in reviewing the role of the public sector and local government in delivering DHC. In this light, research into the relationship between DHC and local government and its planning systems will support a greater understanding of urban environmental management.

1.2 Why is Planning Relevant for DHC?

What is planning, and what is it concerned with?

Planning is described for the purposes of this research as the systems which coordinate intentional state activity in the making of, and the management of, inhabited places. Defining planning is “notoriously problematic” (Sandercock, 1998) because the notion of place and place management is deeply embedded in conceptions of society and state action. For this research, a definition is deliberately chosen which includes not only the diverse government institutions and organisations that undertake planning activities in different countries, but also the tools and processes such organisations use to manage place. This definition of planning is broader than

statutory minimums of land use control, including all policy actions associated with management of place: environmental policies, transport planning, housing forecasts, etc.

Planning therefore occurs not just through government regulation of private activity (development control, building regulations) but also through direct action (government-led or public-private development, infrastructure investment), fiscal controls (taxation, development agreements, lease covenants), planmaking or policymaking (community visions, land use plans, development policy), and knowledge sharing and coordination (guidance, community consultation and engagement).

Because of its focus – inhabited places – planning philosophy is necessarily concerned with human society and its use of space, the state and its investment in or management of inhabited space, and the market and its use of inhabited space. Planning practice and theory is self-conscious (Healey P. , 2007) and has been concerned with the ethics and values of deciding about management of place. Since the 1960s, with the first criticisms of an apparently rational and socially neutral approach to planning activity, planners, and planning theorists have been concerned with decision-making for and priorities in the creation and management of place, grappling with questions of 'who plans?', 'how', and 'for whom?' (Meyerson, 1973; Banfield, 1973).

In response to these challenges, planning theory and policy has sought, often unsuccessfully, to elaborate a coherent intellectual foundation for the practice of planning. Advocacy planning and a political economy approach to planning have sought to position the planner as a politically responsible actor in society (Harvey, 1973). Issues of social justice (Fainstein, 2000; Young, 1991) and social complexity or postmodern planning (Sandercock, 1998; Allmendinger, 2001) were considered in response to the effects globalization and the rapid growth of mega cities (Throgmorton & Eckstein, 2003; Scharpf, 2000; Sassen, 2002). One of the themes identified in that body of research is that cities must compete globally for capital, business, and skilled residents. Environmental health, quality of life, and place-marketing therefore become increasingly important aspects of urban economic success (Thornley, 2005). In international development literature this is often described as a call for 'good urban management' (Pfeiffer & Hall, 2000). This, alongside international pressure on global resource shortages and climate change, drives an increased social expectation of governments to manage environmental concerns (Borja, 1997).

Why is planning concerned with energy use in cities?

In one sense, planning systems are being called upon to coordinate changes to urban energy use because environmental policy goals have spatial implications. The causes and solutions of environmental issues are often locally specific, with implications for urban form, local government physical interventions, and social or human activity in defined locations (Campbell, 2002). As one example, air quality can be affected by regional and national transport patterns generally, but resolves as an environmental or health concern in very specific areas; the

solutions are influenced by non-spatial policy (improved car emissions testing) but can also be locally deployed (traffic management, road spraying, tree planting, etc).

This spatial manifestation leads governments to increasingly rely upon planning processes as a proactive regulatory tool in policy making and delivery for quality of life, environmental concerns, and other social issues such as housing values. Both applied and theoretical planning and public policy literature points to planning systems as a policy coordinator for a wide – and growing – range of 'spatial' policy issues (Healey P. , 2007; Crawford & French, 2008; Thornley, 2005). Allmendinger and Haughton go further to argue that spatial planning should be re-envisaged "in light of the broader dynamics of `reterritorialisation' of the state and allied to a new politics of scale" (2007, p. 1480). For them, understanding the role of planning systems requires "examining how land-use plans are both shaping and being shaped by other sectoral policies, such as housing, health, economic development, transport, environment, and social policy" (2007, p. 1480). This integration of social and economic concerns is often called spatial planning.

Looking at the UK as an example, the increasing scope of the planning system is described in the *Barker Review of Land Use Planning Interim Report* (2006) which identified twenty-one areas where local authorities had been given additional responsibilities since the *Town and Country Planning Act* 1990: of these, eight relate directly to the environment. UK energy policy also demonstrates how planning is being called upon to address challenging policy problems in a spatial manner. The 1980s saw deregulation and privatization of the energy industries; since 2000, the rise of environmental concerns about pollution, resource use, and more recently climate change have increased government desire to intervene in the liberalised market (DTI, 2007; DTI, 2003). Government agencies began to promote specific decentralised and renewable energy technologies alongside market mechanisms such as the European Union Emissions Trading Scheme as solutions (Williams, 2010). Policy targets and associated market interventions in support of renewable technologies quickly encountered tension in the physical, spatial realm with other policy aims for land use, biodiversity, preservation of landscape, and ecological damage (TCPA, 2008; Smith, 2007; CLG, 2007). A further conflict emerged between government goals for energy efficiency in new buildings (e.g. zero carbon homes) and the capability of the existing planning process and authorities to regulate this via development control (Ellis, 2008; Williams, 2010; Keirstead & Schultz, London and beyond: Taking a closer look at urban energy policy, 2010). As a result, local planning authorities were given new remits to plan or coordinate local energy generation in national policy statements (Ellis, 2008; CLG, 2010; CLG, 2007). This emphasis on local coordination and planning of energy generation continued in the 2012 consolidation of planning policy. The *National Planning Policy Framework* overtly recognises the need for a place-based strategy for energy needs which considers landscape constraints and community initiative (CLG, 2012). This trend is not limited to the UK; cities around the world are turning to urban planning processes and tools to manage local energy provision in response to carbon and energy concerns (Carbon Disclosure Project, 2013; C40 Cities Climate Leadership Group, 2011).

A second and arguably more fundamental reason that planning systems are being called upon to coordinate changes in urban energy use is that urban planning processes and products - visions for the management and future of cities - have energy implications. People use energy to go about their lives and operate their businesses; cities host this activity and the structure of cities influences the use of energy as well as its movement and generation. Well insulated homes and offices support business activities in the same way as non-insulated buildings but consume less energy to cool and heat. Building orientations shape the potential for local solar generation and the need for lighting inside. Dense housing which shares energy through walls or pipes consumes more energy per square meter but less per person than low density housing. By intentionally shaping the growth or regeneration of a city, planning is intentionally shaping the current and future use and generation of energy within that city.

And as human activity continues to urbanise, the growing discussion on the importance of urban resource infrastructures should have important implications for how planning organisations approach the future of cities and spaces (UN-HABITAT, 2009; Sherriff & Turcu, 2012). Just as major infrastructure systems for water, sewerage, and electricity have structured cities in the past (UN-HABITAT, 2009; Graham & Marvin, 2001) a diversification of energy generation and supply will also impact the physical and economic shape of buildings and places.

How has planning been concerned with energy use in cities?

The relationship between urban form, urban management, and energy use has been a relatively neglected area within planning literature and practice (Williams J. , 2013; Monstadt J. , 2009). This weak tradition of planning for energy use and infrastructure for environmental concerns contrasts with a markedly stronger tradition of planning transport infrastructure for the efficient movement of people in cities (Bannister, 2002), or the tradition of controlling land use to reduce the effects of flooding.

This disparity is notable in light of the recognition afforded to urban planning's role in creating energy use and generation patterns seen in both the development literature (e.g. (Allen & You, 2004) (UN-HABITAT, 2009)) and geography literature (e.g. (Betsill & Bulkeley, 2006; Campbell, 2002; Bulkeley, Castan Broto, Hodson, & Marvin, 2010)), due to their concerns with environment, urban change, and transitions. The former tends to be concerned with managing the environmental impact of rapid population growth and the latter focuses on the complexity of urban energy and carbon flows and structural challenges of technology change. However implicit in both approaches is a recognition of the importance of place-shaping processes and organisations in addressing environmental concerns.

This situation has evolved in the past few years, with a more nuanced consideration of urban planning's relationship to energy emerging in consideration of the roles of planning in addressing climate change (Romero-Lankao, 2012; Coutard & Rutherford, 2010; Brandoni & Polonara, 2012), and Williams' (2013) recent international investigation into the implications of planning's theoretical concepts and structural approaches for low carbon infrastructure. This

thesis can contribute to this important and emerging literature discussion, as Chapter 2 explains in more detail.

How is planning understood as part of wider urban policy making and delivery?

Current policy-making and policy-implementation in contemporary industrialised societies is regularly characterised by social scientists using the term 'governance' to describe a shift in the way policy goals are made and implemented. Jordan, in *The Governance of Sustainable Development: Taking Stock and Looking Forwards* explains that "By using the term 'governance' instead of 'government'...draws attention to the empirical fact that these processes and reforms have meant that many contemporary policies are now implemented by a wider array of public, private, and voluntary organisations than would traditionally have been included within a purely `governmental' framework" (Jordan, 2008, p. 22).

There is a broad consensus that patterns of policy making and implementation described by the term 'governance' are changes away from central government as the principal provider of control and regulation and towards a practice of coordinating activities among citizens, activist organisations, lobby groups, the private sector, and other stakeholders (e.g., Hirst, 2006; Kooiman, 2003; Hajer & Wagenaar, 2003). There is also a consensus that governance implies policy making and delivery is fragmented and often contested. As Bulkeley and Kern explain, the emergence of new forms of governing practice suggest that it is no longer possible to take for granted the context within which policy-making is being constructed and implemented. The complex interplay between shifts in levels of governing and relations between them, and between modes of governing, creates a “fragmented or ‘splintered’ governance landscape . . . of urban governance practices” (2006, p. 2242). As a result, policy is designed and implemented by coalitions of stakeholders which can take time to come together and the outcome is dependent on often evolving power relationships (Stoker, 2000).

Public policy literature often takes this dispersed but interconnected approach to policy and incorporates a 'network' perspective to governance, adopting conceptualisations and language from Castels' 'network society' and from inter-organisational management studies (e.g., Hajer & Wagenaar, 2003; Healey P., 2007). In this conceptualisation, policy is implemented and arrived at by networks of actors (individuals and organisations) who exchange information, agree on goals and negotiate implementation (Rhodes, 1997). Others argue that these interactions do not happen in a vacuum but within a context and history of relationships which provide a cognitive framework for policy making and implementation. Different disciplines have understood the influence of this 'institutional setting' on policy making in a variety of ways, generally arguing that underneath this pluri-centric and horizontal interaction there is an underlying culture which guides the structure of networks and the actions of actors (e.g., Lowndes V. , 1996; Immergut, 1998).

As planning is understood as the intentional state activity of the making and management of places, governance behaviours imply that coordinating urban policy and change happens in a context of institutional fragmentation, with a high number and diversity of actors who have

influence on urban policy implementation and urban development. Hooghe and Marks (2001) called this the 'multi-actor and multi-level game'. Bulkeley and Kern (2006) further describe how open and multi-stakeholder circumstances increase the complexity of policy formation and delivery in cities.

To operate within governance patterns of policy making and implementation, planning organisations have to negotiate with other stakeholders to achieve spatial policy goals. Planning processes can be part of those negotiations; for example, a local authority permitting increased housing densification in exchange for improved public realm. Governance also challenges the use of traditional government-led planning processes and introduces the formation of new institutional arrangements, such as public-private partnerships or civic coalitions, which can alter the implementation of policy and the powers of planning processes (Healey P. , 2007). Salet, Thornley and Kreukels in *Metropolitan Governance and Spatial Planning* (2002) discuss the challenges of spatial coordination in governance patterns of behaviour. They specifically highlight the challenge of balancing environmental qualities in a context of institutional fragmentation and a growing separation of the 'material' boundaries of a city (its consumption and production footprint) from the morphological boundaries of authority control.

Understanding policy creation and implementation with a governance network paradigm has also raised questions about democratic procedures (Booher & Innes, 2002), community steering (Sehested, 2009), and transparency and accountability in urban planning (Nyseth, 2008). Comparative planning authors have stressed that the ability of planning systems to undertake place management is influenced by the institutional (often legal) context of government control over land and therefore the power of planning systems in governance networks varies significantly between place and context (Newman & Thornley, 2005; Stead & Cotella, 2011).

1.3 Research Aims and Thesis Structure

Broadly, this research aims to contribute to theoretical and empirical dialogue on the potential contribution of planning systems, in relation to other urban policy and management organisations and processes, in building and managing urban infrastructure that will achieve environmental policy goals. Set within questions of a public policy nature, namely the interaction of the public sector, the market, and civil society in achieving desired societal and environmental outcomes, the research is particularly focused on the role of planning organisations and processes within governance networks in delivering DHC systems.

DHC is a highly efficient form of providing locally generated thermal energy for heating and cooling urban environments, but requires strategic heat resource planning between many consumers and substantial financial investment to construct. The premise of the research is that the delivery of DHC as a policy goal requires the coordination and negotiation of multiple actors across space and time, and that planning organisations and processes might have an important role to play in this interaction.

There is a shortage of practical and policy insight into how planning systems shape or support the creation of new urban DHC systems. The research intends to contribute to planning literature and environmental policy thinking by undertaking qualitative in-depth analysis of the role of planning organisations in governance networks in five international attempts to deliver DHC. This comparative approach should enable the identification of how planning, institutional context, and governance networks can influence the creation of new DHC systems.

Research questions

Building on the literature context described above, three research questions are proposed. One, **How do governance networks support the implementation of district heating and cooling systems?** This question recognises the weakened regulatory or management capacity of the public sector in creating new urban infrastructure for environmental goals. It positions DHC as a complex policy change which requires public and private actors to interact in horizontal, pluri-centric networks of coordination and negation. This research question seeks to understand how features of modern governance policy making and delivery constrain or enable the delivery of DHC in networks of negotiation and interaction among public, private, and civic actors.

The second research question is **How does the institutional setting influence the delivery of district heating and cooling systems?** This question seeks to understand importance of historical or legal context on the ability of actors in governance networks to deliver urban energy infrastructure. It asks if the institutional setting is constraining or shaping the actors who engage in DHC as a policy goal and the ways in which they work towards delivery of DHC. Comparative planning studies indicate that legal and policy context is particularly relevant in understanding how planning processes and organisations might shape other actors.

Together these questions help inform the third research question, formulated as, **What is the role of planning, in relation to market, civic, and to other government organisations, in delivering district heating and cooling systems?** The research aims to consider the role of planning organisations and processes both in light of a rising global trend for governments to address energy use in cities and increased expectations for planning systems to address environmental concerns.

Structure of this thesis

The subsequent two chapters review existing literature and understanding around the research questions, providing additional theoretical context and background. Chapter 2 discusses governance networks as observed phenomenon of policy making and explores what the existing literature reveals about the position of planning organisations and processes within urban policy. It builds on a desktop review to suggest potential roles for planning in delivering DHC systems. Chapter 3 focuses on the context for the second research question, describing how concerns of legal, regulative or social context inform governance behaviours. The implications for the role of planning and the third research question are discussed in both chapters. Chapter 4 considers how existing literature described in Chapters 2 and 3 informs the research approach to the three questions, discussing implications for the research design. The

text builds a case for the use of a conceptual framework, Actor-Centered Institutionalism (ACI), which can distinguish both governance behaviours and institutional concerns across a comparative analysis of international case studies. It provides a concluding section summarising the research approach and outlining the potential contribution of the research.

Chapter 5 describes how ACI structures the research methodologies and case study selection. It describes the data collection and analysis, linking the case study analysis to the three research questions. Chapters 6 to 10 address each case in turn, using the structure of ACI to analyse the data and respond to the research questions. Chapter 11 then describes the comparative analysis across the five cases, using the presence of failed attempts to implement DCH to draw conclusions for the three research questions. The final chapter summarises the contribution of this research, discusses implications for future research, reflects on the limits of the research design, and proposes implications for practice.

Chapter 2. Planning for DHC in Governance Networks

This chapter discusses existing literature on modern policy making and implementation, providing background to the research's concern with how cities can build DHC systems. It begins by reviewing strands of governance theory and portrays DHC as a complex policy problem which requires governance network patterns of behaviour. It then explores how planning systems can be understood in governance and how planning processes might support DHC. Implications for research questions one and three are summarised in a concluding section.

2.1 Introducing Governance

Due to its wide-spread use across many academic disciplines, the term “governance” has a multiplicity of definitions and uses. Paul Hirst in *Debating Governance* (2006) and *Theories of Democratic Network Governance* (2007) identifies five main applications. One, the use of ‘good governance’ by the World Bank in economic development, where it implies that an effective political framework is conducive to private economic action. Second, in international relations to describe supra-national platforms for decision making, such as the IPPC, the UN and the World Bank. Third, to refer to responsible structures for decision making in corporate bodies; ‘corporate governance’. Fourth, in organisational studies to describe the application of commercial management styles, such as target setting, to public sector organisations (Sorensen & Torfing, 2007) (Hirst, 2006).

Finally, governance is used by a wide range of disciplines to describe the patterns of public-private cooperation and partnership to coordinate policy making (Sorensen & Torfing, 2007). It is this latter use of the term which concerns this research: governance as a characterization of observed behaviour patterns around policy goals. The patterns described are real changes away from central government as the principal provider of control and regulation and towards a practice of coordinating activities among citizens, activist organisations, lobby groups, the private sector and other stakeholders (Hirst, 2006; Kooiman, 2003; Hajer & Wagenaar, 2003). A shift towards a less centralised policy decision making and towards governance interactions has been demonstrated by a number of studies; Berger’s review of EU regions (2003) and Healey et al.’s review of the Grainger Town Partnership (Healey, De Magalhaes, Madanipour, & Pendlebury, 2002) are two of the more well known.

Researchers of many stripes agree that governance patterns of interaction are a response to the failure of government and of markets alike to provide efficient solutions to policy problems (Marsh, 1998; Kooiman, 2003; Besussi, 2006; Rhodes, 2007). The failure results from the characteristics of the policy problems themselves and from structural changes in society and market forces (Sorensen & Torfing, 2007; Kooiman, 2003).

An often cited structural reason for the emergence of governance patterns in multiple countries is increasing societal diversity, referring generally to a fragmentation and specialisation of society and markets (Kooiman, 2003; Sorensen & Torfing, 2007; UN-HABITAT, 2009) and, particularly in the EU, to the introduction of multiple layers of government regulation and policy, from deregulated regions and local government to the European Union. Increasing social diversity and economic specialisation results in a greater number or range of policy initiatives to achieve desired policy outcomes, as no one policy can address everyone or every type of activity. Rhodes is particularly adept at illustrating how privatisation of previously state activity resulted in increased fragmentation and increased government (and governance) activity, not less (Rhodes, 2007). Scharpf also finds the context of 'transnational interdependence' as main cause of governance, arising from the cross-boundary nature of policy problems (transnational environmental pollution) and the multi-level nature of modern policy solutions which act at local, regional, national, and transnational levels (Scharpf, 1997). Economic globalisation and the privatization of previously public services, mixed with societal diversity combine to weaken the ability of a central government to enact top-down policy.

Problem complexity is also cited as a reason for the shift to governance patterns: the increasing level of knowledge and power required to address policy issues and generate solutions (Kooiman, 2003). Stoker (2000) terms this 'high bounded rationality' and argues that gaining understanding for technical and complex policy issues is beyond any one organisation. Hajer and Wagenaar argue that this practical inability of governments to act unilaterally is supplemented by a change in social perception away from state activity as a positive, rational, and civilizing force to a 'sense of unease' about the capability of state action. This arises from an awareness of potential perverse consequences of large scale rational planning, such as the 'new towns' of the United Kingdom, and a belief that market forces are efficient and lead to the 'best' outcomes (2003). Therefore the formation of policy becomes a sensitive process and a testing ground for acceptability of policy implementation.

Hajer and Wagenaar, in their influential book *Deliberative Policy Analysis* (2003), provide a robust summary of the reasons for the failure of government and markets to provide efficient policy solutions. Their five challenges for policy analysis can also usefully viewed as five challenges for policy solutions which require governance patterns of behaviour in response. As a litmus test for policy problems, their 'new spaces of politics' and related implications for governance decision making patterns are summarised in Table 3.

Challenge of policy problems	Implications for government decision making patterns
• Structural changes in society mean that challenges are no longer top-down or local/regional/central, but non-hierarchical.	• Politics and policy making often happen in configurations that do not conform to the old formats.
• Politics and policy making under the condition of radical uncertainty. • Awareness of perverse consequences of large scale rational planning. • Deep unease about possibilities of effective and responsible state power.	• Governments no longer make decisions 'once appropriate knowledge is available'. • Instead often make decisions in uncertain knowledge arenas (this is appreciated by public).
• Increase importance of 'difference' for our understanding of politics. • Cultural complexity in society.	• Understanding of issues, language issues, problem of translation • Importance of framing.
• Acting upon an awareness of interdependence and need to collaborate.	• Creating collaboration. • New modes of conflict resolution – shared problem solving.
• Policymaking and the dynamics of trust and identity. • Lack of general trust in policies.	• Policymaking process important for creating trust in politics. • Process as 'will formation' for policy goals. • Range of interactive, roundtable practices.

Table 3: The new spaces of politics (summarised from Hajer and Wagenaar, 2003)

Network governance

A substantial portion of recent town planning and public policy literature on governance incorporates a 'network perspective' either in theoretical language or conceptualization (Berger, 2003; Healey P. , 2007; Nyseth, 2008). A network perspective on governance emerged from public policy (Rhodes, 1997) inter-organizational analysis (Hanf & Scharpf, 1978) and socio-economic research and literature (Jones, Hesterley, & Borghatti, 1997), and their respective concerns with how to solve societal, economic or environmental problems with exchange based relationships. In all lineages, networks are a conceptualization of exchange based governance patterns in a complex multi-stakeholder environment (Hajer & Wagenaar, 2003).

This research acknowledges the distinction between the *policy* networks of Rhodes and Kickert (1997), with an emphasis on the structural exchange relations between interdependent political bodies and the *governance* networks of Scharpf, Mayntz (1997) and Kooiman (2003), with an emphasis on horizontal, actor-led loose structural coupling between autonomous public and private actors creating a negotiated consensus which provides the basis for coordination. In both approaches, networks are not critical theories or normative goals, but empirical descriptions based on the operation of 21st century democratic governments (Kooiman, 2003). Employing Sorensen and Torfing's useful classification of governance network theories (2007), the policy networks of Rhodes and Kickert can be understood as 'interdependency theory' focused on conflict within a hierarchy of actors who are organisationally dependent on one another.

Scharpf, Mayntz, and Kooiman's governance networks are classified as 'governability theory' by Sorensen and Torfing: focused on coordination between many independent actors. Kooiman, in particular is clear that governance network patterns emerge when no single actor has sufficient

resources to act unilaterally, and the relationships between actors are complex and the hierarchy (if it exists) is not apparent or understood (2003). For Scharpf, Mayntz, and Kooiman, governance networks can be understood as more fluid than policy networks and involving civic and market stakeholders as well as traditional political institutions.

Sorensen and Torfing (2007), writing in *Theories of Democratic Network Governance* describe network governance patterns as:

> 1) A relatively stable horizontal articulation of interdependent, but operationally autonomous actors;
> 2) Who interact through negotiations;
> 3) Which take place within a regulative, normative, cognitive and imaginary framework;
> 4) That is self-regulating within limits set by external agencies; and
> 5) Which contributes to the production of public purpose. (p. 9)

In this definition of governance networks, policy objectives are generated and delivered by non-subservient organisations and individuals (actors), who rely upon each other's resources and capabilities to generate policy but who are not able to command each other directly. Sorensen and Torfing are clear that 'horizontal' does not imply equality, but a lack of hierarchy. These are a mix of public, semi-public, and private actors who coordinate policy through exchange and negotiations, giving and taking knowledge and resources in a trust oriented manner without 'majority vote' or other formal or legal mechanisms. These interactions do not happen in a vacuum but within a context and history of relationships which provide a cognitive framework. Finally, the aim of these interactions is for the public good; that is an outcome which addresses a policy problem (2007).

Recent thinking on governance networks has been concerned with exploring normative aspects of governance network theory, particularly democratic problems and potentials (Sorensen & Torfing, 2007; Nyseth, 2008) and the potential for governance networks as pathways to sustainable development and good urban management (Allen & You, 2004; Pfeiffer & Hall, 2000). This research is positioned within the latter approach, focusing on the particular challenges for large urban energy infrastructure.

A governance network, as opposed to a policy network, approach to governance is considered as an appropriate interpretation for this research. Chapter 1 describes how the research's focus on DHC systems should address with the interaction between public, private, and civic actors needed to build and operate the systems. Rhodes' policy networks are found in hierarchical patterns of behaviour between government actors and arise from government policy studies. Kooiman's network governance approach which explicitly mixes the public and the private and is therefore more applicable to the investigation of DHC system. Additionally, the research's focus on the role of planning organisations in delivering DHC requires a research framework which concentrates on decision making among individuals towards the policy outcome (a governance network focus) rather than conflict between individuals (the policy networks focus).

Multi-level governance

Other governance approaches have focused specifically on policy responses to environmental challenges. Multi-level governance is an approach towards understanding governance patterns on issues on climate change (Betsill & Bulkeley, 2006) and environmental policy within the EU, building on earlier framing of governance networks into 'vertical' and 'horizontal' levels (Hooghe & Marks, 2001). It contends that a city's capacity to address environmental issues is significantly influenced by links between and across scales of governance; for example national policy and targets as enablers or barriers to local action or transnational networks as facilitating knowledge exchange. In this literature, network forms of interaction often imply a sharing of knowledge and leadership among actors rather than explicit negotiations. Over the course of the past ten years, multi-level governance has made strong case for climate change mitigation and adaptation - including energy management - as an issue for urban actors rather than national or international actors. Adger, Jordan, Betsill, and Bulkeley describe how local actors draw on international knowledge and support to establish policy, positions, and strategies for climate change action (Adger & Jordan, 2009; Betsill & Bulkeley, 2013).

However Betsill and Bulkeley's recent reflection on the state of multi-level governance analysis on climate change concluded the research has tended to focus on municipal activity and vertical relationships between local governments and national governments, leaving relationships between the public and private sector un-examined or assumed static. As they acknowledge,

> To date, there has been limited engagement with the ways in which, say, the activities of small- and medium-sized enterprises, the urban investment strategies of major companies and donors, or other processes that govern production and consumption, may serve to sustain, limit or contest urban climate responses. One example that has recently been highlighted is the limited extent to which studies of the multilevel governance of urban climate change responses have engaged with the dynamics of urban infrastructure systems. (Betsill & Bulkeley, 2013, p. 114).

They highlight the spatially constrained nature of urban infrastructure systems like DHC. This implies that multi-level governance is unlikely to be an appropriate approach to guide the research aims and it is not proposed to be taken forward as a guidance concept for this research. However in light of their gap identification, this research's deliberate focus on the intersection of public and private activity on urban energy infrastructure has the potential to contribute to multi-level governance literature.

Planning as governance

Planning theory has also taken up governance investigations as a continuation of earlier stakeholder and advocacy theory within planning studies. Communicative planning and advocacy planning in particular have explored the role of planning in a modern world where government and social institutions, citizens groups, environmental activists, etc are all involved in the process of forming and delivering urban policy solutions beyond land use zoning or urban development growth (Healey P. , 2007). Communicative planning theory proposes that “Planners should not formulate and argue for the interests of the weakest but instead should

generate processes and dialogues which allow the weakest parties to formulate their own needs and interests", applying Habermas's theories on communicative action (Sehested, 2009, p. 245; Boelens, 2010; Healey P. , 1999). In this approach, planning organisations and planners are not explicit actors in urban governance negotiations, but instead guardians or stewards of processes which shape the scope and nature of governance interactions. "The planning project, infused with this understanding of socio-spatial dynamics, becomes a governance project focused on managing dilemmas of co-existing in shared spaces" (Healey P. , 2007, p. 3).

Understanding planning processes as governance behaviours and focusing on process can be understood as a retreat from prescriptive policies in response to the 'new spaces of politics', an increased understanding of cities as complex and dynamic settings, and as a result of the growing number of stakeholders engaged in spatial planning processes (Newman & Thornley, 2005; Sehested, 2009; Healey P. , 2007). More recently, considerations of planning processes as governance have shown an increased concern with democracy (Nyseth, 2008) and power relationships (Booher & Innes, 2002). In this approach, planning theory has moved beyond a normative role for planning processes in isolation and is now concerned with identifying normative processes and patterns of interaction between planning organisations and the other actors involved in managing space and society (Healey P. , 2007; Sehested, 2009; Nyseth, 2008; Tewdr-Jones & Allmendinger, 1998). Communicative planning's focus on qualities and shape of process can be understood as a echo of network governance hypotheses about the quality and characteristics of the network interactions in shaping outcomes alongside actor resource.

This theoretical understanding provides context to how planning systems might be conceived within modern policy making and suggests that planning processes and organisations might have specific, helpful roles in creating and supporting governance networks. The next section explores what governance means for DHC; a subsequent section explores how planning organisations can be understood as actors within governance networks and reviews existing knowledge about the role of planning in DHC.

2.2 DHC Requires Governance Networks

Chapter 1 describes how delivery of DHC is a complex policy challenge which requires spatial, intellectual, and financial coordination and exchange among multiple landowners, energy users, government organisations, and a range of other organisations and individuals. The barriers to the delivery of DHC were set out as: requiring local and expert knowledge, requiring strategic energy planning, the need to overcome a monopolistic nature through regulation, and potentially high installation costs. By its very nature DHC is a communal infrastructure shared by multiple parties and cannot be implemented by one organisation alone.

The complexity of DHC is reinforced by external political and economic factors which mirror Hager and Wagenaar's 'New Spaces of Politics' (2003) which drive governance network patterns of behaviour. In liberalised and privatised energy markets, governments do not have the regulatory or political power to force the construction of DHC, and instead must deliver their

policy goals through interaction and exchange with the market (London First, 2008; Monstadt J. , 2009); a core feature of governance networks. As a technical solution, the complex variables for delivery, such as layout of pipework, cost, location for central plant, etc create a barrier to understanding among the various organisations involved. This also increases the difficulty in promoting DHC as a policy solution (London First, 2008; TCPA, 2008). As a spatially specific solution, the delivery of DHC requires that national policy goals need to be reconciled with local powers, policies, and capabilities. The technical complexities of DHC need to be conveyed in a public policy setting; therefore the framing and explanation of the drivers and benefits becomes important. To overcome these barriers requires national and local involvement by a range of organisations and individuals at many scales; the solution is both multi-actor and multi-scalar.

Other characteristics of DHC which drive governance network patterns of behaviour arise from its delivery and management. The construction and ongoing administration of DHC systems requires exchange of knowledge and resources between a significant number of actors, from national ministers to local residents groups, and often including multiple government authorities. This is due to both fiscal and physical reasons. To obtain capital investment, a large customer or grouping of multiple loads to serve as a 'base' load is preferred; this usually involves local authorities and their institutional buildings, public housing, or their political ability to facilitate multiple private energy demands (London First, 2008; TCPA, 2008). Physically retrofitting a DHC pipe network into an existing urban area requires government coordination and political will, given the disruptive nature of the work and interface with other below ground services as well as development permissions.

Because the cost and carbon efficiency of DHC are strongest at larger scales (e.g. district or city-wide systems) (International Energy Agency, 2005), the number of actors involved can be significant. In the Copenhagen district heating system, which supplies 97% of the city's heating needs, the installation and ongoing management involves at least 22 agencies and institutions, not including financial organisations or heating customers (C40 Cities, 2010). Support of the general public is particularly crucial in a community energy approach, where a co-operative local organisation owns or manages the DHC system (TCPA, 2008).

As a complex, multi-actor, and multi-scalar environmental policy goal, DHC delivery requires governance network patterns of behaviour. Revisiting Hager and Wagenaar's summary of the five challenges for policy problems (2003), Table 4 summarises how delivery of DHC fits Hajer and Wagenaar's pattern of a policy challenge which requires governance networks patterns of action.

Challenge for Policy Problems	Implications for Governance Patterns	Relevance for DHC Delivery
No longer top-down or local - regional - central.	Politics and policy making often happen in configurations that do not conform to the old formats. Multi-level governance, regimes, etc.	Reconcile national policy goals with local powers, policies, capacities, and local stakeholders (e.g. residents).
Politics and policy making under the condition of radical uncertainty. Awareness of perverse consequences of large scale rational planning. Deep unease about possibilities of effective and responsible state power.	Governments no longer make decisions 'once appropriate knowledge is available'; instead often make decisions in uncertain knowledge areas. This is appreciated by public.	Need local and specialist knowledge to understand technical suitability of DHC . DHC requires government coordination and can be seen as an overly state-controlled activity
Increase importance of 'difference' for our understanding of politics. Technocracy. Cultural complexity in society	Understanding of issues, language issues. Problem of translation Importance of framing	DHC is a technological solution with different benefits to different audiences. Challenges conceptual relationship of government and utilities.
Acting upon an awareness of interdependence and need to collaborate.	Problem of discursive barrier. Need for collaboration. Creating communities of action.	Technology with multiple actors involved; requires collaboration between many parties.
Policymaking and the dynamics of trust and identity. Lack of general trust in politics.	Policymaking process important for creating trust in politics and 'will formation for policy goals. Range of interactive, roundtable practices.	DHC as policy goal alone will not suffice; need to engage general public and technical support.

Table 4: Comparison of DHC delivery characteristics with Hager and Wagenaar's (2003) five challenges for governance networks

The actors of DHC

This section reflects on the various organisations and individuals who could be involved in the creation and operation of DHC systems; they can be understood as actors in a governance network. A literature review did not uncover any reports or papers which expressly outlined the various actors, or their roles, involved in the delivery of DHC. To compensate, a desktop review was conducted on a number of DHC systems in operation. The following text includes examples selected to illustrate the range of actors who can be involved in DHC.

Government organisations and departments can be an actor in DHC systems at a national and or a local level, and through a range of departmental responsibilities such as energy, urban areas, environment, and finance. At a national level, they can be involved by supporting DHC in policy statements, developing standard regulation for heat or coolth sales, or through direct fiscal incentives such as taxes or feed in tariffs. An example of a national government actor can be seen in South Korea where the Integrated Energy Supply Act of 1999 requires new urban developments to use district heating; it also established tax incentives for both suppliers and users (United Nations, 2002). At a local or urban level governments can be involved in network coordination and exchange in a variety of ways, from local policy statements, financial support, strategic spatial planning of the systems, through to direct investment in the DHC systems by

providing land for the energy centre(s). A local government actor example can be found in Denmark, where the (national) 2000 Heat Act sets out in Article 3, that it is "(..) the duty of each district council, in cooperation with the supply companies and other involved parties, to prepare a plan for the supply of heat in the municipality" (EcoHeat4.eu, 2010). Other roles can be seen in Southampton City Council, United Kingdom where the local municipality provided land at no cost, offered public buildings as the main customers, and helped to secure a financial grant to overcome the set-up costs of a local DHC system (London First, 2008).

Businesses which are local to the DHC system can agree to becoming energy customers of the network. Other roles include providing land or space for the DHC network, or publicly supporting or opposing the DHC system. In San Diego, a 2.5 mile subterranean district cooling system feeds more than 4 million square feet of space, including hotels, theatres, and shopping centres, due to strong business demand for cheap cooling energy (NRG, 2005). Residents have a similar role as potential customers and as public supporters or detractors of a potential system. In Vienna, Austria, residents are encouraged to purchase energy from the DHC system through both active marketing and local government policy (City of Vienna, 2007; Wien Energy, 2008).

Industry alliances and civic campaign groups can actively promote DHC as a priority environmental policy goal, or share knowledge about its potential benefits and the technical options available. These types of actors include both global organisations such as the International District Energy Association, as well as local organisations, such as London First in the UK, and their promotion of DHC as an environmental solution in *Cutting the Capital's Carbon Footprint – Delivering Decentralised Energy* (2008). Political figures and parties can also have a place in the delivery of DHC, through support or opposition or through leadership of the multiple organisations and individuals involved. In Copenhagen, it was an alliance of five mayors which initially enabled the city-wide district heating system to start up in the 1980s (Danish Board of Distict Heating, 2007).

Energy utility companies have a potential role as installers, owners, and operators of the DHC systems. They often bring their technical understanding, and can further support the delivery or expansion of DHC through providing land or encouraging new customers. Vienna's Wien Energy (2008) provides a good example of this, as does Utilicom which owns, finances, and operates the DHC system in Southampton (London First, 2008).

Finally, another actor potentially involved in the delivery of DHC are banks and other financial institutions, who can provide the not insignificant financial capital for construction. The willingness of banks to provide the loans can depend on the level of national or government support for the system, as well as other factors such as perceived customer take up. In Southampton, finance was provided through the energy company, where in Denmark, Finland and South Korea the capital costs were financed through banking institutions (United Nations, 2002; Danish Energy Authority, 2005; C40 Cities , 2010).

Table 5 is proposed as a potential categorisation of actors and their roles in delivering DHC based upon the research's initial case study review. The review found that there is no 'typical' arrangement and that each case study involves different types of actors at different levels. This implies the research framework will need to be adaptable to a range of actors as well as different types of government structures and administrative legacies.

Actor	Predominant Roles	Secondary Roles
National government	Fiscal policies and legal regulation in support	Promotion of technology Direct financial support
Local government	Government energy demand used as 'base load'	Own or manage systems Provide land Guarantee financial risk
Planning authority	Identify appropriate areas of cities Regulate or incentivise connection	Map energy demands Raise awareness
Business	Agree to or enable connection to network Purchase energy	Provide land Support or resist installation
Residents	Agree to or enable connection to network Purchase energy	Support or resist installation
NGOs, campaign groups	Promote DHC Raise understanding and share knowledge	
Politicians or political parties	Support or oppose DHC Gain support for scheme among other actors	
Energy companies	Install; bring technical knowledge Own system and supply energy	Provide land Encourage new customers
Banks and other sources of finance	Invest in installation or maintenance	

Table 5: Potential typology of actors involved in delivering DHC

2.3 Planning for DHC in governance networks

Planning theory recognises planning processes as governance processes, as networks of relations between actors, but planning organisations can also be understood as actors within broader governance networks. Authors who examine municipal planning organisations as a force within urban governance networks have sought to understand how planning organisations communicate and negotiate with other civic, market, and public sector actors. Often writing from a global competitive cities perspective e.g. (Newman & Thornley, 2005) (Stoker, 2000), these approaches tend to see planning organisations as participants in governance through market forces; a public sector actor who acts to constrain or enable private investment in urban areas.

One well known approach is set out by Tiesdell and Allmendinger, writing with Adams, who categorise four ways that planning processes can influence the shape of places (Adams D. , 2008; Tiesdell & Allmendinger, 2005). Writing from regulatory perspective, they understand planning tools as instruments to intervene in an economic market which shapes cities. 'Market shaping' interventions are designed to shape the context within which market transactions occur; for example the production of a statutory development plan which excludes specific land from agriculture or development on the grounds of water pollution. Market shaping interventions can be either statutorily enforceable or persuasive but they provide 'authoritative information

and state commitment'. A communicative planning perspective would suggest the process of developing such interventions could itself be a sphere of negotiation and collaboration, alongside the output itself setting the context for further governance activity.

'Market regulation' interventions are designed to control market actions and transactions, ensuring some consideration of the public interest; Tiesdell and Allemendinger cite development control and building regulations as an example. Linking this to environmental policy goals for illustration, in the United Kingdom the grant of planning permissions is often conditioned with energy efficiency or pollution limitations. 'Market stimulation' interventions such as using government powers to enable land assembly, release, or grants, make the market work better by having a direct impact on the financial appraisals. An example here could be grants to support the redevelopment and rehabilitation of contaminated land, as exists in the United States. And finally 'capacity building' intervention builds capacity of government or market operators through such actions as encouraging public-private development partnerships, or promotion skills for sustainable communities (Adams D. , 2008; Tiesdell & Allmendinger, 2005).

It is widely accepted that the market interventions of planning function best when the market shaping roles - visions for places, developed through stakeholder engagement - are active and strong. Tiesdell and Allmendinger's understanding of planning processes as interventions in urban governance provides a helpful categorisation of the potential roles of planning. A subsequent section below describes how these might apply to DHC.

Category	Role of Planning	Intervention
Market Shaping	Shape the context within which market actions and transactions occur; Provide 'authoritative information and commitment	Statutory Development Plan Environmental Plan Formal collaboration with market Corporate Plan to invest in area
Market Regulation	Regulate or control market actions and transactions	Development control Building regulations Environmental tax
Market Stimulation	Make the market work better, by having a direct impact on the financial appraisals	Land assembly Grants Financial incentives Direct government investment in development
Capacity Building	Build capacity of public sector or market operators	Publicizing benefits or examples Study tours Skills development Sharing knowledge

Table 6: Summary of Allmendinger and Tiesdell's (2005) conceptualisation of planning interventions

Planning for urban energy infrastructure in governance networks

The influence of planning organisations and processes in urban utilities has been historically understudied in both planning and utility literature (Williams, 2013; Gochenour, 1994; Kerr, 2009; Keirstead & Shah, 2013). Monstadt, writing in *Environment and Planning* in 2009, identifies this relatively weak link between urban planning and socio-technical literature on utility infrastructure; "This interlinkage of infrastructural and urban developments has hitherto...been undertheorized and empirically understudied both in social studies of technology and in urban

studies." (p. 1924). He argues that the city level dimension is particularly absent, as are environmental impacts of urban utility control and change. However two recent and useful explorations into the role of planning in low carbon infrastructure are discussed here to provide context for research question three.

Simin Davoudi's 2009 report on the English government's use of planning systems to address climate change attempted a typology of planning interventions for climate change. While the report addressed a wider range of climate change policies, it suggested that planning has the greatest breadth of roles for large scale renewables supply, with substantial roles in small scale renewables and energy efficiency. Davoudi characterised such interventions as 'site allocation and identification', a regulatory 'infrastructure planning commission', regulatory powers of permitted development and planning conditions, and strategic collaboration with the energy industry and local communities (2009). All of these roles appear relevant to this research given the nature of DHC systems as described previously.

Williams takes Davoudi's categorisation further in a 2013 article in *Environment and Planning B*, describing potential roles for planning in delivering urban low carbon infrastructure (LCI) as well as linking those roles to approaches of planning and mechanisms for delivery. The article reflects on international examples of LCI delivery, recognising a broader scope of planning roles because "systematic urban planning and regulatory functions of urban government have partially given way to project-driven practices, entrepreneurial and collaborative approaches to governance (Harvey, 1989; Healey, 2006)" (Williams J. , 2013, p. 685). Williams acknowledges that planning interventions and the multiple roles of planning are not mutually exclusive; multiple roles are possible in one context. She also illustrates how it is difficult to disassociate the impact of a particular approach from other drivers or influences on LCI, such as local and national energy subsidies. She highlights that institutional context is a significant factor on the role of planning and "may influence the extent to which the planning approaches .... are transferable without wider changes within the system" (p. 703), and the article usefully points at roles and mechanisms which might be more suitable in different contexts.

For example, an approach where planning is part of citizen-led development projects for LCI will only be successful in a context where 'citizens are proactive' and 'pro-environmental' and there is long term political support. In this context, she suggests the role of planning is one of capacity building, expert guidance, and conflict resolution. A second typology, the system planning approach, attempts a more top-down, but holistic attempt to integrate LCI within the traditional or existing roles for planning of housing, transport, and economic infrastructure. Her third approach to the planning for LCI sees a focus on land-control mechanisms to support the market in building LCI, helping the private or third sector function better. Table 7 summarises Williams' categories of potential roles for planning.

Neither of these papers directly addresses how the roles for planning organisations or interventions might be affected by or help address the implications of the ongoing privatisation and de-localisation of infrastructure. Nevertheless they provide useful categorisations and

typologies of planning interventions around energy use in urban areas, linking such roles to influence on the private and civic sectors.

Approach	Role	Mechanism for Delivery
Collaborative	Capacity building Providing expert guidance Conflict resolution	Citizen-led development projects Citizen-led consultation; Visioning and design exercises
Systemic	Involvement of LCI providers in plan-making process Coordination of: infrastructural LCI systems, land use and development Plans and policies for the delivery of LCI and development in cities Key stakeholders in the provision of LCI	Strategic planning process
Market Shaping	Creating certainty for suppliers and markets Reducing build costs Raising funds for low-carbon systems	Development control Zoning and coding Infrastructure levies Length of planning process

Table 7: Summary of Williams' (2013) identification of the role of planning in delivering LCI

Planning organisations and processes delivering DHC

Building on these identified roles for planning in supporting LCI generally, the following examples call upon a desktop review to illustrate potential roles for planning in delivering DHC, employing Tiesdell and Allmendinger's (2005) categorisation of planning's market interventions. This provides initial context for research question three, **What is the role of planning, in relation to market, civic, and to other government organisations, in delivering district heating and cooling systems?**.

In Amsterdam's Zuidas district (Nuon Warmte; Nuon, 2010; C40 Cities, 2010) the council's 'market shaping' approach saw it undertake energy mapping (determining heat or cooling loads in existing buildings) and suggest locations for the district cooling pipework and energy centres in an area of new development, illustrating the role of planning organisations as coordinator of DHC systems, land use, and development. The institutional context permitted the planning authority to local DHC pipework in the city and coordinate new connections to it. This type of spatial task can also go a long way towards the 'will formation' of Hager and Wagenaar and is essential for coordination of delivery between multiple actors, particularly providing an indication of future investment and return for private energy companies.

This spatial coordination can be complemented by municipal control or influence on new development through the planning approvals process. Development codes or policies which encourage or require connection to existing or envisaged DHC systems, as South Korea has done (Hayes, 2010), create certainty on demand for providers and funders of DHC systems. Development control or permitting powers can also support DHC by controlling any negative impacts or reducing conflicts with local communities. The varied fuel sources of DHC – such as waste incineration plants – can have air quality and other environmental health implications which can be regulated through planning organisations during the initial permitting process, and then by the local government more generally during operation. An example of this is London,

where the local boroughs have the power to refuse particular energy generation types on air quality or other grounds, and where the mayor promotes DHC as one solution through development policies and approval powers (Greater London Authority, 2004; Greater London Authority, 2006; Greater London Authority, 2007). Both examples illustrate planning's 'market regulating' powers in Tiesdell and Allmendinger's conceptualisation of planning interventions. However the level of control planning has over new development to connect is not universal and varies nationally.

Williams (2013) uses Freiberg to illustrate the capacity building role of planning in low carbon infrastructure generally; this also applies to DHC. Actions in this role could be as a communicator of DHC benefits to a non-technical audience through consultations, harnessing local interest in climate change to build political support, or ensuring projects are accountable. Vienna's government committed to raise public awareness of the environmental benefits of its DHC system in new developments to encourage its expansion (Austrian Energy Agency, 2009; City of Vienna, 2010; TCPA, 2008). Williams also illustrates how in a community-owned DHC system, where the generation and pipe network are installed and managed not by an energy company but by local resident group, planning organisations could play a very different role.

Another role for local authorities is to create certainty about the future of potential DHC systems by leveraging public sector energy demand or public sector land ownership, a 'market stimulation' tool in Tiesdell and Allmendinger's categorisation. This may not happen through a planning organisation, but it is likely to use planning processes. For example, by requiring publicly owned housing or local government buildings to be connected to a DHC system, local authorities can provide financial certainty to private sector DHC operators. An example of this is the Southampton District Energy system in the UK, where the local authority used the civic centre as a main heat load to start a privately-operated DHC system, as well as giving land for the energy centre on a 'peppercorn' rent (London First, 2008).

In some countries, the ongoing ownership and maintenance of DHC can be the responsibility of the local authority. In these situations, the municipal planning organisations could play a more involved role in the initial design and delivery of DHC and in safeguarding or expanding it through spatial planning procedures. An example of this role is Hamburg, where the local authority is considering re-commencing its local authority owned energy company (which was closed during early privatization drives) in order to meet its goals for DHC (Lutsch, 2009; City of Hamburg, 2007). This role is a slightly stronger interpretation of Tiesdell and Allmendinger's 'market stimulation' conceptualisation.

2.4 Implications for the Research Questions

This chapter discusses governance theories and planning theories relevant to the research questions. It describes how governance proponents such as Hajer, Wagenaar, and Kooiman understand the challenges of modern policy formation and subsequent delivery implications. Multi-level governance is discussed but discounted as not appropriate for the research focus. Planning processes can be understood as governance processes, as a structure guiding the

process of coordination and negotiation of others. A governance network approach is put forward as powerful way to conceptualise and approach the research; through this the research approaches DHC as policy goal which requires public and private actors interacting in horizontal, pluri-centric networks of coordination and negotiation.

A governance network approach is significant for thinking about public-private relationships in delivering DHC in three ways. First, a network perspective can assist in understanding how governance addresses policy problems like DHC in both a process and outcome sense – it assumes causal linkages between the characteristics of interactions of a group of actors addressing an issue and the outcomes of that action. This goes beyond a description of behaviour patterns. Networked governance suggests that the quality and type of coordination and negotiations between actors has a direct influence on the outcome of the negotiations, alongside the actors and their resources. This proposed link between the quality of the network patterns and the policy outcomes needs further investigation; both Jordan and Lowndes have called for empirical research into this causal inference as a focus of future policy research (Adger & Jordan, 2009; Lowndes, 2009). This potential link can be explored by research question one.

Second, it points at a way of conceptualising the research questions. It provides a useful vocabulary for defining and describing patterns of interaction between actors and institutions involved in DHC, such as planning organisations and utilities companies. Words such as ‘actor’, ‘node’, ‘web’, and ‘interwoven’ provide a powerful conceptualization of relationships between institutions or forms of regulation, and enable a sense of power and relationship to be conveyed. The vocabulary, with its dual implication of a naturally generated system and ‘internet-like’ ability to move information freely, implies biological levels of complexity and fluidity over time – the opposite of anthropogenic hierarchy. The vocabulary and mental images of the governance network approach are helpful in describing how actors behave when facing difficult and complex policy challenges like DHC especially where large numbers and/or types of actors are involved in solutions. Given the range of debate around these ideas and concepts, the research will have to be very clear about terminology and employ a strong analytical framework to structure analysis to address the research questions.

Finally, a governance network approach has proven fruitful in generating cross-disciplinary analysis methodologies which could be helpful to this research. Hermans (2009) reviews a full range of methodologies in some detail, highlighting that while most popular methods can be grouped generally into stakeholder analysis, other methods such as discourse analysis and cognitive mapping are being employed with a spectrum of quantitative and qualitative results. Particularly, social network analysis, based in graph theory, has a history of providing useful quantitative analysis of governance patterns in response to policy challenges (Marsh, 1998). Chapter 5 will investigate these analysis methodologies in more detail.

Therefore to address research question one, **How do governance networks support implementation of DHC?** the research design should be structured to understand individual

actor capabilities and behaviours, as well as the characteristics of interaction and negotiation between government actors, citizens, and commercial organisations which lead to delivery of DHC. The approach chosen will need to distinguish between different types and qualities of interactions between many actors; the content of negotiations should also be understood alongside the characteristics of interaction.

The chapter ends with an initial outline of how planning might support DHC in governance networks. This begins to address research question three, **What is the role of planning, in relation to market, civic, and to other government organisations, in delivering district heating and cooling systems?.** The literature discussed in this chapter explains that planning systems, defined as organisations and interventions, can have a tripartite nature in governance networks. One, planning organisations as actors in the network, negotiating with other actors using planning interventions. Two, planning processes and tools as governance processes, structuring the engagement of other actors in building and managing urban areas. And three, planning interventions can be resources that other non-planning actors negotiate with. Therefore to address the third research question, the research structure will have to unpick how planning tools and activities influence and direct other urban actors at both an actor and a structural level. Tiesdell and Allemendinger provide a useful categorisation of planning's influence and power in governance networks, but the research design should recognise that planning interventions could be used not only by planning organisations but also by other market or other government actors.

While the research can build on conceptualisations of planning processes in governance, the role of planning delivering DHC is a relatively understudied area in both planning and urban infrastructure policy. There is a historical absence of investigation into planning's influence on utilities or specific actors in support of major utilities infrastructure. The analysis conducted in this thesis should seek to build on the recent work of Williams and Davoudi by exploring in greater detail the activities and orientations of planning authorities and the use of planning interventions in delivering DHC systems. This research also has the potential to contribute to the ongoing evolution of communicative planning theories.

In summary, the structural changes and ‘new spaces of politics’ that drive governance patterns in policymaking between public, private and civic actors apply equally as challenges to the barriers and opportunities of delivering DHC. Building on a desktop review, this chapter introduces potential actors in the policy formation and delivery of DHC, highlighting the range of actors that could be involved. These examples begin to illustrate the potential roles that planning might play for DHC, using Tiesdell and Allmendinger's market setting, regulation, capacity building and stimulation categorisations. The examples support an understanding of planning organisations and interventions interacting with and influencing market, civic, and other government organisations to support the delivery of DHC systems. This chapter's reliance on industry case studies also reinforces how the relationship between urban policy, planning, and DHC systems is not thoroughly studied.

The discussion in this chapter, and in particular the desktop review of DHC systems in urban areas, raises issues beyond governance networks and highlights the institutional nature of planning processes and control of urban infrastructure generally. There is variation between countries and cities as to the legal capability of planning organisations to influence civic and market actors, their structural relationships to other government organisations, and their practices, tools, and processes of place management. The next chapter explores this institutional dimension of urban governance networks and planning, assessing what current literature understands about the relationship between formal and informal context in governing and delivering urban energy infrastructure.

Chapter 3 Institutional Dimensions of Planning for DHC

Governance networks are not the only perspective that provides an interpretation of current public-private relationships: new institutionalists add a further dimension by arguing that underneath this pluri-centric and horizontal interaction there is an underlying culture which guides the structure of networks and the actions of actors. This chapter turns to institutional considerations of planning systems and DHC, exploring how legislative, regulative, and behavioural context influence control of land use and the implementation and management of urban energy infrastructure. It provides context for research question two, **How does the institutional setting influence the delivery of district heating and cooling systems?**, in particular considering what multi-level transitions and geographies of infrastructure might imply for the role of planning and the functioning of governance networks. A summary sets out which concepts are being taken forward in the research approach.

3.1 Introducing Institutionalism

New institutionalism categorises a group of theories of social dynamics which emerged from political science during the 1980s as a reaction to behaviouralism (Hall & Taylor, 1996; Healey P. , 1999). Arguing for the importance of institutionalized social conventions to explain human action and inaction, new institutionalists like Lowndes (1996) and Immergut (1998) demonstrated that public policy institutions are not only formal government structures but are dynamic, historically embedded entities that sustain and disseminate systems of beliefs and practices (DiGaetano & Strom, 2003). Institutions are defined in this theory as established ways of addressing policy or political issues, not as the organisations themselves. As Healey explains “Institutions are the framework of norms, rules, and practices which structure action in social contexts” (Healey P. , 2007).

There are many forms of new institutionalism; Hall and Taylor (1996) group them into three analytical approaches (historical, rational choice, sociological) but Scharpf (2000) divides them more simply into two (concerned with origins, concerned with outcomes). Lowndes (2009) also categorises governance approaches such as multi-level governance a strand of new institutionalism. Despite the wide range of approaches within the new institutionalist school of thought, they share the view that institutional factors are the most appropriate points of departure for social analysis (Pierre & Peters, 2005). Discursive or constructivist approaches to understanding institutions in public policy focus on the power of discourse to influence norms and ideas and legitimatise policy ideas (Schmidt V. A., 2002; Rydin, 2003), treating language and dialogue as an independent variable effective policy making - as an institution in its own right. Rational choice approaches to policy evaluation seek to derive characterisations of rules, behaviours, and institutions from empirical studies; these characterisations are then applied to further analysis (Hall & Taylor, 1996; Lowndes V. , 1996) to argue for normative institutional behaviours in defined policy contexts. Historical institutionalism builds on cross national

comparisons of public policy to emphasise the importance of formal procedures and legacies (Immergut, 1998; Hall & Taylor, 1996).

New institutionalist theories and governance patterns of behaviour are not at odds; governance analysis recognises that patterns of behaviour between actors are situated in a context and institutionalist theories provide insight into that context (Kooiman, 2003; Sorensen & Torfing, 2007). Kooiman in *Governing as Governance* classifies institutions as the second order of governance and argues that for understanding governance networks, the "variety of institutional theories is rather an asset than a hindrance to the understanding of governing institutions in a diverse complex and dynamic world" (2003). Sorensen and Torfing's definition of network governance incorporates a new institutionalist perspective, in referencing that the negotiations "take place within a regulative, normative, cognitive, and imaginary framework" (2007, p. 9). However new institutionalists argue that governance theories are not sufficient to explain policy making and implementation.

An approach which seeks to bridge governance and institutional analysis is Actor Centered Institutionalism (ACI) (Pater, 2005). ACI was developed by Renate Mayntz and Fritz Scharpf to study "governance structures and processes in a variety of service sectors (such as health care, telecommunications, and research and development) that are characterised by a high levels of state involvement" (Scharpf, 1997, p. 34) and provides a framework to analyse policy processes which gives equal weight to the agency of actors and the enabling or constraining effects of the institutional setting. In maintaining a conceptual separation between actors' interaction dynamics and institutional factors, ACI is recognised as particularly effective framework for comparative analysis of public policy and processes of governance (Scharpf, 2000; Jackson, 2009; Stead & Cotella, 2011).

In summary, research question two exists in response to new institutionalist concerns, and forces the research to understand not only the actors and interactions of DHC but also the context in which the actors operate and are made legitimate. Institutionalist approaches offer a variety of approaches to analysis, but there is tension between governance and institutionalist methodologies and approaches to analysis; the research design will have to overcome this in selecting a framework and methodology.

3.2 The Institutional Context of Planning

In considering how planning organisations interact with and influence other policy actors and the private sector, the research must should respect new instuitionalist approaches, as context will affect the role of planning in delivering DHC. The institutional context for planning systems are heavily influenced by formal structures: government organisations, legal, and legislative frameworks shape not only who does planning activity and what it does but how the process interacts with other actors (Nadin & Stead, 2013). The activity of planning is also influenced by informal contexts, such as engagement with private and community actors, or the knowledge and technical capacity of planning organisations and professional cultures (Healey P. , 2007).

Albrechts, writing in *Environment and Planning B: Planning and Design,* provides a particularly clear description of how context influences the capacity of planning systems.

> The capacity of strategic spatial planning systems to deliver the desired outcome is dependent not only on the system itself, but also on the conditions underlying it (see also Mintzberg, 1994). These conditions including public and professional attitudes towards spatial planning (in terms of planning content and process) and the political will on the part of the institutions involved in setting the process in motion (Granados Cabezas, 1995) affect the ability of planning systems to implement the chosen strategies. The steps required to deliver and to implement the desired spatial outcome vary according to the underlying structure. (2004, p. 749),

Given the global diversity of cities and nation states (and a subsequent diversity of institutional contexts for planning systems), it is no surprise that planning studies have struggled to develop comprehensive typologies or classifications of planning systems. Where large international comparisons exist they tend to concentrate on the governmental and legal systems underpinning state control of land use, recognising the importance of administrative and legal systems in driving the structure of planning organisations and processes (Nadin & Stead, 2013). Legal structures often dictate the form of the planning system: influencing the relationship between state and private land use as well as the relationship between central government and local authority. The formal institutional setting also influences the funding available to planning organisations and often the scope of issues planning systems are expected to address (Newman & Thornley, 1996).

Newman and Thornley's 1996 review, *Urban Planning in Europe,* analyses the characteristics of planning systems within the four main families of European legal and administrative systems. Despite seeking to make general conclusions, their book more accurately demonstrates the wide range of planning systems and struggles to find similarities between different planning systems. This is true even within the same legal and administrative family; for example the countries of the Napoleonic family (e.g. France, Netherlands, Belgium, Spain) have significant differences in planning powers to coordinate, control or deliver arising from historical context, political trends, resources available, and the legal enforceability of planning law.

The variation in power and topical responsibilities can be particularly wide in the topical scope of municipal planning powers; for example in pre-European Union Berlin the Lander state owned and managed energy utilities and planning processes were closely linked to infrastructure through corporative arrangements at a municipal level (Monstadt J. , 2007). In France today energy companies (e.g. EDF) are private but associated physical infrastructure is coordinated at the national or regional level by a non-spatial policy department (Ashurst, 2009). In Berlin historically, the local planning authority had responsibility, knowledge, and power on urban energy infrastructure; in France today it is has neither the responsibility nor the powers to act.

Newman and Thornley also provide examples of differences in legal enforceability of planning activity to illustrate how this influences the patterns of policy activity. For example, in France, the

legal system does not grant the government strong comprehensive planning powers, but planning law does provide local authorities considerable implementation powers. Therefore while authorities do not have strong land use planning remit, they can compulsory purchase land for public use, and undertake development to deliver on government aims. In Denmark, the legal system provides a strong basis for plan making and land use control, and regions are empowered to define the broad structure of the urban pattern, designate urban zones, and allocate large institutions and communication facilities. These are complemented by legally binding municipal and local plans; if a proposed development is in line with these it is automatically approved. Therefore state objectives can often be delivered through administrative procedures and plan-making – controlling the market – without active public sector delivery (Newman & Thornley, 1996).

More recent studies have used focused comparisons to understand the ability of planning systems to participate in policy development and implementation. For example, Kantor and Savitch's (2002) *Cities in the International Marketplace* and Newman and Thornley's (2005) *Planning World Cities* both compare urban responses to globalisation, considering planning organisations and tools as one aspect within urban governance. These focus less on the differences between systems and instead on how variation in institutional context enables or constrains planning organisations and practices to participate with other actors in responding to external forces.

The struggle of comparative planning studies to generalise suggests that this research must understand the specific legal and administrative setting within which planning sits to understand how it can support DHC. A straightforward answer for the role of planning in delivering DHC will be unlikely, even if the research could control for the institutional setting. The institutional context of planning systems is particularly important given the research's focus on an environmental policy goal, a contested area of public intervention. For example, Newman and Thornley suggest that the "issue for the future will be the extent to which environmental concerns are translated into urban planning policy. They would carry with them the implication that a long-term outlook is required and that there is a need to take account of the broader public interest. These implications lead to greater acceptance of public intervention and less reliance on the market." (1996, p. 254).

3.3 The Institutions of Urban Energy Infrastructure

This section reviews sociological and political literature on urban utility infrastructure, considering how cultural and institutional context as understood through this lens can inform the three research questions. Socio-technical systems conceptualisations of infrastructure such as Large Technical Systems (LTS) see technical constraints and capabilities for infrastructure (e.g. urban telecommunications networks) as intertwined with social constraints and driving forces. In the 1980s researchers interested in LTS began to theorise on the relationship between networked technical utilities and the society dependent upon them (Coutard, 2005; Mayntz R, 1988). This research focused heavily on the how LTS evolve, working to trace how and why

they grew. To describe their failures social reasons and concepts were called upon to help explain these changes and search for optimum approaches to management. For example, Hughes' 1983 study of the invention, development and growth of electricity supply systems showed that LTS development cannot be explained rationally and is heavily influenced by external social factors (Mayntz R, 1988).

This research is concerned with how to create new urban utility infrastructure and the LTS approach does not provide a robust conceptualisation of how policy actors could or should intervene to create new LTS. However the historical categorisation of networked utilities as systems whose delivery and operation are closely intertwined with society (individuals and organizations, legal frameworks, and institutional and political structures) supports this research's position that delivering DHC is a governance challenge as well as the research's need to understand social and political context.

Socio-economic relations of utility infrastructure

Building on the rather technical nature of much of the LTS work, there is a growing body of literature which also rejects the purely 'technocratic' nature of infrastructure and considers the sociological and economic implications of a socio-technical infrastructure in a rapidly changing context. Capably led by Marvin Moss, Guy, and Graham, the work considers normative questions such as 'which' and 'whose' infrastructure; addressing topics such as inequality of provision and rights to access, describing how these questions resolve at specific physical places (Graham & Marvin, 2001; Marvin, Graham, & Guy, 1999; Guy, Marvin, & Moss, 2000). Graham and Marvin, in *Splintering Urbanism* (2001) provide a series of illustrations on how the privatisation of infrastructure and a simultaneous disconnection from local organisational control has separated infrastructure management from territorial governance and society and calls into question deeply political relationships between government, society, and infrastructure. They address a wide spectrum of infrastructure, including roads, but illustrate how the newly privatised nature of energy, water, and internet networks in cities exacerbates the 'splintering' of provision. To address this they propose a research agenda not on the urban infrastructure itself but on the process of its governance, touching on questions of new institutionalism and negotiation based governance. This socio-technical agenda has recently developed in two relevant directions: a more analytical approach to implications for regulation, and a more normative one on urban sustainability and climate change, linking with transitions literature.

Privatisation and the regulation of infrastructure

On the former, literature on the implications of regulation from the impact of the privatisation of utilities infrastructure (Marvin, Graham, & Guy, 1999; Offner, 2000; Adams C. , 2007; Hodson & Marvin, 2010) highlights that large privatized utilities are often managed by supra-national companies, with no local interest or representation; this has negative consequences for the ability of local authorities to influence or control these services. "There are some policy linkages between utilities and local authorities over the development of new networks, renovation, and refurbishment of existing systems and the provision of services to new development. But the main feature of these relations is the low levels of statutory control and influence over the

activities of utility companies." (Marvin, Graham, & Guy, 1999, p. 154) The structure taken in any one city or authority depends upon the wider governance arrangement, for example citizen support for public ownership, local politics, historical development of the transport or utilities sectors and national laws and regulations (Marvin, Graham, & Guy, 1999). Particularly in Europe, where privatisation and liberalization have been driven by European policy, "crucial regulatory functions have shifted to the national or European policy level" (Monstadt J. , 2007, p. 335). This shift has moved energy infrastructure ownership and regulatory functions away from a local or urban level, suggesting that city spatial considerations and planning organisations currently play a weak role in promoting DHC infrastructure (Marvin, Graham, & Guy, 1999; Offner, 2000). These authors also relate how the 'hidden' nature of utilities infrastructure (Hodson & Marvin, 2009) hinders interest and understanding by both planning professionals and the general public.

However, they also argue that the same structural changes can make planning's processes which interface with market and civic actors (development control powers or masterplanning new development) more important as historic government influences and other types of regulation wane. Offner, in *Territorial Deregulation: Local Authorities at Risk from Technical Networks*, reflects on how the privatization of utility networks may create new possibilities for local policy and regulation. He suggests three potential areas of control for local authorities in regulating utilities provision: "control of public space; the localization and conception of network hubs; and the encouragement of the rise of user power as players in the regulation of network services." (2000, p. 177)**.** The first two are particularly relevant for planning systems with their spatial management remit; they can be classed as 'market regulation' and 'market shaping' tools. The ability of planning systems to dominate the conceptualisation of network hubs would relate to the influence of the local development plan; and also to how knowledgeable or capable the planning professionals are about energy utilities and infrastructure. Furthermore, Offner argues that control of public space (such as road space) in cities can hold real power given the congested nature of utilities under roads in urban areas. Given that DHC requires space for energy generation plant as well as road (or other) space for pipework connections, his suggestion points to local authorities as potentially having a controlling power relationship in the delivery of DHC. What this means for planning and DHC will depend upon the context and the institutional setting of the relevant planning system. For example, planning organisations could be mandated to plan DHC infrastructure through legal spatial plans or instead have a weaker power to control DHC development through land use and road infrastructure permits.

Multi-level transitions and urban infrastructure

This socio-technical literature did not originally focus on the environmental implications of urban energy and resource infrastructure; Monstadt in 2009 described how "the environmental aspects of utility restructuring tend to be treated as a sideline" (p. 1935). However as a socio-technical perspective on urban infrastructure began addressing environmental challenges, authors began calling up on well developed concepts of transitions management, in particular multilevel transitions, to support conceptual discussion and analysis about the management of

change in society for sustainable urban infrastructure (Elzen, Geels, & Green, 2004). This approach has reinforced an awareness that changes to urban government and the urban governance of energy infrastructure are critical to achieving greater sustainability in cities (Bulkeley, Castan Broto, Hodson, & Marvin, 2010; Guy, Marvin, & Moss, 2000). Seeing governance as beyond the state, this transitions literature also emphasises the many organisational influences on energy use and distribution; e.g. the CLUES project explores the diversity of organisations and pathways which could be involved in changes to urban energy infrastructure (Rydin Y, Turcu C, Guy S, & Austin P, 2013).

The transitions approach also recognises the need to look beyond the traditional boundaries of cities. In *Cities and Low Carbon Transitions* (2010), Spath and Rohracher provide a useful and illustrative comparison of two cities - Freiberg and Graz - grappling with energy transitions, and concludes that municipal processes in both were driven by a heterogeneous set of non-governmental actors and by entrepreneurs within the city administration rather than by strategic actions of municipal governments. They suggest that "actor networks probably need to span beyond the municipal level for substantial changes to be achieved" (p. 103) and that a further condition of success is that municipal level resources are not too restricted. This chapter and the previous chapter suggest avenues to explore for the role of planning in DHC systems; planning organisations as policy entrepreneurs, the relationship between DHC and the financial capacity of local governments, and the relationship between city level planning organisations and national or multi-level actors.

In a slightly different vein, Coutard and Rutherford investigate potential for governance of decentralised technology in *The rise of post-networked cities in Europe?* (2010) within *Cities and Low Carbon Transitions* (2010). They describe cases of local-scale governance commensurate with a decentralised technology, but also suggest that local authorities could use low carbon dialogue as a means for authorities to recover responsibility for basic service provision. This argues for greater 'government' in contrast to the intermediaries, niches, and regime influencing practices of more conventional transitions advocacy.

Guy, Marvin, Medd, and Moss, in *Shaping Urban Infrastructures,* focus on the role of intermediaries in urban transitions and discuss the potential actors which can explore, nurture, and stabilise new infrastructure technologies. While they do not identify planning organisations as potential intermediary actor who "does not fit neatly into the three categories of provider, user, and regulator" (2011, p. 18), their exploration of the potentials and limits of intermediaries does suggest implications for the role of planning. In a similar vein, Quitzau, Hoffmann, and Elle (2012) explore how planning systems in particular can act as a niche support of transitions, creating 'protected spaces' for technological innovation in support of environmental goals.

3.4 The Institutional Context of DHC

Literature explored in this chapter outlines how the ability of DHC systems to be delivered as an environmental policy goal is likely to be constrained by structural trends of privatized utilities and local contextual trends of costs, and government capabilities and knowledge. Socio-technical

systems theory has been applied directly to DHC in a small number of studies (e.g. (Hawkey, 2009; Palm, 2006)) which begin to illustrate how political power and planning organisations are indeed intertwined with the functioning of DHC. Building upon these studies and the wider literature, this section outlines institutional influences which are likely to be significant on the ability of cities to establish DHC as a environmental policy goal.

For local government, prominent institutional influences on their ability to support DHC are formal settings such local government legislation, property ownership, and powers of procurement or partnership. Planning organisations are likewise shaped by the legal framework as a formal institutional context. As discussed above, these shape their participation in governance networks through constraints or enablers of scope and resources, for example, the ability of planning policy to control the environmental impact of development or the ability of local government to borrow money to procure new utilities.

Formal, institutional context also affects the ownership and management of existing local utilities which could support DHC, by for example providing waste heat from electrical generation to a DHC system. The complex and 'splintered' nature of power and control over urban utilities identified by Graham and Marvin - a formal institutional factor - can shape actor constellations and may explain why some cases succeeded and others failed. Ownership of existing utilities would influence not only local government and planning actors but the wider actor set: the cost of energy from DHC or the level of competition to DHC providers. The cost of fuel for DHC is a similar further formal influence; for example, the shape and focus of negotiations among actors will be different if the DHC system is fuelled by mains gas or by geothermal heat.

Informal conventions such as internal structures of local government departments and other existing civic or political relationships are likely to shape who engages with governance networks for DHC. Informal influences also include experience or history of DHC, societal expectations about government and utilities infrastructure, and societal pressure about the role of government in environmental goals. Experience and associated knowledge of DHC has been recognised as particularly relevant in a UK context. Hawkey's study *Will district heating come to town?* identified how privatisation of utilities in the UK has led to local authorities being less involved in utility service delivery and therefore challenged their ability to support DHC; "these skills are important to a local authority’s ability to act as a driving force behind developing a scheme" (2009, p. 47). While Palm's 2006 analysis of DHC in two Swedish municipalities illustrates how historical experience with DHC and conflicting departmental ideas of responsibility over environmental concerns shaped who engaged in DHC policy and drove decisions about future investment in DHC versus consumer energy demand reduction programmes.

Table 8 outlines potential institutional influences which will be explored further through the research design in response to the second research question.

	Formal	Informal
Local government	• Local government legislation • Local government powers of procurement and partnerships	• Structure of internal government departments • Existing political relationships
Planning organisations	• Planning legal framework	
All actors	• Cost of fuel • Existing utilities	• Experience or history of DHC • Social pressure on environment • Willingness to change

Table 8: Examples of institutional influences on DHC delivery

3.5 Implications for the Research Questions

What new institutionalism and existing literature on socio-economic context of utility infrastructure indicates for this research is that the relevant powers, culture, and perspectives, the 'conventional wisdoms' and 'house views', of all actors in the governance networks for DHC will have to be understood in order to comprehend why and how DHC systems can be delivered. The research will need to understand how actors, particularly planning organisations, conceive of their potential powers and tools and their role within wider society as well as their assumptions about other actors around urban energy. The recognition of has driven the formation of research question two, **How does the institutional setting influence the delivery of district heating and cooling systems?**.

The new institutionalist approach also rejects the potential for an overarching generic explanatory theory about the role of planning organisations in multiple contexts, and calls for a contextually based response to the third research question. It also reinforces the need for governance network patterns of behaviour in delivering urban DHC, supporting the first research question. However on the whole the strands of literature reviewed in this chapter focus on universal or normative behaviours and do not explicitly address urban infrastructure as a governance network challenge requiring negotiation.

Understanding urban infrastructure in context has highlighted the effect of privatisation of infrastructure, increasing the challenge of delivering DHC as a locally specific urban infrastructure solution to energy and environmental goals. This reinforces the research aims to understand the institutional context of DHC and suggests the research structure should seek to understand the nature of national or local control over existing and new energy infrastructure. An analysis of the governance network for DHC without this context is unlikely to form a contribution to policy or future research.

The challenges and barriers identified in this literature also point at potential answers for the research questions and suggests roles for specific actors in delivering DHC. For example, Marvin, Guy, and Grahams' (1999) identification of the institutionally weak role of local governments and the potential for planning interventions and processes to be used as a lever over energy infrastructure; the concept of planning systems as between provider and user; and the need for entrepreneurial or beyond-city policy support. These all should be explored in relation to DHC through the case analysis.

The new institutionalist literature also highlights how the role of planning in shaping, creating and regulating urban utility infrastructure for environmental goals is only recently beginning to be addressed. There is potential for this research to contribute to transitions and low carbon cities literature by highlighting how planning could provide routes to greater engagement and leverage of urban actors in urban energy infrastructure. Finally, Actor Centered Institutionalism emerges as a potentially viable conceptual framework to address all the three research questions as it enables an analysis of individual actors as separate from but within an institutional setting; it has the potential to bridge governance and intuitionalist perspectives in a policy context of relatively significant government control of the built environment. This is focus of the next chapter.

Chapter 4. Bringing Institutions and Governance Networks Together to Understand DHC

This chapter builds a case for the use of a conceptual framework which can distinguish both governance behaviours and institutional concerns across a comparative analysis of international case studies. Actor Centered Institutionalism (ACI) is then presented as a bridging conceptual framework which is necessary and suitable to address the three research questions. A set of questions for each case study to address are developed from the presentation of ACI. The chapter ends by summarising the research approach, linking case study questions to the three main research questions and considering the potential contribution of the research.

4.1 Revisiting the Research Questions

The literature and desktop review of DHC systems in Chapters 2 and 3 explored existing understanding around the research questions. The questions arise from two approaches to policy studies, governance networks and new institutionalism, which both drive a contextual approach to the research aims. While they are not at odds, the research design will have to bridge both approaches. As Kooiman writes, the research will have to be capable of "distinguishing an intentional and a structural level in governing interactions which articulates that governing actions and governance structure (culture) cannot be understood without each other" (2003).

Chapter 2 argues that delivering DHC requires network governance patterns of behaviour among multiple actors. Addressing research question one, **How do governance networks support the implementation of district heating and cooling systems?**, requires the research to focus on individual actor capabilities and behaviours, as well as the characteristics of interaction and negotiation between government actors, citizens, and commercial organisations which lead to delivery of DHC. Governance network literature points at the use of specific analytical methodologies.

New institutionalist approaches call for a focus on actors underlying perspectives, opinions and considerations of other actors roles in DHC. To address the second research question, **How does the institutional setting influence the delivery of district heating and cooling systems?**, the research should seek to analyse the formal limits and capabilities of actors as well as actor opinions and perceptions to understand how these formal and cultural factors influence governance negotiations and if they are important for the delivery of DHC.

In approaching research question three, **What is the role of planning, in relation to market, civic, and to other government organisations, in delivering district heating and cooling systems?**, urban planning processes and tools can be understood as governance processes, structuring the engagement of other actors in building and managing urban areas; and planning organisations can also be understood as an actor in governance networks for DHC. But the new institutionalist approaches underscore how the legal and formal context of planning systems will

significantly affect the role of planning in governance networks for DHC. The research therefore needs to understand how planning organisations conceive of their potential powers and tools and their role within wider society as well as their assumptions about other actors around urban energy. Both governance and institutionalist approaches reject the potential for an overarching generic explanatory theory about the role of planning organisations in delivering DHC, and call for a contextually based response to the third question.

The literature discussion brought to light how the research lies between multiple strands of discussion about urban infrastructure, not all of which have yet addressed each other. For example, Williams' recent paper, which establishes a conceptualisation of the roles and functions of planning, provides a helpful base for this thesis to work with but it does not directly address trends towards privatisation and de-localisation of the management of urban energy infrastructure. Nor does the socio-economic or transitions literature currently address the breadth of planning studies which require government control of land use and utilities to be understood contextually. The analysis conducted in this thesis will seek to build on the work of William, Marvin, and others by exploring in greater detail the activities and orientations of planning authorities and the use of planning interventions in delivering DHC systems.

Implications for research design

Both governance networks and new institutionalism very strongly point away from a research approach which seeks a working hypothesis of governance and institutional effects on DHC which can be applied to any situation. Instead, a detailed contextual analysis of existing cases is likely to be more successful in addressing the research aims. This suggests an in-depth qualitative case study methodology for this research, where data gathering and analysis methodologies are receptive to local context and meaning, and which enable conflicting perspectives and understandings to be represented. Additionally, the network governance literature calls for a focus on the quality and characteristics of the connections and interactions between those involved in achieving the policy goal, to investigate the causal link between interaction quality and policy outcomes. This suggests a research design which provides for in-depth analysis of specific situations. However within this qualitative approach the research design will have to sufficiently address both the actor level and the institutional context.

An international, comparative, case study approach is proposed for the research. A comparative approach supports qualitative research by substituting for the experimental method. It supports an analysis of the variety of roles for planning organisations, a greater understanding of the mechanisms of network governance behind various DHC systems, and consideration of institutional settings by comparison between different countries. A cross-national approach also potentially broadens the applicability of the research findings, as answer to the research questions and the implications for network governance should be more transferrable to other contexts.

Building on the literature review, the research proposes to employ an conceptual framework to structure this qualitative international comparative analysis. A conceptual framework can guide

the research, highlighting important factors and structuring a conceptual comparison between cases. Use of a framework is supported for two reasons by authors reflecting on the nature of social science research. Pierre, in *Comparative Urban Governance: Uncovering Complex Causalities,* argues that a framework provides guidelines for the search for explanations in a complex empirical setting, where universal assumptions cannot be applied (2005). And Mossberger and Denters argue that a conceptual framework helps draw 'limited generalisations' from small-n case studies which can be used for practical purposes in *Building Blocks for a Methodology for Comparative Urban Political Research* (2006).

Building on the literature review discussion, a conceptual framework which bridges institutional and governance approaches to answer the research questions should have the following characteristics:

- Actor centric: it should recognise the governance network patterns but enable focus on one individual actor (planning organisations);
- Interaction oriented: it should be able to describe connection patterns in governance networks;
- Institutions: it should recognise institutional settings as a variable and enable a focus on the effects of institutions on actors and their actions;
- In depth and comparative: it should support qualitative contextual analysis and yet be rigorous enough to enable comparison between international settings and analysis of different governance patterns;
- Causal factors: it should suggest 'working hypothesis' of factors that support the delivery of DHC.

4.2 Actor-Centered Institutionalism: A Conceptual Framework for the Research Questions

An approach which addresses the theoretical and methodological objectives and concerns outlined above, is "Actor-Centered Institutionalism" (ACI) developed by Renate Mayntz and Fritz W. Scharpf (Scharpf, 1997; Scharpf, 2000). ACI is an analytic framework for considering the conditions under which "politics is able to produce effective and legitimate solutions to policy problems" (Scharpf, 1997, p. 1). It does not claim to be a final theory but was proposed as an approach to the investigation of collective policymaking and decision making processes. ACI was initially outlined in a German-language publication in 1995, and the framework was detailed in a 1997 English-language book, *Games Real Actor Play: Actor-Centered Institutionalism in Policy Research.*

Scharpf describes the ACI approach as "proceeding from the assumption that social phenomena are to be explained as the outcome of interactions among intentional actors (...) but that these interactions are structured, and the outcome shaped, by the characteristics of the institutional setting within which they occur." (1997, p. 1). It treats institutions as one set of variables "affecting the interactions between policy actors and hence the greater or lesser

capacity of policy-making systems to adopt and implement effective responses to policy problems." (Scharpf, 2000, p. 764). This approach is explicitly a governance approach which incorporates new institutionalist concerns (Stead & Cotella, 2011); it aligns with the concerns of this research to be both interaction oriented and perception oriented .

ACI aims to transcend differences between actor-centred, rational choice and institution-oriented approaches in two ways: in that it gives actors analytical powers and does not assume that actors follow cultural norms or institutional rules blindly, and in that it assumes that the goals pursued by actors change and the goals are influenced by other actors behaviour (Scharpf, 1997). It proposes that there are five variables which drive policy outcomes: a particular institutional setting, which influences the remaining variables; a specific policy problem, which drives the specified actors, capable of strategy building around a picture of actor interactions, which happen with limited knowledge but rationally; and in particular styles, or characters, of interaction.

Use and suitability

ACI is recognised by public policy researchers as a constructive combination of institutional and actor approaches (Jackson, 2009) and is regularly used in comparative analysis of policy implementation between different countries (Mur-Veeman, van Raak, & Paulus, 2008; Mayntz, 2003; Stead & Cotella, 2011). Of particular relevance to this research, Stead and Cotella argue in *The Planning Review* and that ACI "provides an interesting framework for exploring the evolution of spatial planning and territorial governance systems" because it complements both actor and contextual approaches while allowing organisations (e.g. community advocacy groups) to be conceived as composite actors (2011, p. 16). They also praise its ability to enable comparison between countries while still recognising the place-specific nature of actor influences on planning processes and powers. Similarly, Peters, in *Institutional Theory in Political Science; the New Institutionalism* (2011) and Reimer and Blotevogel in *Planning Practice and Research* (2012), praise ACI for enabling individual actors to clearly be described, rather than a set of rules and norms which apply to all actors. This supports the requirement of the research questions for planning to be understood separately, but in relation to, market and civic actors.

ACI has been employed to structure analysis across range of topics and with range of research methodologies, including process-tracing in health politics (Ovseiko, 2008), statistical multi-level analysis in urban politics (Pluss, 2009), interviews and analytical narratives in work-based training and skills research (Van Lieshout, 2007), and secondary analysis in an international comparison of implementation of health care policies (Mur-Veeman, van Raak, & Paulus, 2008). In the 1997 book which sets out ACI, Scharpf describes how the framework can be applied with game-theoretic analysis based on qualitative methods. However the book's introduction acknowledges that the framework can be applied to other methodological approaches. The ACI framework is both conceptually suitable for the research questions and is flexible in its potential to incorporate a range of research methodologies.

ACI in detail

In ACI, the starting point for explaining policy-making processes and their outcomes is to "identify the set of interactions that produces the policy outcomes which are to be explained" (Scharpf, 1997, p. 43). Scharpf is clear that the set could be multiple types and kinds of interactions; he gives voting and conference negotiations towards the same policy outcome as an example. Building on the governance network literature, such interactions include negotiations, exchanges of resources, communications, interferences or more formal interventions. Kooiman defines interactions as "mutually influencing relations" making clear the intentional and connected nature of the actors (Kooiman, 2003).

Scharpf's next step is to identify the actors, individual or collective, that are involved in the policy-making process. "Actors are characterized by specific action capabilities, preferences and perceptions" (p.43). The resources available to actors characterize their action capabilities: financial and human resources, knowledge, competences and the rights they possess. Actor orientations, their preferences and perceptions of other actors may be relatively stable or may be changeable, but "they are activated and specified by the stimulus provided by a particular policy problem or issue" (p.43). Preferences have three dimensions: individual and institutional self-interest, norms, and considerations of individual and corporate identity. Actors are assumed to be capable of making purposeful choices among alternative courses of action and they are assumed rational in the sense that they will attempt to maximize their own self-interest (in terms of payoffs); but they are not assumed to be perfectly rational or holding access to all information.

Scharpf also encourages the concept of *composite actors* where it does not obscure the research interests, because it facilities the task of explaining and predicting policy outcomes in the real world, where collective actors - organisations, ministries, associations – are often the primary actors. The concept is reserved to groups of actors with intent, not mere exchange relationships – "the individuals involved intended to create a joint product or achieve a common purpose". (Scharpf, 1997, p. 54). Scharpf and later Jackson (2009) discuss how these composite actors are influenced by institutional factors in two ways; first that they are created according to rules of organisation, and secondly that the common frame of reference within the collective actor can drive their perceptions and choices in negotiations.

The third task in ACI is to identify 'actor constellations', which include a "static description of players involved, their strategy options, the outcomes associated with strategy combinations, and the preference of the players over these outcomes" (1997, p. 44). For Scharpf, 'actor constellations' are the bridging link between institutionally oriented research and interaction oriented research. The 'actor constellation' is a static picture of how the full set of actors perceive the policy problem, each other, and the potential options to achieve the policy goal; it builds up a picture of whether their aspirations and preferences are compatible with one another.

Finally, the static picture of actor constellations is then ‘played out’ in a variety of ‘modes of interaction’, which define the style character of the interactions themselves. The combination of the ‘actor constellations’ and the ‘mode of interaction’ produces ‘policy outcomes’. A given actor constellation does not alone drive the policy outcome; the mode of interaction between the actors must also be analysed and understood. “In other words, for a given actor constellation, the expected policy outcome would differ if the institutionalized mode of interaction is varied – and conversely, a given mode of interaction would lead to effective policy solutions for some constellations but may fail to do so when confronted with other types of actor constellations.” (Scharpf, 1997, p. 48).

Scharpf describes four types of modes of interaction: ‘unilateral action,’ ‘negotiated agreement’, ‘majority vote’ and ‘hierarchical direction’ (Scharpf, 1997). Scharpf describes and characterises these potential modes of interaction in some detail, using game-theoretic concepts to arrive at recommended types of negotiation for actors in governance patterns of behaviour. He highlights value of a negotiated 'positive coordination' approach as most promise for reaching goals which involve property rights; these combine 'problem solving' types of negotiation with 'distributive bargaining' negotiations. The former focuses on creating value; the latter focuses on a formal exchange of resources; positive coordination combines them. Positive coordination negotiations require transparent 'fair settlement' discussions, recognising the existence and legitimacy of the benefits and negatives on all sides (1997, p. 133).

The ACI framework acknowledges that the actors, actor constellations, and modes of interaction are all largely, but not completely, shaped by the institutions and the institutional setting of the policy problem under discussion. However Scharpf argues that that institutional influences are an abstract concept and does not set out a theoretically defined set of variables that serve as explanatory factors in the framework; "Rather, we use it as shorthand term to describe the most important influences on those factors that in fact drive our explanations" (p. 39). Within ACI institutions are defined as rule systems that structure actor behaviour, but do not completely determine actor behaviour. Rule systems can have a more formal character (rules sanctioned by legal framework or public authorities) – the ‘administrative systems’ of Newman and Thornley, or a more informal character (norms, conventions and expectations) – the social conventions of Lowndes.

The summary of the framework of ACI in Figure 1 is reproduced from *Games Real Actors Play.*

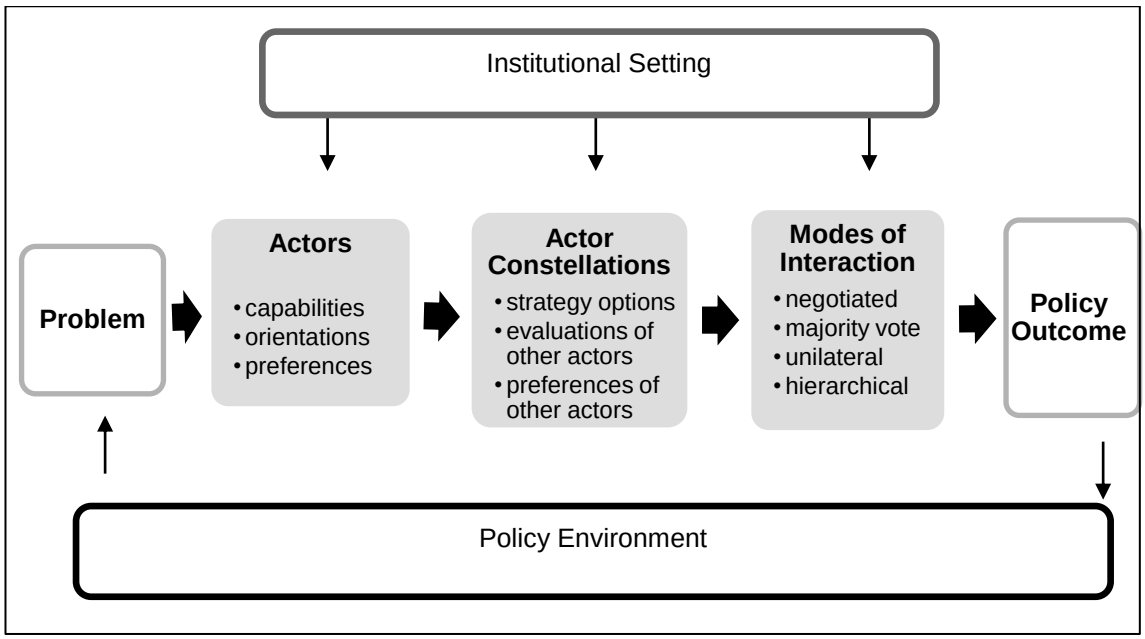

Figure 1: Framework of Actor- Centered Institutionalism (Scharpf, 1997, p. 44)

4.3 Applying ACI to the Research Questions

When the proposed research questions are applied to the framework of Actor-Centered Institutionalism, a research structure directly emerges. The problem is defined as the delivery of DHC in urban areas, and the outcome is the completion and operation (or failure to establish) of a DHC system. The details of the institutional setting, interactions, actors, and resulting actor constellations and modes of interaction will vary across countries and individual systems.

An indication of likely examples can be given building on the literature review above. Following the framework, and starting with the set of interactions which address the policy problem, the literature review indicates interactions are likely to be both formal and informal interactions between public, private and civic organistaions. Examples identified through the case study review above include, among others: fiscal incentives, exchanges of knowledge, conferences, policy statements, public campaigns, exchanges of time and funding, donations of land, and more formal interventions such as the passing of laws or the creation of a regulatory framework.

Building on Chapter 2, the actors who can potentially be involved are national government, local government, planning organisations and institutions, businesses, residents, NGOs or campaign groups, political parties and politicians, energy companies and banks or other sources of finance. The capabilities, orientations and preferences of these actors will be informed by the institutional settings – both formal and informal. These orientations and preferences will need to be uncovered through the research design and methodology. In the definition of planning adopted for this research – both organisations and interventions – planning will initially be seen by ACI as a collective actor, comprised of individuals.

The research methodology will need to enable identification of the ‘actor constellations’ of ACI, which develop a picture of how the actors perceive other actors their capabilities, strategies and preferences. Not only are ‘actor constellations’ individual to specific situations of the delivery of

DHC, the factors that make up 'actor constellations' are difficult to discern from published reports, as they deal with conceptual potential. The need to understand how actors *think about and perceive* other actors and their potential strategies points at particular research methodologies. Chapter 5 reflects this in the development of the research methodology.

Turning to the 'mode of interaction', the literature review illustrates that a 'negotiated' approach is likely, given the type of policy challenge that DHC presents and the governance network patterns of behaviour required to address it. Network governance theories assume a causal linkage between patterns and strengths of interaction within a set of actors, and the outcomes of that interaction (Marsh, 1998; Sehested, 2009; Jordan, 2008). Scharpf's ACI framework, which looks at the set of potential interactions through the actor constellations and at how the interactions are played out through generic 'modes', does not specifically provide for qualitative patterns or characteristics of interaction to play a guiding role in the policy outcomes.

To include within the framework space for these characteristics of interaction, the research adds an additional dimension of 'relational characteristics' to the variable 'modes of interaction'. 'Relational characteristics' are proposed as the patterns and quality of interactions among purposeful actors. Patterns are the arrangements of interaction: e.g. do all actors negotiate with all other actors? Are some actors at the centre of negotiations? Quality is the frequency of interactions between actors, and the strength of those interactions: e.g. do the actors negotiate or exchange more than once? According to governance network theory, understanding the answers to these questions will inform the answer to the research question.

Figure 2 provides a summary of the research aims as applied to Scharpf's ACI framework, with the addition of the concept of relational characteristics as a quality of modes of interaction.

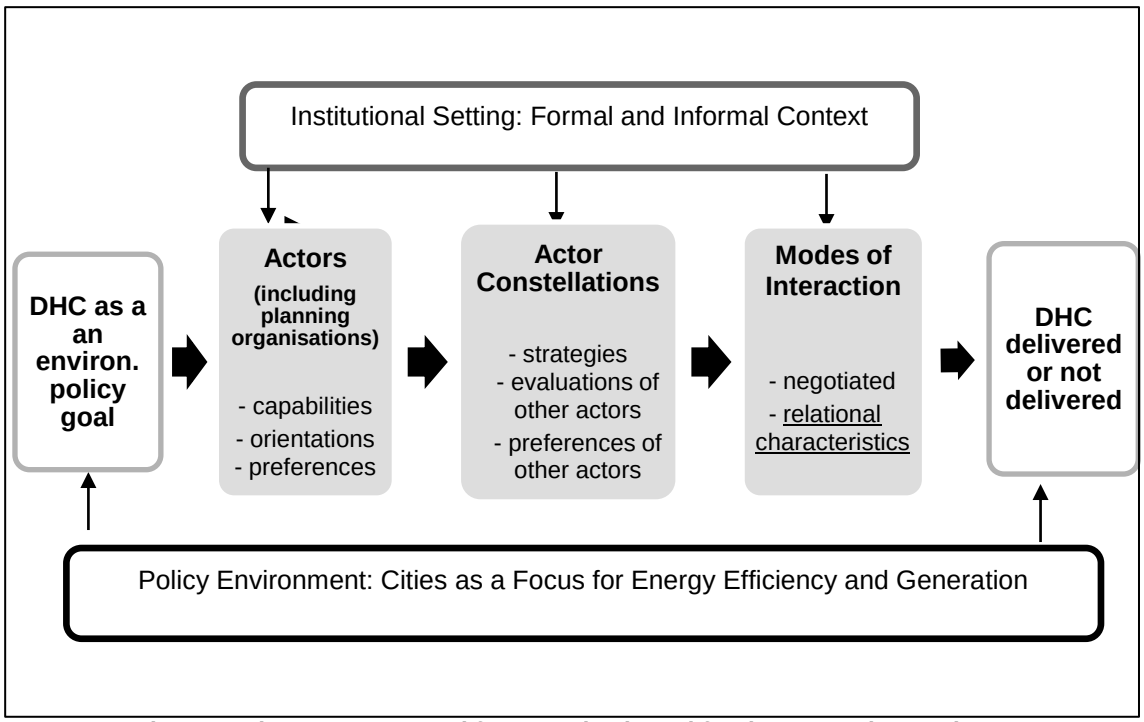

Figure 2: The ACI conceptual framework adapted for the research questions

Addressing the research questions

The conceptual framework described in Figure 2 can address all three research questions identified in Chapter 1. It can structure an evaluation of how negotiations and actor arrangements in governance networks support implementation of DHC. The inclusion of institutional context as an influence on both actors, actor strategies and modes of interaction robustly reflects the new institutionalists' call to understand how context affects policy. And by requiring the research to focus on the capabilities, orientations and preferences of individual actors as well as how strategies are played out through interaction, the framework can support the evaluation of the role of one actor - planning - and planning as a process or intervention which structures other actors' behaviour.

The ACI conceptual framework can be applied to the individual cases for qualitative analysis as well as used to structure comparative analysis between the case studies. When applied to a specific attempt to deliver DHC in urban areas, a series of eight questions emerge for each case analysis to address:

1. Who are the primary actors?
2. How are the actors influenced by the institutional setting?
3. What are the actors' self-identified capabilities, orientations, and preferences?
4. How can the actor constellation be described?
5. How can the interactions be characterised?
6. What are the relational characteristics ?
7. Is this network governance?
8. How can the role of planning be described?

The information needed to address these case study level questions will be gathered through the research design structure and addressed on a case by case basis. The responses to these eight questions will then be considered in comparison across the cases and thereby inform the three research questions. Chapter 5 describes the research methodology in detail.

4.4 Summary of Research Approach and Potential Contribution to Knowledge

As a conceptual bridge between governance network theories and institutional understanding of policy, Actor-Centered Institutionalism (ACI) is proposed as a suitable conceptual framework for the research questions and aims. It provides a robust vocabulary and analytical lens to structure a comparative study and develop response to all the three research questions. ACI will guide the empirical analysis to focus on the potential role of planning organisations, to understand the influence of governance behaviours and to evaluate the influence of the institutional setting.

The research asks currently relevant questions about the ability of policy makers to deliver an environmental policy goal: urban energy infrastructure. It is particularly concerned to uncover the role of planning organisations and practices in supporting the creation of District Heating and Cooling (DHC) systems, and to evaluate the influence of context and governance network behaviours in urban energy infrastructure creation. The research will consider planning

organisations as one actor among other public, private, and civic actors, who have a collective understanding, the actor constellation, of each other's strategies and powers given the local institutional setting. The ability of the actor constellation to deliver DHC is affected by the set of actors, the constellation, and the characteristics of negotiation, all of which are influenced by formal and informal institutional context.

Broadly this research aims to contribute to theoretical and empirical dialogue on the responsibilities and potential contribution of planning in relation to other stakeholders in building and managing urban infrastructure for environmental policy goals. It is set within discussions on the efficacy and functioning of governance networks and seeks to evaluate how patterns of interaction and negotiation support DHC. Through an international viewpoint, the research also seeks to weigh up the influence of institutional context in relation to network process. This area of urban policy is relatively understudied; in particular there is a lack of insight into how planning practices and organisations can support DHC.

The research intends to further understanding of how planning organisations and processes can shape energy use in cities and support infrastructure goals for environmental reasons by examining what levers of power and relationships planning has in relation to other urban actors. The actor-centric, in-depth and comparative approach proposed can potentially lead to detailed recommendations on planning actions for urban energy generation and use. The literature review highlights that both of these areas of investigation are historically understudied and this research could make a contribution to ongoing categorisation and analysis of planning for environmental goals as well as make recommendations for practical policymaking and implementation. From a theoretical perspective, it could serve as evidence in the ongoing evolution of communicative planning theory by looking at the role of planning processes in delivering DHC and considering the importance of regulative and stimulating functions of planning in shaping private and civic activity for urban energy infrastructure.

Turning to literature on policy making in cities more generally, a research structure which utilises a governance networks perspective and positions planning in relation to other actors may contribute to ongoing discussions about the capacity of governance structures to support change in urban energy infrastructure. The research can investigate the proposed link between quality and type of negotiations and the outcome of policy delivery. The case studies should enable consideration of the robustness of governance networks as an observed phenomenon of urban policy making and support the explanatory ambitions of governance network research. They will also provide a detailed account of governance network processes for urban infrastructure which could serve as a base for further evaluation of democratic and efficacy concerns around governance networks as a policy solution for large scale infrastructure.

The international perspective of the research should enable the findings to evaluate influence of contextual institutional factors versus the negotiation and exchange characteristics of governance networks patterns. This evaluation could generate pointers for future research and understanding, influencing future urban policy studies. The same perspective means the

research will gather information of interest to theoretical discussions on the ability of cities to influence material flows of resources in a context of climate change, urbanisation and environmental limits. The findings could address identified gaps and questions about the scales of governance engaged in urban environmental responses.

Chapter 5. Research Methodology

This chapter outlines the research design and methodology. It discusses the challenges and benefits of an international, comparative approach and applies theoretical and methodological guidelines on comparative study to the Actor-Centered Institutionalism (ACI) framework. ACI is then used to inform the case study selection, methods of data collection and analysis. The chapter ends with a summary of the research design and a statement of how the methods of research, structured by ACI, will address the research questions.

5.1 Comparative Research

The aim of the research is to understand the role of planning in delivering DHC, with planning organisations positioned as one actor in network governance patterns and within an institutionalist perspective which recognises the influence of structural settings on actors. An in-depth and international comparative case study research design is proposed, with ACI serving as a conceptual framework to structure analysis, comparison and to answer the research questions.

A comparative approach is supported by a series of papers which argue for greater use of comparative studies in urban politics and governance studies (Pierre J. , 2005; Sellers, 2005; Mossberger & Denters, 2006; Wolman, 2008). At the core of their call is a reminder that comparative study is a scientific method which substitutes for the experimental method. Wolman sets out an approach to valid causal inference in qualitative research, arguing that the logic of good qualitative and quantitative research does not differ (Wolman, 2008). The utility of comparative studies is illustrated further by Kantor and Savich for whom, comparison “more precisely shows how variables work differently in a variety of settings,” “affords a better to chance to understand how the discovery of anomalies within different social systems can be refined and ultimately enhance theoretical understanding,” and finally “provides contrast models that point up crucial distinctions within a given set of findings” (2006, p. 135). Employing an in-depth approach comes with other strengths, argue King, Keohane and Verba in *Designing Social Inquiry.* Particularly, "one of the often overlooked advantages of the in-depth case study method is that the development of good causal hypothesis is complementary to good description rather than competitive with it." (1994, p. 45). Pierre, writing about urban politics in the *Urban Affairs Review*, is particularly supportive of comparative studies as useful for understanding patterns in urban governance: "understanding urban governance more broadly, that is, to investigate to what extent different social, political, and economic forces tend to produce different models of urban governance, requires a comparative approach” (2005, p. 453).

Approaches in comparative research

There is a long history of comparative approaches employed in sociological, political and urban research, with a multiplicity of methods, perspectives and models. Kantor and Savitch (2006),

Lichbach and Zuckerman (1997) and DiGaetano and Strom (2003) group these into structural, cultural and rational choice approaches to comparative study, as described in Table 9.

Approach to Analysis	Perspective	Proponents	Characteristic
Structural analysis	Political	Marx, Weber	emphasises the formal organisations of governments; seeks similarities
Cultural analysis	Anthropological	Montesquieu, Weber, Mosca	nuanced and detailed readings of particular cases to highlight differences
Rational choice	Micro economic	Hobbs, Smith, Pareto	actors deliberately act to maximise their advantage

Table 9: Approaches to comparative study (adapted from Lichbach and Zukerman (1997))

ACI was developed by Scharpf and Mayntz to explicitly combine the structural and rational choice approaches in an integrated framework. Scharpf comments, "what is gained by this fusion of paradigms is a better "goodness of fit" between theoretical perspectives and the observed reality of political interaction that is driven by the interactive strategies of purposive actors operating within institutional settings that, at the same time, constrain these strategies" (1997, p. 36).

ACI's integrated approach is chosen to address the research questions. The delivery of complicated urban infrastructure across significant physical areas arises as the result of a sophisticated interaction of individual actors, social contexts, government powers and macro- and micro-powers. The case studies are envisioned to be multi-actor and multi-scalar, crossing political and economic hierarchies, revealing relationships and arrangements which are too complex for structural analysis and too broad for cultural approach to analysis. An integrated approach enables interaction-oriented research (Scharpf, 1997), an analysis of how and why policy solutions are implemented in different settings.

Issues in comparative research

As many papers on global comparative studies have described, international comparisons have weaknesses as well; from the meta issues of cultural relativity and contextual meanings through to the more mundane of accessing data in other languages (Kantor & Savitch, 2006; Mossberger & Denters, 2006; Pierre J. , 2005). A review of the literature highlights two weaknesses for this research. One is that international comparative studies are "inevitably plagued with the small-n problem of too many variables and too few cases" (Scharpf, 2000, p. 765); the lack of sufficient numbers of case studies. To address the problem of too many variables and too few cases, research can broadly choose between quantitative multi-variate regression, or follow a in-depth, narrative approach (King, Keohane, & Verba, 1994; Mossberger & Denters, 2006; Scharpf, 2000). Scharpf and Hall argue that undertaking cross-section time series regressions to identify statistical regularities is suitable for identification of stable relationships of structural character, e.g. the varieties of capitalism school of research (Hall & Soskice, 2001; Scharpf, 2000).

Scharpf (2000), Denters (2006) and King, Keohane and Verba (1994) argue that in depth, narrative-based comparative case studies are better suited to research "focused on empirically supported generalizations about the influence of policymaking institutions on the capacity for effective policy responses" (Scharpf, 2000, p. 767). All three stress that to arrive at potentially generalizable conclusions, the research must find ways to cope with the excessive variety and complexity of causal influences. An in-depth case study approach is preferred for this research, supported by the ACI framework which provides a structure to rationalise causal influences. The next section discusses how the ACI framework can cope with excessive causal inferences.

A second relevant weakness in international comparative studies, particularly with in depth research is accounting for different contextual meanings between languages and political settings (Kantor & Savitch, 2006; Mossberger & Denters, 2006). For example, 'regional' or 'decentralised' are words with substantially different meanings in different settings. Mossberger & Denters (2006), Kantor and Savich (2006), and King, Keohane and Verba (1994) argue that an in-depth approach can overcome this with care. Denters particularly argues that the research should be interested not only in the identity of measures but in their 'functional equivalence'.

5.2 Methods of Case Study Selection using ACI

An in-depth, narrative approach to the research limits the number of case studies to be investigated on practical grounds. The following section sets out the research's methodological approach to choosing case studies. It discusses the issues and rules for qualitative case study selection and then turns to apply these to the ACI framework. The case study selection process is then described.

Methodological considerations

Carefully designed comparative research enables intellectual rigor in qualitative research. However, as King, Keohane and Verba illustrate, the structure by which case studies are selected is central to the success of a qualitative study. They argue that "poor case selection can vitiate even the most ingenuous attempts, at a later stage, to make valid causal inferences" (1994, p. 115). King, Keohane and Verba, followed by Denters and Mossberger (2006), outline the methods in designing comparative study selection. They both agree that random selection of case studies is difficult, particularly in the social sciences. In intentional or purposive sampling of case studies they argue "there are two basic options available: selection on the dependent variable and selection on the independent variable". The dependant variable(s) are also known as 'outcome variable' (e.g. DHC delivered), and the independent variable(s) are also known as the explanatory variables or observations, with the 'key' independent variable the 'cause' of the dependant variable. By holding some independent variables constant and varying the remaining independent variables, you come to understand what influences the dependant variable.

Both papers are adamant that selecting case studies on dependant variable can lead to inability to test causal relationships between factors and variables in the case studies to be compared. If all case studies are successful in delivering DHC, and you conclude that x-variable caused the success, you cannot test for the absence of x-variable leading to failure.

King, Keohane and Verba (1994) provide further points regarding variable selection which are helpful. Firstly that “selecting observations for inclusion in a study according to the categories of the key explanatory variable causes no inference problems" (p. 137). Secondly that “the best 'intentional' research design selects observations to ensure variation in the explanatory variables without regard to the values of the dependant variables” (p. 140). And finally that, though the research may look at a wide range of influences or observations in each case study, it is appropriate to control selected variables, to seek out the variables with the most substantial causal relationships to the dependant variable.

Kantor and Savitch also sketch out limitations that restrict case study selection; firstly that they must have some similarities to enable like for like comparison, secondly that language can be an important factor in understanding, thirdly that comparable data should be available, and finally that conceptual parameters should be similar, e.g. the concept of ‘regional’ (2006). The challenge of conceptual language aspect is also covered in other papers but can be overcome with careful attention.

To summarise, the research design should identify the dependant variable, the outcome of the causal relationships. Selection of case studies for independent variables or even key independent variables causes no inference problems. Within those case studies selected, a wide range of potential influences should be examined. It is appropriate to hold certain influences constant in order to better understand causality between influences and success.

Dependent and independent variables in ACI

This section applies the above case study selection guidelines to the preferred conceptual framework, Actor-Centered Institutionalism (ACI) described in Chapter 4. ACI proposes that, in reference to a defined policy issue in a specific institutional setting, policy outcomes are influenced by actors interacting according to actor constellations in a defined mode of interaction (Scharpf, 1997).

For this research, the policy outcome is the delivery of DHC. Therefore, building on research design theory, the research is structured with delivery of DHC as the dependant variable – the outcome for which causal factors and relationships are sought. Case studies where DHC was sought by actors, but not delivered, are included in the case study selection; effectively this ensures that the research is not selecting case studies based on the dependant variable. This enables testing of causal relationships between explanatory variables, a core component of comparative research theory as described above.

As the selection of case studies based on independent variables causes no inference problems, and ACI provides a structure which can cope with variety and complexity of causal influences. ACI concepts are employed to determine which independent variables to hold constant through the case study selection process. In ACI, there are five components which drive policy outcomes; the following text addresses how they will be considered in case study selection.

First, a particular institutional setting. To focus on network governance, the research selects for case studies with both public and private actors within them. It excludes case studies which are only private or only public sector driven. Secondly, a specific policy problem: DHC should be an environmental policy goal in each case. The research selects for case studies where the environmental benefits are a publicly stated goal and excludes case studies where environmental concerns are not mentioned. Third, specified actors. The research selects for case studies where planning institutions are involved and excludes case studies where they are not involved in the delivery of DHC. Fourth, actor constellations. This component is collective picture of actor perceptions about the policy problem. Therefore it is not a variable and the research cannot control case studies based on this variable.

Fifth, the mode of interaction. In network governance, actors are relatively stable, non-hierarchical, interdependent but autonomous, and interact through negotiations. The research excludes case studies with explicitly horizontal connections between major actors to guarantee a level of network governance patters in each case; this is similar to selecting for case studies with both public and private actors. As described in Chapter 4, the research adds a further component within the mode of interaction on the success of governance networks in the form of relational characteristics. Relational characteristics are proposed as the patterns and quality of interactions among purposeful actors. The research does not propose to select case studies on this component. A summary of these implications for the case study selection process is provided in Table 10.

ACI Component	Research Approach	Case Study Selection
DHC as an environmental policy goal	Static independent variable	All cases have DHC as an environmental policy goal
Institutional Setting	Independent variable	Cases have both public and private actors
Actors	Independent variable	Planning activity in support of DHC as a static independent variable
Actor Constellations	Determined by problem and actor set	
Mode of Interaction-Negotiated	Determined by nature of policy goal	Cases are predominantly horizontal interactions
Relational Characteristics	Independent variable	
DHC delivered or not delivered	Dependent variable	Both delivered and not delivered

Table 10: ACI and the selection of case studies

Case study selection

A literature review was unable to locate an existing review of case studies of urban DHC in a comprehensive or rigorous way across the globe. Therefore a wide range of sources of information have been used to establish a 'long list' of case studies: researcher's industry knowledge, global energy company websites, World Energy Council and International Energy Agency publications, Google searches, searches of academic journals, and energy statistics published by individual countries. These generated the long list of case studies in Table 11.

City	Country	Dependant Variable
Amsterdam	The Netherlands	Delivered
Barcelona	Spain	Delivered
Berlin	Germany	Delivered
Burlington	USA	Not Delivered
Cambridge	USA	Delivered
Chicago	USA	Not Delivered
Copenhagen	Denmark	Delivered
Dubai	UAE	Delivered
Frankfurt Am Main	Germany	Delivered
Hamburg	Germany	Not Delivered
Harbin	China	Delivered
Helsinki	Finland	Delivered
London (Southwark)	UK	Not Delivered
London (Kings Cross)	UK	Delivered
Lerwick	UK	Delivered
Miami	USA	Delivered
Paris	France	Delivered
Portland	USA	Not Delivered
Reykjavik	Iceland	Delivered
San Diego	USA	Delivered
Seoul	South Korea	Delivered
Singapore	Singapore	Delivered
Southampton	UK	Delivered
Toronto	Canada	Delivered
Victoria, BC	Canada	Not Delivered
Vienna	Austria	Delivered

Table 11: Long list of cities with DHC systems

In practice, selecting case studies according to the dependent variable and holding static two independent variables tends to exclude the following groups of case studies. Case studies where long-standing tax regimes or the physical climate encouraged DHC on economic grounds were not included as for those situations DHC was not a messy policy problem and network governance patterns were not observed. Similarly, case studies in countries where DHC had been practiced for many years and was no longer perceived as a environmental policy goal but simply standard practice were not included. Case studies in non-urban or industrial settings, and DHC systems installed before approximately 1980 which have not been significantly expanded or upgraded in the intervening years were also not included; the significant structural changes to both urban policy (governance patterns) and energy markets (liberalization) since that time tended to signify that non-hierarchal governance patterns were absent.

Further to the above ACI components which served as independent variables, the following influenced case study selection. First, the availability of information in English. The research avoided case studies were little or no desktop information was available in English; this was a

practical decision which led to the absence of Asian examples from the research scope. Second, access to actors. Due to the need to understand organisation and individual perceptions, it was important that the research be able to interview actors involved in the cases. Therefore the research focused on fairly recent case studies. Access to actors did remain a data concern throughout the research, as discussed below.

Applying the case study selection criteria established above to the long list of case studies in Table 11, the following case studies were chosen for detailed study.

1.	Elephant and Castle, London	Not delivered
2.	Districlima 22@, Barcelona	Delivered
3.	Deep Lake Water Cooling, Toronto	Delivered
4.	Burlington, Virginia	Not delivered
5.	Lerwick, Shetland	Delivered

To summarise, the research design employs ACI to inform the case study selection, being mindful of theoretical and methodological considerations of comparative case study research. Both case studies where DHC has been delivered and where it has not been delivered are chosen. Selection of case studies for the actor component causes no inference problems. It is appropriate to hold certain variables constant in order to better understand causality between influences and success; these variables were selected by employing concepts in ACI. Case study selection holds static a key component – ACI's policy goal (DHC as an environmental policy goal) - and excludes cases studies where DHC is delivered on financial grounds alone. Alongside the selection for cases with planning organisations actively involved, this focuses the case studies to situations which address the research questions.

In support of the comparative methodology it is helpful to standardise terminology about government actors. For the purposes of this thesis, local government or municipal government indicates the lowest form of state organisation to pro-actively manage an urban area (e.g. London Borough of Southwark). Metropolitan government indicates the next step up within an urban context; this can be a collective of many organisations (e.g. Barcelona Metropolitan organisations, Greater London Authority). State government indicates a large sub-national level of government which can have varying degrees of autonomy and legislative power (e.g. State of Vermont, Generalitat de Catalyna, Scottish Government, Province of Ontario). National government indicates the highest level of government of a nation-state, with implications for citizenship and controlled borders.

5.3 ACI Structures the Methods of Data Collection and Analysis

This section considers suitable methods for data collection and analysis to inform the research design and respond to the three questions. The literature review identified that previous governance research and the proposed conceptual framework, Actor-Centered Institutionalism (ACI), point at specific analysis methodologies. These methodologies are discussed and then applied to the research questions, generating a detailed research design. This section draws

heavily on Hermans and Thisse (2009) and Reed et al (2005) and their review of multi-actor analysis methodologies.

Hermans and Thisse (2009) review and explain a full range of governance analysis methodologies in detail, highlighting that while most popular methods can be grouped generally into stakeholder analysis, other methods such as discourse analysis and cognitive mapping are being employed with a spectrum of quantitative and qualitative results. Stakeholder analysis is the least analytical of the methods reviewed; Hermans and Thisse argue that its lack of specificity is offset by its practical usability. More analytical methods include social network analysis, multi-attribute assessments and vote-exchange models; their specificity is balanced by their limitation to specific sub-sets of policy processes, and their rigid data input parameters (2009).

Chapter 4 describes how ACI points at a structure for the research design, clearly identifying focus areas for the research and proposing a research approach which can address the research questions. Looking at the first three components of ACI (policy problem, actors, and actor constellations), the methodology is required to address of a broad spectrum of kinds of interactions and be able to draw out and understand not only the capabilities of the actors, but also their orientations and preferences both generally and towards other actors. This requirement to understand the 'perceptions' of each actor towards the other actors' strategies and preferences across a broad range of topics suggests a in-depth, qualitative approach would be more appropriate than specific, quantitative analysis. Stakeholder analysis, with its history of applications to many in-depth qualitative studies and its ability to be 'inclusive' the types and kinds of actors and interactions is particularly suited to these needs of ACI and the research questions. While Hermans and Thisse acknowledge that stakeholder analysis is stronger on identifying resources than perceptions, Reed et al believe that stakeholder analysis methodologies can also be strong in understanding actor relationships and perceptions (Hermans & Thisse, 2009; Reed, et al., 2009).

Stakeholder analysis methods are proposed as the appropriate analysis tools to address the research questions. Stakeholder analysis methods are a loosely grouped range of flexible analysis methods which assist in understanding policy making as a process influenced by multiple actors. Stakeholder analysis methods are widely recognised as appropriate to generate information on the relevant actors and to understand their behaviour, interests, agendas and influences (Reed, et al., 2009; Hermans & Thisse, 2009). The methods attempt to structure the stakeholder (or actor) environment, to assess cooperative potential and threat of obstruction. The outcomes are a series of tables and matrices for actor classification and participation strategies. The analysis and matrices build on the ACI framework, as detailed below.

This research employs an iterative approach to actor identification and matrix analysis, building on initial desktop research to undertake semi-structured interviews. The relationship between these analysis methods and the research questions is described below

Social Network Analysis and the challenge of messy policy problems.

Social Network Analysis (SNA) was considered as potential quantitative analysis pathway to understand the relational characteristics of actors within the case studies. Hermans (2009), (Marsh, 1998). and Reed et al (2005) all highly recommend social network analysis (SNA) to understand network governance relational characteristics. The SNA approach was trialled on the Elephant and Castle Case study, where interviewees were asked to quantitatively rank the importance of other actors and their strength of communications with others. Two adjacency matrices were established and initial analyses run on communication, influence, reciprocity, centrality and equivalence. However the trial illustrated the difficulties of establishing a boundary set for actors engaged in the network and gathering sufficient quantitative information from each actor within the set. The boundary set is critical to SNA calculations which compare individual relationships against the total possible set; therefore while the results were interesting they were not considered robust. It would have been even more difficult to collect sufficient information for robust boundary sets across all cases; comparison of SNA findings across cases would not have been valid. Therefore the research did not continue with SNA.

Relational characteristics are instead analysed through a qualitative approach. Size, duration, density, and centrality are judged instead through comparing the relative qualities in the five case studies.

Data collection

The research exclusively uses primary sources arising from the identified actors in each case study to undertake the ACI stakeholder analysis of actor powers, orientations and preferences as well as to analyse the collective actor constellation. Secondary sources of information or analysis not arising directly from the actors (e.g. other academic or industry publications) are used to inform an understanding of the institutional context and to corroborate patterns of behaviour emerging from the primary analysis.

In ACI, the starting point for explaining policy-making processes and their outcomes is to "identify the set of interactions that produces the policy outcomes which are to be explained" (Scharpf, 1997, p. 43). Research into each case study begins with a review of publicly available information to identify these interactions. The review considers information available such as corporate and personal websites, government policies; research conducted by academics as well as industry bodies and published presentations by individuals. Reports and publications are sought through internet keyword searches, relevant planning, policy and energy research archives, and reference tracing. This stage establishes the set of interactions to be studied, identifies actors and potential composite actors, as well as actor capabilities, preferences and strategies used over time. It also begins to delineate the time and actor boundaries of each case study, as part of building up 'the set of interactions which produces the policy outcomes to be explained' (Scharpf, 1997).

Identifying actors, and identifying their voices

From this review of the interactions around the particular DHC system, the research indentifies the actors, individual or collective, that are involved in the policy-making process. Given the governance network approach chosen for the research, boundaries of who constitutes actors and the actor set are not pre-supposed and instead emerge from an iterative process from desktop research and then the interviews themselves. In this way the actor set grows during the research process.

Actors are considered possible to exist at both organisation and individual level. Coding and stakeholder analysis are structured accordingly, often dually coding as composite sets of actors as well as individuals. As described in Chapter 4, Scharpf encourages concept of *composite actors* where it does not obscure the research interests, because it facilities the task of explaining and predicting policy outcomes in the real world, where collective actors - organisations, ministries, associations – are often the primary actors.

Desktop research, employing internet searches and academic sources, first identifies potential actors organisations associated with the network. Once a long list of organisations are indentified, further internet searches are conducted to 'trace' influences by other actors, such as consultants who might have advised actors. This iterative process continues during the interviews, where questions enquire about organisations and individuals with influence over the DH system.

Analysis of actors – coding of data and inclusion in the stakeholder matrices – is undertaken on the broadest conception of an actor set using sources authored by actors. However the research also aims to interview 'primary actors' with direct influence on the case study outcomes; Scharpf distinguishes between a wider actor set and primary actors that are directly and necessarily participating in the making of policy choices" (Scharpf p 71). This narrowing to focus on influential individuals and organisations is supported by recommendations in *Methodology Problems in Urban Governance* (Gissendannero, 2003).

Interviewees are contacted by email or phone to request an interview. At least two follow up requests are made if the initial contact was unsuccessful. It is not possible to interview all primary actors; in some cases actors declined interviews, and in others the individuals had moved on to another organisation and could not be found. At a minimum, the research interviews at least one individual associated with planning organisations, one individual associated with market concerns (either energy company or local business), and one individual associated with a government policy organisation in each case study. Table 13 provides a summary of interview coverage.

Where individuals could not be contacted for an interview, written records from the desktop search or library research authored by that interviewee or their organisation are assumed to represent their actor orientations and preferences and coded as such. Where no information can be found, this is noted.

Academic research or third party commentators (e.g. industry body case study) which described the case study or analysed the case are never assumed to represent actor orientations and are not used in the stakeholder analysis to substitute for lack of directly authored information or interviews. However this secondary information is coded and used to understand the institutional context of actors and to reflect upon the results of the stakeholder analysis.

Interview structure

Semi-structured interviews are undertaken following the selection methodology described above. Semi-structured interviews are a popular data collection approach in social science research, Reed et al confirm they are useful for in-depth insights to stakeholder relationships and to confirm prior desktop or focus group research. The researcher is led by a pre-set list of questions, but remained flexible during the interviews, allowing the interviewee to respond in the manner of their choosing, and allowing the interviewee to contribute above and around the pre-set questions. This approach, as compared to a more formally structured approach, is "most useful where the researcher seeks information regarding a specific, defined phenomenon (such as an event or document) .... but with significant depth or 'richness' (Reed, et al., 2009, p. 1944). This flexible, open-ended approach is appropriate to support the perception oriented nature of the research, concerned not only with what but why and why them of the DHC system.

The interviews seek to gather information on the actor capabilities, preferences and orientations, their chosen strategies, as well as information on their evaluations and preferences of other actors and of policy outcomes. Specific interview questions address the research questions about relational characteristics and institutional setting The interview pro-forma is provided in Appendix B. A schedule of interviews undertaken is provided below in Table 13. Table 12 enumerates the relationships between interviews and actor sets to illustrate the robust nature of the interview based data collection.

	Interviews Conducted	Number of Interviewees	Number of Primary Actors	Number of actors in wider set
Barcelona	3	4	9	23
Burlington	4	5	7	20
Lerwick	4	8	8	15
London	7	7	10	16
Toronto	8	9	10	26

Table 12: Overview of data collection and actor sets

Given the international nature of the research, and classic problems of interpretation and vocabulary in policy analysis where meanings and context are closely linked (Hajer & Wagenaar, 2003), it is important to have the exact vocabulary used by the interviewees for cross-checking and post-interview interpretation. Interviews are recorded with permission of the interviewees using simple recording technology located within the researcher's mobile phone. The recordings are then transcribed into text, generally without the use of transcription software, before coding and analysis.

In two specific cases, professional transcriptions and translations were commissioned. For the case of Lerwick, the researcher had access to an academic transcription service with experience of the Scottish accent. Therefore transcription of the interview records was outsourced, and the resulting document was double checked with the researcher's personal notes and the sound recording. In Barcelona, a professional academic translator was commissioned to attend the interviews and transcribe the recordings to supplement the researcher's basic level of verbal Spanish. Two Barcelona interviews were conducted in English with support from the translator where requested by the interviewee. One interview was conducted whereby the researcher asked questions in English but the interviewees responded a mixture of Spanish and Catalan. Coding and analysis were conducted using the professional English translations of interview transcripts.

Data quality

The level of information about the cases and the mindset of actors within the cases - their preferences, orientations, and preferences of other actors – is considered sufficiently robust for all five cases.

For the case of Barcelona, three interviews with four individuals were conducted, supplemented by email correspondence. Further information was primarily obtained through primary sources: government policy documents, urban plans, published organisational literature and a search of websites produced by the actors. Existing academic and industry analysis exists on Barcelona's governance and planning history; this was called upon where it added to understanding of the primary sources. Additionally, a master's thesis, *Integrating Urban Infrastructure Solutions,* had previously analysed the infrastructure delivery in the 22@ district (Torguet, 2009); information included in that thesis was not used in the stakeholder analysis but was referred to post hoc for a sanity check. Data quality is considered to be robust if uneven; views of local elected officials were primarily sourced through newspaper articles and authored introductions to published policy documents. The most significant gap in understanding is regarding the perspectives of the consumers of the Districlima system.

For Burlington, five interviews with six individuals were conducted in August 2012. Other data was primarily obtained through a library search of local newspapers, the records of the planning department, and an internet search of relevant organisational websites. The local DHC advocacy committee also shared information on who attended the public meetings in 2011. The interviews provide a robust if uneven set of data; the research lacks interviews with a representative of the Burlington Electric Department, the University of Vermont, and Fletcher Allen Hospital. Their perspectives have been sourced from published documents and websites. The research was also not able to obtain feasibility studies dating to the 1980s; this is not considered a barrier as the analysis is directed to more recent (since 2007) interactions.

For Lerwick, four interviews with eight individuals were conducted in November 2011, supplemented by email correspondence. Other data was obtained through an internet search and planning policy documents in the council offices. Online information, such as Shetland

Times articles and Shetland Charitable Trust documents, tend to extend back to the mid 1990s and therefore written records from the inception of the plant are weaker. There is one published academic paper on the DHC system in Lerwick, written by Neville Martin the manager of Shetland Heat and Power Limited and William Spence the Manager of the Incineration Plant (Martin & Spence, 2010).

For London, seven interviews were conducted over the summer of 2011, supplemented by email correspondence and a survey designed to gauge the kind of interactions among actors (the results of which is not included in this thesis as described in above). The interviews provide a robust if uneven set of data; a more rounded view of local councillor and officer positions is provided by committee reports and newspaper articles. There are gaps in understanding the perspective of Lend Lease prior to 2008 and the direct perspective of the finance department. Other data was primarily obtained through an internet search. Newspaper articles, national and regional government policies and Southwark Council committee reports in particular provided useful sources of actor voices and perspectives.

For Toronto, eight interviews with nine individuals were conducted in September 2012. The set of interviewees is robust and varied, although not all interviewees can be classed as primary actors directly engaged with the decision to proceed with Deep Lake Water Cooling. Other data was obtained through an internet search with newspaper articles and some company websites providing information, and via a electronic and library search of City of Toronto meeting minutes and councillor reports. The city council minutes provided a useful view into the often extended process of internal decision making within the council committees.

	Interviews
Barcelona	• Former Director of Infrastructure, 22@ BCN *together with* Head of Energy Infrastructure, Barcelona Regional. 27 November 2012. (Interview A3) • Chief Executive, Districlima. 27 November 2012. (Interview S2) • Technical Director, Barcelona Energy Agency. 14 December 2012. (Interview G4)
Burlington	• Local resident *together with* Managing Director of the McNeil Power Station (both on the BURDES committee). 30th August 2012. (Interview C2) • Joel Banner Baird, journalist at Burlington Free Press. 29th August, 2012. (Interview C3) • Director of Planning and Zoning, City of Burlington.29th August 2012. (Interview P4) • Senior Vice President, Ever Green Energy. 11 July 2012. (Interview A4)
Lerwick	• Manager, Shetland Heat and Power Company *together with* Financial Controller, Shetland Islands Charitable Trust *together with* Robert Henderson, Local Councillor and Trustee of Shetland Islands Charitable Trust. 7 November 2011. (Interview S1) • Energy Manager *together with* Energy Recovery Plant Manager, *together with* Waste Services Manager. All Shetland Islands Council. 8 Nov 2011. (Interview G3) • Town Planner, Shetland Islands Council. 8 Nov 2011. (Interview P2) • Site Engineer, Gilbert Bain Hospital, 8 November 2011. (Interview U1)
London	• Founder, Brian Dunlop Associates. 11 July 2011. (Interview A1) • Project Director for Elephant and Castle Regeneration, Southwark Council. 2 August 2011. (Interview G1) • Head of Infrastructure and Sustainability, Lend Lease. 12 August 2011. (Interview D1) • Former Project Director of Elephant and Castle Regeneration, Southwark Council. 13 October 2011. (Interview P1) • Former Councillor and Leader of the Council. 20 October 2011. (Interview E1) • Director of Research, Clinton Climate Change Initiative. 30 June 2011. (Interview C1) • Director, Inventa Partners. 8 September 2011. (Interview A2)
Toronto	• Director, Toronto Environment Office. 4 September 2012. (Interview G2) • Chair, Ontario Clean Air Alliance. 4 September 2012 (Interview C4) • Chief Executive, Enwave. 5th September 2012. (Interview S3) • General Manager, Toronto Water. 6th September 2012. (Interview G5) • Project Manager, Environment Zoning By-law and Environmental Planning, City of Toronto *together with* Senior Engineer, Energy Efficiency Office, City of Toronto. 6th September 2012. (Interview P5) • Joe Pantalone, former Councillor. 6th September 2012. (Interview E2) • Richard Gilbert, former Councillor. 6th September 2012. (Interview E3) • Senior Vice President, Oxford Properties. 24 September 2012. (Interview U2)

Table 13 : Schedule of interviews undertaken for research

5.4 Analysis Methods

This section describes the process by which the desktop research and interview data are analysed to address the research questions, using coding and stakeholder matrix analysis.

The method of stakeholder analysis is the completion of a bespoke series of matrices, building on the Actor-Centered Institutionalism framework concepts. The matrices are completed through a coding process. All documentation – interviews as well as written documents - relevant to each case study is reviewed and coded using four types of codes. The codes arise from the ACI framework, and are grouped as follows:

1. Type 1: Self-identified: Actor A thinks X of Actor A, e.g.:
    - A1A : A describes its own capabilities and resources
    - A2A: A describes its own orientations about the DHC network
    - A3A: A describes its own preferences for the DHC network
    - A4A: A describes its own marking shaping strategy for DHC
    - A5A: A describes its own regulation of DHC
    - A6A: A describes its own market incentives for DHC
    - A7A : A describes its own market capacity building around DHC
2. Type 2: Other identified: Actor X thinks X of Actor B, e.g.:
    - A1B: A describes what it understands about B's capabilities and resources
    - B2C: B describes what it understands about C's orientations towards the DHC network
    - D3A: D describes what it understands about A's preferences towards the DHC network.
3. Type 3: Statements of fact: describing process, naming of actors involved, and methods of communication or collaboration. Three codes were used:
    - 20: A neutral description of the process of establishing the DHC network.
    - 21: A reference to the actors involved in the policy or decision making about the DHC network
    - 22: A description of communication or collaboration methods in establishing the DHC network.
4. Type 4: Other commentary on the case study by actors not directly involved in delivery of the DHC network (journalists, other research, post-hoc perceptions, etc). This third party commentary was coded '23'.

Coding is an iterative process with the interviews and desktop research, whereby actors identified in code 21 are then investigated and documentation associated with them added into the coding process. Coding is undertaken using Atlas TI version 5.6.3. These codes enable the completion of the stakeholder analysis matrices. Appendix C contains a list of all codes used in each case study and the full stakeholder analysis matrices.

Stakeholder analysis matrices

Four stakeholder analysis matrices are used to define the set of actors and the actor constellation and to inform the understanding of the mode of interaction. One 'self-identified actor' analysis matrix summarises the capabilities, orientations, and preferences of all the actors involved in one case study, as identified by each actor. Essentially, this matrix is a summary of what each actor thinks of itself. This was completed with codes A1A, A2A, and A3A, as Table 14 illustrates.

Actor	Capabilities	Orientation	Preferences
e.g. local government	e.g. did not know about DHC; hosted workshops; owned local waste incineration plant	e.g. promote energy and sustainability; concerned with price of fuel for residents; do not want to own utilities.	e.g. encourage DHC; coordinate discussions between private energy company and private customers;
Typical code	LG1LG	LG2LG	LG3LG

Table 14: Example self-identified actor matrix

A second 'collective actor' analysis matrix represents the same information about each actor, but instead of summarising what each actor thinks of itself, it summarises the perception of each actor by all other actors. Using the coding process, it groups responses from all actors and from the desktop research, so that each specific actor is described in a collective way by all the other actors. The codes for this matrix have greater variation, examples such as: A1B, B1A, D3F, etc. This collectively identified matrix highlights conflict in perceptions among actors in terms of their perception of other actors, and also identifies where consensus exists. This collective actor matrix begins to build a picture of the actor constellations in each case study. The research is careful to note changes in perceptions of other actors, recognizing that actor constellations are not static but evolve over time, through the effect of negotiations or interactions. Table 15 provides an example of a collective actor matrix; the full matrices are included in Appendix C.

Actor	Capabilities	Orientation	Preferences
e.g. Government energy ministry	e.g. generate new laws, control land use, financial investment	e.g. campaigning organisation, government department	e.g. coordinating other actors, regulating the private sector
Typical code	LPA1GEM; B1GEM	LPA2GEM; F2GEM	LPA3GEM; H3GEM
e.g. local planning authority	e.g. control land use, require new buildings to connect	e.g. policy department	e.g. state goals and interfere in new development
Typical code	GEM1LPA; C1LPA	GEM2LPA; D2LPA	GEM3LPA; F3LPA

Table 15 : Example collective actor matrix

Actors and actor constellations are analysed in detail through a further two matrices which describe the market interventions of the actor set. These strategy matrices map the 'potential' and the ‘actual’ strategies for each actor against four categories of market intervention identified by Allmendinger and Tiesdell, as discussed in Chapter 2. The self-identified strategy matrix defines how each actor perceives their potential options given institutional constraints and powers, and what roles or policy influences that actor enables. This employs codes such as A4A, A5A, A6A, A7A, etc as described above. The collective strategy matrix summarises what all actors perceive of other actors potential and actual interventions, using codes which referenced other actors, for example A4F, C5B, D6A, E7Z, etc. Again, this 'what everyone thinks of everyone else' matrix highlights areas of conflict or consensus in perception of others.

The ++ indicators represent a scale of regulatory options as identified by the researcher: 0 (none), + (minor), ++ (medium), and +++ (significant). To illustrate, in the collective strategy matrix below in Table 17, Actor B has a minor market shaping role (e.g. participating in policy development) but a significant potential incentive role (e.g. providing infrastructure grants).

	Market Shaping	Market Regulation	Market Incentives	Market Capacity Building
Actor A	+	+	0	+
Actor B	0	0	++	0
Typical Code	A4A	A5A	B6B	B7B

Table 16: Example self-identified strategy matrix

	Market Shaping		Market Regulation		Market Incentives		Market Capacity Building	
	Potential	Actual	Potential	Actual	Potential	Actual	Potential	Actual
Actor A	++	+	+++	+	0	0	+++	0
Typical Code	C4A; D4A	C4A	C5A	C5A	B6A	B6A	B7A; F7A	B7A
Actor B	+	+	0	0	+++	+	0	0
Typical Code	C4B; A4B	C4B	C5B	C5B	A6B; D6B	C6B	A7B; C7B	A7B

Table 17: Example collective strategy matrix

Applied on a case by case basis, these matrices address the ACI questions concerning what strategies of action are available to actors, and how actors perceive of each other's potential strategies. They describe the actor constellation. By comparing the matrix with the known outcome of delivery (or not) of DHC with the potential and chosen strategies across case studies, these matrices help the research understand if perceived and actual strategies – or the gap between perceived and actual - are a causal factor in the delivery of DHC.

Full code lists and detailed analysis matrices for each case study can be found in Appendix C.

ACI Framework	Established Through
DHC as an environmental policy goal	Desktop review
Institutional Setting	Desktop review Interviews Self-identified actor analysis Collective actor analysis
Actors Planning specifically	Desktop review Interviews Self-identified actor analysis Self-identified strategy analysis
Actor constellations	Desktop review Bespoke Interviews Collective actor analysis Collective strategy analysis
Mode of interaction - negotiated	Selection of case studies Confirmed by desktop reviews Interviews Collective strategy analysis
Relational characteristics	Interviews Comparative analysis
DHC delivered or not delivered	Selection of case studies

Table 18 : Research analysis methods in summary

Evaluation and research narrative

The final step in the research methodology is to reflect on the stakeholder analysis and strategy analysis in light of the research questions. This is done at both a case study level and in a comparative, cross-case study level. For each case study, the research evaluates how the components of ACI result in the policy outcomes, using the matrices to 'get to grips' with what causes the success or failure of DHC as an environmental policy goal. This case evaluation considers the eight case study questions identified in Chapter 4.

1. Who are the primary actors?
2. How are the actors influenced by the institutional setting?
3. What are the actors' self-identified capabilities, orientations, and preferences?
4. How can the actor constellation be described?
5. How can the interactions be characterised?
6. Is this network governance?
7. What are the relational characteristics?
8. How can the role of planning be described?

These questions are addressed for each case study in Chapters 6 to 10 through a combination of description of the actors, narrative describing the outcome of the stakeholder analysis, direct quotes from actors and stakeholders interviewed, and the researcher's reflection on specific research case study questions. A narrative approach is considered appropriate given the breadth of information presented; it unlocks the story of the governance network without labouring the coding procedures. The coding procedures and stakeholder analysis matrices are detailed in Appendix C.

The answers to the eight case study questions enable the research to compare across the cases studies on how each component of ACI related to outcome of the attempt to establish a DHC network. Chapter 11 describes the comparative analysis which directly addresses the three main research questions.

Data Collection	Processing	Analysis
Desktop Research	Transcription	Reflection on Institutional Setting
Semi-Structured Interviews	Notes	Self-identified Actor Analysis
	Coding of all texts	Collective Actor Analysis
		Strategy Analysis
		Collective Strategy Analysis
		Reflection on Mode of Interaction
		Reflection on existence of governance network behaviours
		Reflection on role of planning.
		Comparative Analysis

Table 19 : Summary of data collection, processing and analysis

5.5 Research Design: In Summary

The aim of this research is to understand the role planning organisations can play in delivering DHC infrastructure through a comparative review of global case studies. To address this, the research must be concerned with the role of planning within governance networks, while recognising that institutional context affects actors and the shape of interactions. Three research questions have been proposed, as follows:

1. **How do governance networks support implementation of DHC systems?**
2. **How does the institutional setting influence the delivery of DHC systems?**
3. **What is the role of planning, in relation to market, civic, and to other government organisations, in delivering DHC systems?**

To address these research questions, a conceptual framework of Actor-Centered Institutionalism is applied to five in depth case studies, which positions the delivery of DHC as the result of actors, set in a constellation of potential strategies and outcomes, which are played out through a negotiated mode of interaction. The institutional setting, actor characteristics, and relational characteristics of interaction between actors are considered potential variables on the policy outcome: DHC delivered or not. The use of ACI enables the research to address all three research questions, bridging governance network and institutionalist approaches and also focus on one actor, planning.

ACI structures the data collection, analysis methodologies, and selection of case studies. The data required, information on actor capabilities, preferences, powers, and opinions of others, is generated through interviews and primary source reviews. Bespoke coding and four types of stakeholder analyses are undertaken on this data for each case study; these address eight case study questions which flow from ACI's concepts. The analysis findings for each case study are presented in an engaging narrative form.

Comparative analysis of the five case studies addresses the three research questions. The inclusion of both ‘DHC delivered’ and ‘DHC not delivered’ case studies will enable the identification of specific actors, actor capabilities, institutional factors, actor constellations, or network characteristics which influence the delivery of DHC systems. The selected case studies are varied in context with different legal, administrative, and cultural settings in each. This variation enables both the analysis of how the institutional setting affects the establishment of a governance network for DHC and a more robust understanding of how the components of ACI relate to successful outcomes for DHC systems. The location of the responses to the research questions can be found in the thesis as follows:

Research Questions	Location of Response
How do governance networks support implementation of DHC systems?	Chapter 11
How does the institutional setting influence the delivery of DHC systems?	Chapter 11
What is the role of planning, in relation to market, civic, and to other government organisations, in delivering DHC systems?	Chapter 11
Case Specific Questions which inform the research questions :	
Who are the primary actors?	Chapters 6 to 10
How are the actors influenced by the institutional setting?	Chapters 6 to 10
What are the actors' self-identified capabilities, orientations, and preferences?	Chapters 6 to 10
How can the actor constellation be described?	Chapters 6 to 10
How can the interactions be characterised?	Chapters 6 to 10
What are the relational characteristics?	Chapters 6 to 10
Is this network governance?	Chapters 6 to 10
How can the role of planning be described?	Chapters 6 to 10

Table 20 : Research question response summary

Chapter 6. Barcelona, Districlima in 22@: Extending Urbanisme

In September 2000 Barcelona City Council approved a masterplan in the form of a *Modification of the General Municipal Plan* (MGMP) for the renovation of Poblenou, a former industrial district in central south-east Barcelona. The plan created the '22@' district, transforming 200 hectares of industrial land in Poblenou into an innovation district aimed at creating a strategic concentration of intensive knowledge-based activities. Following a typical pattern in Barcelona, the city council linked the masterplan to a major event, the Universal Forum of Cultures 2004 to give the complex investment and regeneration process momentum.

The Poblenou MGMP was accompanied by a *Special Infrastructure Plan* (SIP) which established a technical masterplan for a thorough overhaul of Poblenou's energy, telecommunications, water, and waste infrastructure. The plan included designs for a district heating and cooling (DHC) system, setting out the physical location and connection points to buildings. All local developments and neighbourhood projects are legally required to conform to the SIP design standard.

As part of the construction of the buildings for the Forum of Cultures, the city council hosted an 'ideas competition' for energy companies to explore options for building and operating the DHC system. The council eventually contracted with Cofely GDF Suez to built a small district heating, hot water and cooling system to serve the Forum buildings which utilized waste heat from a nearby waste incineration plant. Named "Districlima" this DHC system began operating in 2002.

In 2005, the city council issued a public tender for a 30 year concession to manage and extend the Districlima system. The expectation was that Districlima would expand to the significant new construction across the 22@ district, following the technical standard established in the SIP and serving new or refurbished buildings as customers. Through this second procurement process Cofely was selected by the council as the preferred partner to operate and expand the DHC system. The expanded Districlima is run as a public-private enterprise with Cofely owning 50.8%, Tersa (municipal waste company and source of heat) 20%, Agbar (local water company, also owned by Cofely) 19.2%, IDEA (national energy institute) 5%, and ICAEN (Catalan energy institute) 5%.

As of 2012, Districlima is the largest urban district heating and cooling system in Spain, serving 67 buildings through 13km of pipe networks throughout Poblenou. A new cooling plant opened in 2012 and the system continues to expand. The city is also pursuing additional DHC systems through the Barcelona Energy Agency and its decennial Energy Plans.

For context, a timeline of development of the Districlima system in 22@ is provided in Figure 3.

Timeline of Districlima	
1998	Planning process for 22@ began. (InterviewA3, 2012)
2000	Modification of the General Metropolitan Plan (MPGM) to create 22@ use and 22@ district. (Barcelona City Council, 2000)
	Publication of Special Infrastructure Plan for district. Heating and cooling system included as technical standard, mapped. (Barcelona City Council, 2000)
	Creation of 22 Arroba BCN society to promote and manage 22@ regeneration. (Barcelona City Council, 2012)
2001	Ideas for tender and presentation to 22@ BCN committee. (InterviewA3, 2012)
2002	Districlima established with 1st concession to operate Forum area DHC, financed by municipality. (Districlima, 2012)
2004	Started operating at Universal Forum of Cultures event (Districlima, 2012)
2005	Public tender for 2nd concession of extension to 22@ district. (InterviewA3, 2012)
2012	Tanger chiller plant opens. (Districlima, 2012)

Figure 3: A timeline of Districlima, Barcelona

Barcelona's multi-layered government context

A Mediterranean costal city in north western Spain, Barcelona is the capital city of Catalonia, a nationality and autonomous community within Spain, and is Spain's second largest city with an urban population of over 1.6 million and a metropolitan area population of over 4.5 million people. By several measures it holds a top-50 global city status, and has been widely recognised as an "outstanding example of a certain way of improving cities" (Marshall, 2004, p. 1) for repositioning itself throughout global financial and economic changes over the past 30 years.

Multiple layers of political power and control in Barcelona have been central to planning and urban development of the city. Marshall argues that "the element of conflict, of cross-cutting efforts" has helped Barcelona (Marshall, 1996) in several ways, including "creating an effective balance of public and private oriented policies" (p. 162). The city is affected by six levels of government: federal (Spanish), national (*Generalitat de Catalunya*), provincial (*Diputació Barcelona)*, county (*Consell Comaracal del Barcelonès),* metropolitan (*Área Metropolitana de Barcelona),* and municipal (*Ajutament de Barcelona*) whose levels of legal or political influence varied during the case timeline (Marshall, 2000). By and large, the federal and national levels set out legislation which defines what metropolitan and municipal organisations can do; the provincial and county functions tend to coordinate or support policies across organisations and between levels.

Across the relatively short time span of this case, both political control (elected parties in majority) and legal powers (particularly the Municipal Law) changed in ways which were relevant to understanding the government and governance of urban energy infrastructure in Barcelona. Both Marshall (2000) and Esteban (2004) trace the history of planning and government in the city in detail, and the impact on urban planning is covered below. This case is also notable for spanning the late 2000's global financial crisis, which had a significant impact on the capacity and outlook of local, regional, and national government, private businesses and property developers, and financial institutions among others.

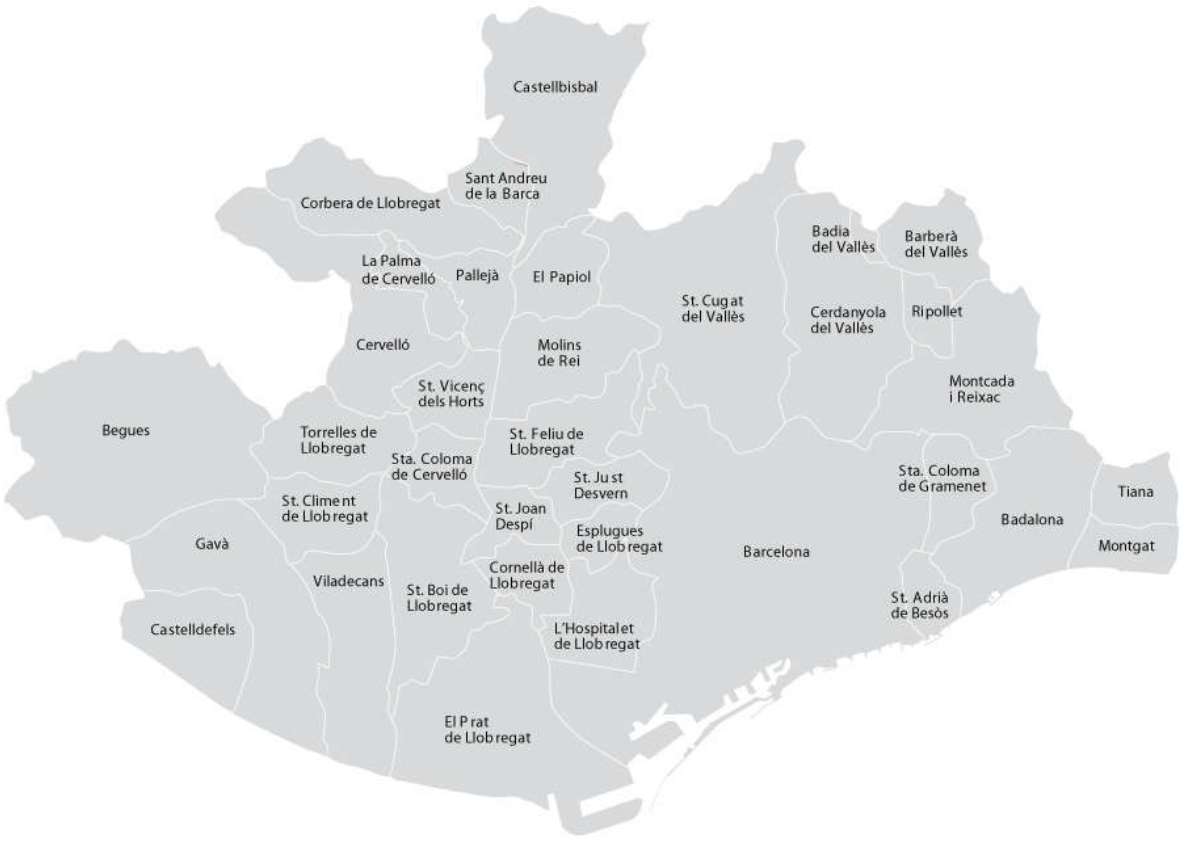

Figure 4:The Metropolitan Region of Barcelona (Area Metropolitana de Barcelona, 2011)

6.1 The Actors

This section introduces the organisations and individuals who comprise the 'primary actor set' for the establishment of Districlima system in Barcelona, describing their institutional setting and capabilities. Appendix C contains the codes and information sources which provided this understanding of actor powers and capabilities.

Local government and urban planning functions

In physical location, the Districlima system and the 22@ district fall predominantly within Barcelona City Council boundaries, however the Tersa waste plant and a small number of urban blocks fall into the adjacent eastern municipality, Sant Adrià de Besòs. The Universal Forum of Cultures project was similarly shared between the two municipalities.

Barcelona City Council is governed by 41 elected councillors, headed by the Mayor of Barcelona. Effectively it is a collection of committees which direct and oversee work undertaken by either permanent executive staff such as the planning department or consortia agencies such as the Barcelona Energy Agency. With regards to local planning authority, Barcelona has seen numerous changes in institutional organisation and responsibilities or powers for development processes in the past twenty years. Pre-1987 a metropolitan commission which covered Barcelona City and adjacent municipalities had strong control over planning, waste, and housing. The use of those powers was shaped by political influences, predominately socialist or nationalist Catalyunan party objectives (Marshall, 2004). After a consolidation and regionalisation of local government in 1987, Barcelona City Council had less control over

planning, waste, and housing, but Barcelona mayors and deputy mayors continued to have strong force in shaping the policies that influence the central urban areas, particularly around large regeneration and infrastructure (Marshall, 2000). During the course of this case study the various bodies dissolved in 1987 by the abolition of the metro level were reconstituted in a weaker form under the 2010 Law of the Metropolitan area (Ajutament de Barcelona, 2013).

Planning's institutional setting

To understand the role and powers of planning Barcelona in 2000, and how the local government planning body was perceived by others, it is useful to understand the history and tradition of urban planning Barcelona. The local government has been undertaking active and socially inspired forward planning and plan making (urbanisme) since the 1850's. Planning in Barcelona is characterised by political involvement and by a clear physical vision for what city should look like at grand and at detailed scale (Marshall, 2004). This context has been labelled as 'Napoleonic-urbanism' by Newman and Thornley (1996).

Marshall, in *Urban Planning and Governance: Is there a Barcelona Model?* provides a detailed explanation of where planning powers of legislation, plan making, investment, coordination, and development control lie. In summary, the federal Spanish government sets legislation and determines national and urban planning organisational powers. The national Catalonian government sets regional planning policy and since 1987 has been responsible for public housing. The city council through Deputy Mayor connections has influence over many of the metropolitan government agencies for water and environment which officially operate at a level between national and local (2000).

After 1987, plan-making and development control powers were consolidated into the federal government. Planning policy and plan-making since then has been dealt with by a 'commission' of various regional bodies, chaired by the Barcelona City Council Mayor. Planning decisions are dealt with by three commissions which provides for local district influence. Marshall also outlines how this evolved the 'metro' planning into an event-focussed activity and argues that a lack of effective implementation instruments weakened infrastructure and physical planning (2000, p. 312). Since then, "strategic planning in the Barcelona sense has meant a kind of urban corporate planning, around a core of economic development goals, with certain social and environmental aims attached" (2000, p. 306).

22@ BCN

The 22@ BCN regeneration company was created by Barcelona City Council to manage the transformation of the Poblenou area and to influence the development through direct investment and regulation. After publication of the MGMP which established the 22@ district and land use designation, the company took over the city's urban planning functions in the area. The organisation was funded by money arising from development approvals (infrastructure levy in the SIP) and the city council (Barcelona City Council, 2012).

Figure 5: Location of 22@ regeneration district, Barcelona (Barcelona City Council, 2012)

Barcelona Regional

While officially and fiscally a private masterplanning and urban design consultancy, Barcelona Regional primarily exists to support the city's planning functions and projects. This can be seen in its structure; the board and shareholders consists of members of the city council (the chair is the mayor), various metropolitan agencies and representatives of the Zona Franca (a large government development agency), the port, the regional rail company, and the city's wholesale market (Barcelona Regional, 2012).

In the context of both the 22@ regeneration and Districlima, Barcelona Regional brought significant knowledge and capability. The company has both project management capability for major regeneration projects and the knowledge and design capabilities to prepare major technical masterplans, as it did with the SIP for the 22@ district. As Marshall describes, "Barcelona Regional has become a significant actor in this field of metropolitan infrastructure planning, despite its limited resources. Broadly it has advocated infrastructure expansion, on the lines pushed by the strategic plans, but it has also commissioned work on ecological implications of changes in the region (see, for example, Folch & Parõ´s, 1998)" (2000, p. 309)

Tersa

Tersa, a 19% owner of Districlima, is a municipal waste company owned by a consortium of metropolitan agencies and government bodies. It operates one large waste-to-energy plant on the seafront east of the Forum. The incineration plant treats 359,107 T/year of residual solid waste and has an electric power of 23 MW and a production of 180,468 MWh/year of electricity on average (Ajutament de Barcelona, 2011). It is the primary fuel source for Districlima, with

almost all heating and a large part of cooling for the system produced using the steam obtained from the waste incineration (Districlima, 2012).

Agència d'Energia de Barcelona

The purpose of the Barcelona Energy Agency is to promote Barcelona as an exemplary city in the handling of energy matters and their repercussion on the environment. A public agency responsible to a Deputy Mayor, it has the ability to identify and plan for efficient local energy use and for the location of renewables through the city's *Energy Plan* (first published in 2002). It has a staff of five people who support plan implementation, foster energy efficiency, carry out trials, and provide information and technical support to government bodies (Barelona Energy Agency, 2012). The agency's policies are influenced by European Union thinking, but staff believe that local resident understanding and awareness is more important (InterviewG4, 2012).

Elected councillors and mayors

Marshall (2004) describes how elected councillors and mayors in Barcelona support the urban planning visions for city, continuing this role even when powers were joined across Catalonia. The research interviews support his description of how individuals 'tied' together institutions, particularly around planning and projects. As the interviewee from Barcelona Regional explained, "Our President is Antoni Vives, who is the Alderman of the Urban Planning Department at Barcelona City Council, on top of that he is also the President of Àrea Metropolitana, that means that he is directing Àrea Metropolitana" (InterviewA3, 2012). Politicians such as Antoni Vives i Tomás are elected on a four year cycle, with deputy mayorships and other such appointments made at the request of the mayor.

Districlima and Cofeley

Districlima is a specially-created public-private enterprise operating a 30 year concession from Barcelona City Council to develop and operate the DHC system (also called Districlima). Technically it is a joint venture between the public and private sector with Cofely owning a controlling stake. Its shares are split between Cofely, Tersa, the regional water company, and two government energy institutions. Cofely is a multi-national utilities conglomerate which operates 180 district cooling and heating systems globally. It also owns AGBAR, the water distribution company which supplies much of Spain and Barcelona, and through this ownership it effectively controls 70% of Districlima (Districlima, 2012; Ajutament de Barcelona, 2011).

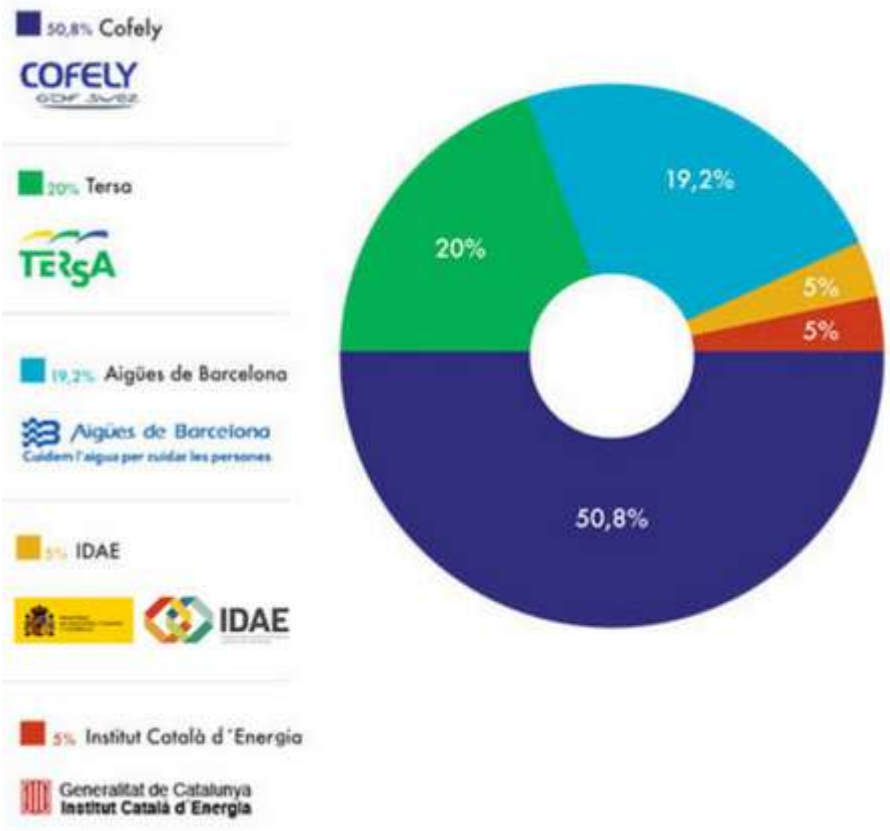

Figure 6: Founder partners of Districlima (Districlima, 2012)

Actors in the wider set

A summary of the primary actors is provided in Table 21 below. Other non-primary actors included Catalonian and federal Spanish organisations, whose engagement in Districlima is minimal due to legislative framework and politics around utilities infrastructure, with little expectation or preference for their active engagement. However the Institute for Energy Diversification and Saving (IDAE), part of Spanish Ministry for the Economy, participated in the creation of the *Barcelona Energy Plan* and is a small shareholder in Districlima (Ajutament de Barcelona, 2011). Likewise the Catalan Energy Institute (ICAEN), which is tasked with supporting initiatives and programmes for the development of energy technologies that improve efficiency (Generalitat de Catalunya, 2012).

Developers and building owners in the 22@ district run the range from large institutional organisations down to individual residential owners. Interviewees perceived them as interested in costs and management, without a preference for greener or environmental infrastructure. The Chief Executive of Districlima commented "And this guy they want cheap building. And sell it and go on. All the efficiency all that is not important. Because the benefits of the network is for the maintenance and the final user" (InterviewS2, 2012). And the former Head of Infrastructure at the 22@ regeneration company acknowledged the developer perspective they overcome: "We clashed with two important property developers but from then on, we succeeded at 22@, it was quite successful" (InterviewA3, 2012).

There a notable absence of civic actors which exist in other cases; this reflects on how the idea of district heating and cooling arose from within Barcelona's urban and energy planning technicians.

Market	Government	Civic
Districlima	Barcelona City Council	
Cofely GDF Suez	22@ BCN	
Barcelona Regional	Tersa	
	Barcelona Energy Agency	
	Barcelona Urban Planning Functions	
	Elected Councillors, Mayors	

Table 21: Set of primary actors for DHC in Barcelona

6.2 Analysis of the Actors and Actor Constellation

This section describes the self-identified and collective actor analysis. Appendix C contains the detailed stakeholder analyses matrices which are described here.

6.2.1 Where's the conflict? Self-identified actor capabilities and preferences

All primary actors self-identify as generally supportive of the concept of a DHC system. They are also all supportive for the same two reasons: belief that new infrastructure makes a modern global city, and because of environmental concerns, particularly about carbon emissions.

Barcelona City Council operated a wide-ranging leadership role; the council or its sub-committees (headed by Deputy Mayors) were supportive of DHC in the 22@ district; they approved the *Energy Plan*, the 22@ masterplan and the SIP. Elected politicians form the city council leadership, but they also head up departments individually and two were publicly supportive of DHC. The forward to the *Energy Plan* by Mayor Joan Clos describes Districlima as “A real example of our commitment to being a benchmark for sustainable and smart urban development” (Ajutament de Barcelona, 2002, p. 1).

Barcelona Regional was effectively the initiator of the idea for DHC in 22@. Their capabilities for infrastructure and DHC design are described above; the Head of Energy Infrastructure at Barcelona Regional described how the company grew its capability in district energy infrastructure by directly employing a previous infrastructure consultant. That interviewee also described how they investigated co-generation and district systems, believing that energy and environmental issues should be integrated into urban planning.

> While I was developing all the urban planning of the 22@, one of the recurrent ideas that Barcelona Regional had was we are going to provide this area, which is a technology district, with modern infrastructures. The feasibility studies were developed during many years, such as co-generation systems that could supply some blocks, a group of buildings, and we thought about the possibility of supplying 4 blocks, 8 blocks, half of the district, all the district, we were analysing different possibilities. Then we thought, hey, instead of planning a new heating and cooling system for the Forum, the best solution would be to take advantage of the synergies of the existing infrastructures. (InterviewA3, 2012)

They followed through on this in the SIP, proposing a system which connected to the Tersa waste incinerator near the Forum. This was then approved by Barcelona's Urban Planning Department and politicians in the city council. In Barcelona's Napoleonic planning system, approved urban plans are legally binding requirements on developers, and the city had a tradition of setting specific public realm and building design requirements.

In the 22@ district, the Planning Department and Barcelona Regional extended design requirements into underground infrastructure which had to be designed to a specific connection standard. The SIP reads, "The *Technical Standards* of the PEI in the annex, depending on specific situations, are legally binding in terms of criteria of actuation or recommendation." “To achieve the development of this project it is essential to co-ordinate a broad *Special Infrastructure Plan* which will act upon public areas as well as private community ones, determining surface land and underground land aspects" (Barcelona City Council, 2000). Their orientation for doing this was to ensure that new development reduced its impact on the environment, and to upgrade the district to meet the needs of a modern city. The plan also requires those private developments adding to currently extant floorspace to pay for waste, telecoms, and energy infrastructure.

The previous Director for Infrastructures at 22@ BCN described in an interview how they accepted the need for the DHC system due to rising energy costs, and that they saw it as infrastructure the city council should lead on through initial investment and coordination. “And if had not been public, we would not have had a network. This happens with all public utilities. If you analyze what happened with the electric supply, public lighting, with the sewers, the water supply, in any public utility the initiative always comes from the local public sector.” However, they originally did not have the technical capacity to know how to procure such an infrastructure, and had to seek assistance from the private sector through an 'ideas competition' (InterviewA3, 2012).

The ideas competition led to a concession approach to procurement, which was tendered to Cofeley who set up the Districlima company to build and operate the DHC system. Cofely had knowledge of how to operate a DHC system and run a business investing in DHC systems for a profit, although they expected to lose money in the first ten years of operating the Districlima system (InterviewS2, 2012). Under the concession, the company does not own and cannot sell the pipework and engineering systems. It is also limited in what price it can charge residential customers. Cofeley believes it is a good thing for cities to be using DHC systems and want to grow this business across Spain.

Later implementation of Districlima was supported by the Barcelona Energy Agency. Their *Energy Plan* explicitly promotes DHC systems such as Districlima, citing them as smart and energy in energy, economic, and environmental terms (Ajutament de Barcelona, 2002). They agreed that a concession approach was the appropriate method to fund Districlima. During the process of establishing the concession the agency was made responsible for administering price controls over DHC systems in the city. In an interview, the Technical Director described

the agency as partners with the Urban Planning Department, and how the agency would prefer energy goals to be integrated into urban planning and land distribution. “At the end the problem is not an energy problem to be solved it is an urbanism problem that has to be solved.” (InterviewG4, 2012).

What are the actors' self-identified capabilities, orientations, and preferences?

Barcelona's set of actors for DHC is robust, with supportive organisations in the public and private sectors, a low-cost fuel source and supportive local politicians. The set did not emerge overnight, but it also grew quickly as new actors were brought in through partnership and concessions. The planning department and its consultants orientation that DHC infrastructure is important to regeneration and to environmental impact established the concept. The concept of district heating and cooling was not well known in Barcelona, but this was addressed this by hiring individuals into Barcelona Regional and into 22@ BCN who did have experience planning, designing, and procuring district infrastructure.

The city’s planning powers and capabilities deliberately grew to include planning of district heating and cooling with the approval of local politicians. Politicians publicly promoted addressing environmental resource issues and built a base of expectations for the city council and city activities. The mayor's introduction to the 2002 *Energy Plan* reads "A decisive policy is required on the part of public administrations to reverse current trends in energy consumption, a policy oriented towards promoting the use of clean, renewable sources of energy, to achieving efficiency in the production of final energy and to reducing consumption by introducing technological improvements and the practice of conscientious" (p. 1).

This pattern of development through urban visions and leadership from politicians follows Barcelona's tradition of urbanisme. The existence of familiar ways of working between all actors supports the lack of conflicting preferences over each actors role in procuring DHC and an acceptance of the SIP and Districlima by other city departments, other utilities in the city, and property owners.

6.2.2 Collective perspectives: Exploring success

When the actor constellation is analysed from a collective perspective, underlying orientations about the role of the government in urban utilities provision helps to explain the low levels of conflict about actor roles and the successful delivery of Districlima.

DHC was understood as integral to the 'innovation' theme in the 22@ district, alongside other vacuum waste management and fibre optic network infrastructure (Barcelona City Council, 2000; Barelona Energy Agency, 2012). And therefore it was accepted by other actors that 22@ BCN should act as the responsible organisation to guide and coordinate infrastructure development. As part of this 22@ BCN also acted as liaison with developers in the area through the planning approvals process (InterviewS2, 2012). The former Director of Infrastructure at 22@ BCN quoted the Deputy Mayor as saying to him:

> "You should intervene in order to convince the developer about the advantages of the service and that is your job, you are the city council, explain it to them, and secondly, you should train the company to meet the needs of private customers."(InterviewA3, 2012)

The 22@ BCN did not tender the concession for Districlima; this was managed by Barcelona City Council directly (InterviewA3, 2012). The research did not uncover public concern about the investment, dissenting councillors or existing utilities in the city who were resistant to the introduction of DHC. In interviews the importance of support from the elected councillors as leaders of the city council became clearer. The council was perceived as not only committed to supporting renewable and efficient energy through policy documents like the *Energy Plan* but also obliged to by environmental commitments at a federal and European level (InterviewA3, 2012; InterviewG4, 2012). The interviews explained that while difficult to convince at first, the support of elected officials in charge of the planning process and other departments were necessary to provide the leadership and the will to make public departments work together for DHC. The planning and urban management experience of specific councillors were recognised by those interviewed, who cited the Olympic legacy as leading to knowledgeable politicians (InterviewA3, 2012).

Figure 7: Photos of Districlima pipe installation, Barcelona (Cary, [Photographs of Districlima pipe installation], 2012)

Other actors did not expect the council to mandate connection through the planning process, but they expected the council to finance the detailed design and initial investment, and direct third party energy companies through the concession (InterviewG4, 2012). Even Cofely understands the need for initial local government action to initiate DHC; "It's difficult to develop a project if the administration or somebody doesn't' put an amount of money in the beginning" (InterviewS2, 2012).

During the negotiations for the concession, it became apparent that the city would also have to protect consumers by setting the price for residential purchase of heating and cooling. A fairly significant form of regulation and new role for the city, (it was delegated to the Barcelona Energy

Agency) it is not apparent that other approaches such as a third party consumer protection organisations were seriously considered (InterviewG4, 2012) (InterviewA3, 2012). This reflects on the sense of responsibility that the city and its elected officials felt for Districlima, as well as their willingness to intervene in utilities infrastructure in support of environmental and social goals.

Barcelona's Urban Planning Department was perceived by others as the initiator of the concept, with an ability to draft the energy plan, set efficiency standards for new buildings, and raise money through an infrastructure levy (InterviewA3, 2012). Others elaborated the need for them to be involved; to plan out the system in line with the urban growth proposals and introduce potential users of the system with the DHC concept during the development phase (InterviewG4, 2012). With Barcelona Energy Agency and Barcelona Regional, other actors recognised their capabilities and their role in developing the DHC system, but did not show an awareness of their strong orientation towards the future potential of DHC in Barcelona (InterviewS2, 2012).

Tersa, the provider of heat and 20% owner of Districlima, were understood to be responsible to the metropolitan government, rather than the city council. Despite this, there was no mention of difficulty or conflict in bringing them into the system through a heat transfer agreement with the city and then with Districlima. The former Director at 22@ commented, "Finally we reached an agreement. It was more a political agreement than a business agreement." Their partial ownership of Districlima was explained as a public statement of partnership and support for the concession (InterviewA3, 2012).

Cofely were perceived as a safe partner to create and operate Districlima; they were not technologically aggressive with the DHC system design, but they were financially sound and already invested in Barcelona through their ownership of the water company. This existing presence was seen as relevant to the success of Districlima, and one of the reasons why they won the contract to operate the concession (first at the Forum, and then for the extension) (InterviewA3, 2012).

Districlima itself was recognised as bringing environmental improvements, such as the use of waste energy, reduction of greenhouse gases and refrigerant losses, and reduction in noise and vibration. It was accepted that it required public investment to start, but that once built it would offer consumers lower prices than other ways of heating and cooling. The concession is for 30 years and interviewees voiced an expectation a concession approach will be continued after that (InterviewA3, 2012) (InterviewG4, 2012).

The collective strategy of market influences, regulation, and interventions also characterises the 'market' for DHC in 22@ that is strongly shaped and regulated by Barcelona City Council. The city regulates DHC in all four of Tiesdell and Allmendinger's classifications. Direct regulation is supplemented by different activities from other city departments, such as the Planning Department and the Energy Agency. The city council through the Planning Department regulates what it can (the design of shared services) and incentives what it cannot (the

connection and supply). There is a wide spectrum of actors engaged in 'market regulating' activity; regulation was 'created' by the city to protect citizens and assist the arms length partnership of Districlima.

Overall the collective strategy analysis finds relative alignment between expectations and actual actions of market influences across the actor constellation; this parallels the actor analysis above which also describes low conflict on expectations. Differences do exist. One is where Barcelona Regional established the concept of DHC in the SIP and MGMP; this is not normal practice in masterplanning in Spain and was a new form of market shaping influence that would have not been expected by other actors. Secondly, Barcelona City Council does not regulate development as much as Districlima would like it; Districlima would prefer for the council to mandate customer connection to the system (InterviewS3, 2012).

An extension of existing governance patterns into urban energy infrastructure

The Districlima approach to DHC where the planning process established a design and energy vision for DHC as well as regulated development to build and pay for it, with the city council supporting investment, was established early on and accepted by others in the actor set. The actor set as whole saw energy infrastructure in regeneration as part of urban design, as part of the importance of getting the built environment right for Poblenou.

Therefore other actors accepted that the Planning Department should not only establish the concept but regulate the market through control of land use and urban design as well as design for infrastructure connections, and they accepted that the department's involvement was necessary to link urban growth and to influence customers during development control.

For Barcelona, taking on the responsibility to build DHC is an extension of traditional ways of thinking about city development; an extension of urbanisme. If Maragall's message was 'It is critical to understand that improving public spaces is relevant to solving social and economic problems' then the legacy of his message in the context of DHC is interpreted as 'it is critical to understanding that improving infrastructure and public spaces is relevant to solving social, environmental, and economic problems of the 21st century.'

How can the actor constellation be described?

There is a notable consensus about a role for public leadership in DHC extending beyond establishing an energy and infrastructure plan. It was expected that public investment was needed to initiate Districlima, with initial infrastructure paid for the city. Within this consensus there were several orientations within Barcelona government departments which influenced their strategies and actions about DHC, as well as their preferences for other actors. On one hand, Barcelona's city commitments around environment and carbon goals are expressed by local politicians as the main driver for Districlima, and the impetus for the Special Infrastructure Plan and the concession to Cofely (Ajutament de Barcelona, 2002). On the other, socialist political orientations of the mayors contributed to their support for urban investment and public sector leadership on infrastructure (InterviewA3, 2012). The system is also price regulated to be cheaper than a reference case for residential customers – clearly a political benefit to elected

officials. Finally, the SIP also raised money from private developers for a range of infrastructure benefits to the area's regeneration; not just DHC but also telecommunications, water, and waste infrastructure. The regeneration approach that delivered Districlima also delivered other political and physical benefits.

Figure 8: Arial photograph of Tersa Waste Treatment Plant (Tersa)

6.3 Interactions: Positive Coordination Negotiations

How can the interactions be characterised?

The process of procuring the Districlima concession was through negotiations, both formal tendering, and some open dialogue. However those interactions were supported by other interactions which included more hierarchical and unilateral exchanges. For example, the requirement for developers in the 22@ district to contribute funds towards infrastructure and build to a set of design requirements for utilities connection underground is a hierarchical market regulation intervention; this is based in the Spanish planning law.

Using Scharpf's characterisations of negotiations described in Chapter 4, the tendering process for the Districlima concession can be characterised a positive coordination negotiations, where the actors recognise the risks and costs, but also the potential benefits. Cofely accepted that Barcelona City Council could not force connection, but was attracted by the Forum centre as a main customer, the existence of the Tersa agreement for low cost heat, and the planning law which supported potential connections. These positive coordination negotiations were supported by a side 'package deal' to control the impact on cost of energy for residents.

What are the relational characteristics?

The interviews indicate close, regular communication and high levels of information sharing between the Planning Department, advisory consultants, the 22@ BNC and the Barcelona

Energy Agency. The relationship with Districlima, Tersa, and local elected officials appeared more formal but that could be a function of the time which has passed since the concession began.

The interviewees describe how in the run up to the concession agreements the exchange of information was controlled in two ways. One, in that the city council hosted an 'ideas competition' to facilitate sharing of knowledge and discussion prior to the formal tender – this assisted in forming expectations and preferences before formal negotiations.

> We told the world market "Gentlemen, we would like to create a network of central heating and cooling but we do not know if the business plan it's going to work and how it should be done." Thanks to the idea competition we realized that we could not go for the "all-or-nothing" approach. In this competition we received about twelve or fourteen bidders, and three or four of them were very good. (InterviewA3, 2012)

The initial decision to host an 'ideas competition'- a space to discuss the system among a wide potential actor set without engaging in negotiations provided knowledge and capability to many actors and influenced their preferences and strategies. Secondly, the tendering process followed a legally mandated structure, which limited communication. The former Director of Infrastructure at 22@ said "We've had some meetings but not a lot because lawyers are really strict with the level of information that you can provide, they want all the people are in the same situation in the moment of the competition" (InterviewA3, 2012). The ideas competition facilitated the formal negotiation process because it focused the formal negotiations on the costs and risks of a few options.

6.4 Conclusions: Urbanisme Delivers

Distinguished from other Mediterranean cities by relatively cool summers and from other major European cities by relatively warm winters, Barcelona is not a location which climatically lends itself to large scale district heating or cooling systems. And yet that is exactly what the city set out to implement in a large scale urban regeneration project, believing that building a modern infrastructure was crucial to its regeneration goals.

In seeking to build a DHC system in Barcelona the actor set emerged from and relied on a local tradition of strong urban planning and political support of physical infrastructure investment to influence developers and other municipal organisations. Together this enabled the city to assemble an attractive package for potential concession and overcome the high cost of installation. Burdett, Colantonio and Taylor provide the following analysis in a 2010 LSE conference paper.

> The value created through these changes (creation of 22@ and 7@ with higher densities allowed) has been so effective at stimulating private investment that the €180 million infrastructure investment plan (including subterranean services, fibre optic networks and a centralised heating system) has been financed almost entirely through private investment, and much of the urban transformation has been

pursued by the private sector. (Barcelona: Global repositioning of an emerging metro. Conference paper. LSE Series.)

And one result of this forward land use planning activity is the Districlima system; the first urban energy distribution system developed in Spain for heating, air conditioning, and sanitary hot water. As of 2012, the system has over 13 km of pipes connecting 67 buildings and it continues to expand. In 2010 the primary energy savings of the system compared to a conventional individual boiler and air-cooled chillers approach was estimated at 56.6 GWh, a 57% reduction; the same comparison on carbon estimated a savings of 10,119 tonnes of carbon, a 63% reduction against conventional approach (Ajutament de Barcelona, 2011).

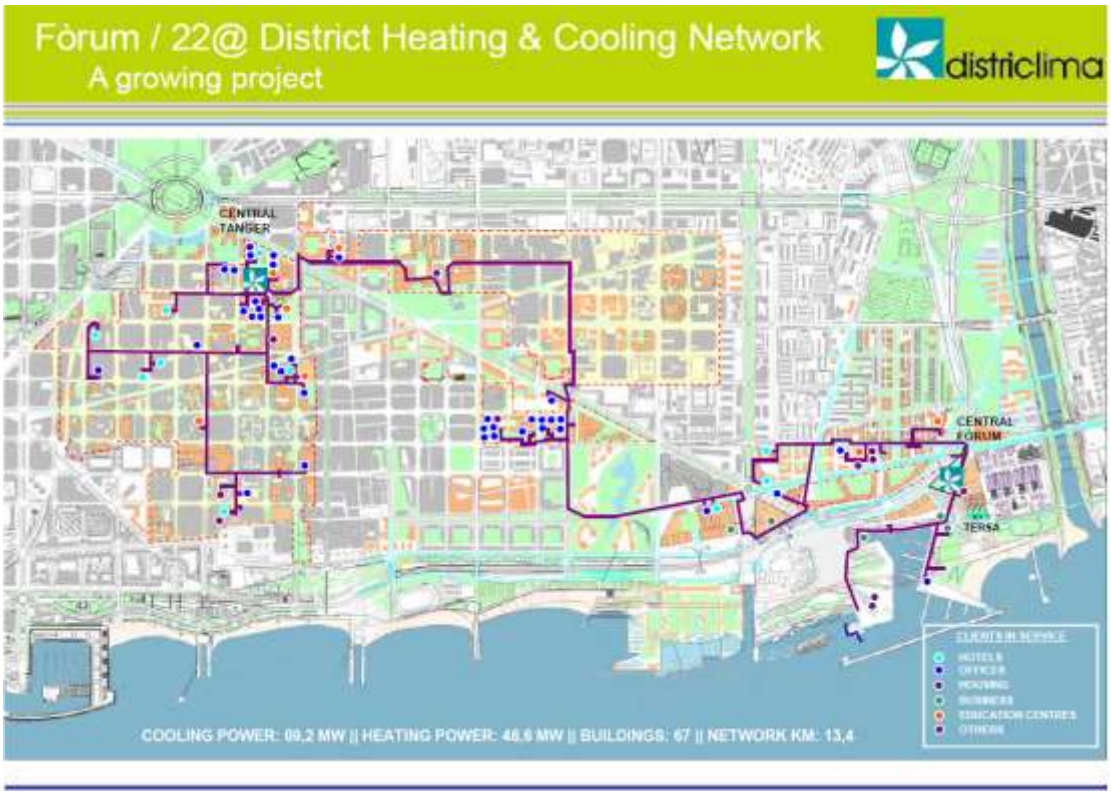

Figure 9: 22@ Districlima district heating and cooling system in 2012 (Districlima, 2012)

Is this network governance?

Returning to Sorensen and Torfing's definition of network governance, the set of interactions described in this chapter meet their five aspects. There is a stable, horizontal articulation of actors with the same people and organisations involved over time. The organisations are interdependent but operationally autonomous; the analysis above describes how they need one another to build the system and recognise each other's capabilities and responsibilities. The strength of the urbanisme tradition as a 'cognitive framework' reduces conflicts of expectation and supports public leadership and initial investment. The network of actors is self-regulating through the bespoke concession contract and by developing price controls for residential consumers. And last but not least DHC is pursued as a environmental goal, helping the city reduce its carbon emissions and improve air quality. The former Director of Infrastructure in the 22@ regeneration company confirmed: "The city council decided to support central heating and cooling systems, with all the benefits that this implied, because it also had a positive

environmental impact." (InterviewA3, 2012). The ideas competition is notable for providing a space for the governance network to neutrally explore options, focussing the final negotiations.

Marshall argues that Barcelona has not seen a full transition to 'governance' away from state legitimacy compared to US or UK policy conditions (Urban Planning and Governance: Is there a Barcelona Model?, 2000) although he admits that the transition is most visible in strategic planning and has also affected the reality of the urban development schemes of the 1990s. The analysis of this case supports the mixed picture Marshall describes, with a local government unable to take unilateral action but easily able to envision, initially invest, and lead on a major infrastructure project without significant conflict, public concern, or disagreement.

How can the role of planning be described?

Planning organisations and planning interventions play a strong role in the formation of Districlima. The Planning Department and Barcelona Regional initiated the idea of DHC, indicated physical locations and a system design in formal policy and in the area masterplan, a market shaping intervention which coordinated land uses, new development, and energy sources. Through development control processes the Planning Department and 22@ BCN regulated the design of buildings to support DHC, instituted an infrastructure levy which raised funds for infrastructure investment, and encouraged connection in dialogue with building owners and developers; these are both market regulating and market shaping functions. The planning processes and organisations also play a mild capacity building role by using the policy setting process to establish an awareness of DHC. The capacity of the actor set to use planning organisations and interventions to support DHC is shaped by the history of strong urban planning and urban design in Barcelona; the actor set's institutional setting. The influence of this tradition cannot be understated, as the former Director of Infrastructure commented

> So, even if Pasqual Maragall was no longer in charge, the local team shared his sensitivity and this allowed us to… because this sensitivity is not easy to find, because it is all about investing public money in something that you don't know whether it is going to work or not, but this is a socialist stance, which considers infrastructure, energy and urban planning are mechanisms to improve the city, this is what made it [DHC] possible. (InterviewA3, 2012)

Chapter 7. Burlington: The Challenge of Moving from Talking to Negotiating

In 1978, voters in Burlington, Vermont, authorized its municipally owned electricity company to build a wood fired electricity power generating station adjacent to the city centre. Since that time, the idea of using the McNeil power station's waste heat to heat downtown buildings, or the nearby hospital and university, has been explored with little success.

Vermont is a city which prides itself on environmental consciousness, and city municipal plans dating back to 1985 mention the possibility of 'community energy' arising from McNeil. A 2012 *Burlington Climate Action Plan* also lists 'implementing the McNeil District Heating project' as the fourth most effective carbon emissions avoidance strategy for the city.

Then in 2007, a group of citizen-volunteers formed the Burlington District Energy Service (BURDES) committee, and restarted previous investigations into taking advantage of the underutilized heat from McNeil. They commissioned an experienced consultancy, Ever-Green Energy, to help them understand the options and to engage with local residents, potential customers, councillors, and city officers. Ever-Green Energy produced a detailed report in 2011 and hosted a series of workshops with relevant stakeholders with the BURDES committee. However, the current political climate is uninterested in investing public funds in utilities, and as of September 2012 the project seemed to have stalled yet again.

Figure 10 establishes the history of attempts to establish a district heating system in Burlington.

Timeline of Burlington Case Study	
1981	Joseph C McNeil generating station begin burning wood to generate electricity. (Burlington Electric Department, 2012)
1985	Burlington Municipal Development Plan mentions heat generation capacity of McNeil (Eldridge, Municipal development plan, 1985)
1991	Burlington Municipal Development Plan says that the city will establish a district to be served by a mini-utility system from McNeil (Eldridge, 1991, p. 85)
1994-1998	Early studies on the potential for district heating from McNeil conducted (Ever-Green Energy, 2011).
1998	City Council resolution to reduce our emissions to 10% below 1990 levels and the creation of the first climate action plan (City of Burlington, 2012).
2000	City's first Climate Action Plan adopted (City of Burlington, 2012).
2001	Burlington Municipal Development Plan says that Burlington Electric Department is studying the feasibility of district heating and cooling. (Eldridge, 2001, pp. VIII-4).
2002	Further study on district heating (Ever-Green Energy, 2011).
2007	Formation of the BURDES committee (Burlington District Energy Service, 2012).
2011	Burlington Municipal Development Plan 2011 continues to promote district and heating and cooling served by McNeil (White, 2011).
	Report by ever green energy published, accompanied by 5 workshops (InterviewC2, 2012).

Figure 10: Timeline of Burlington case study

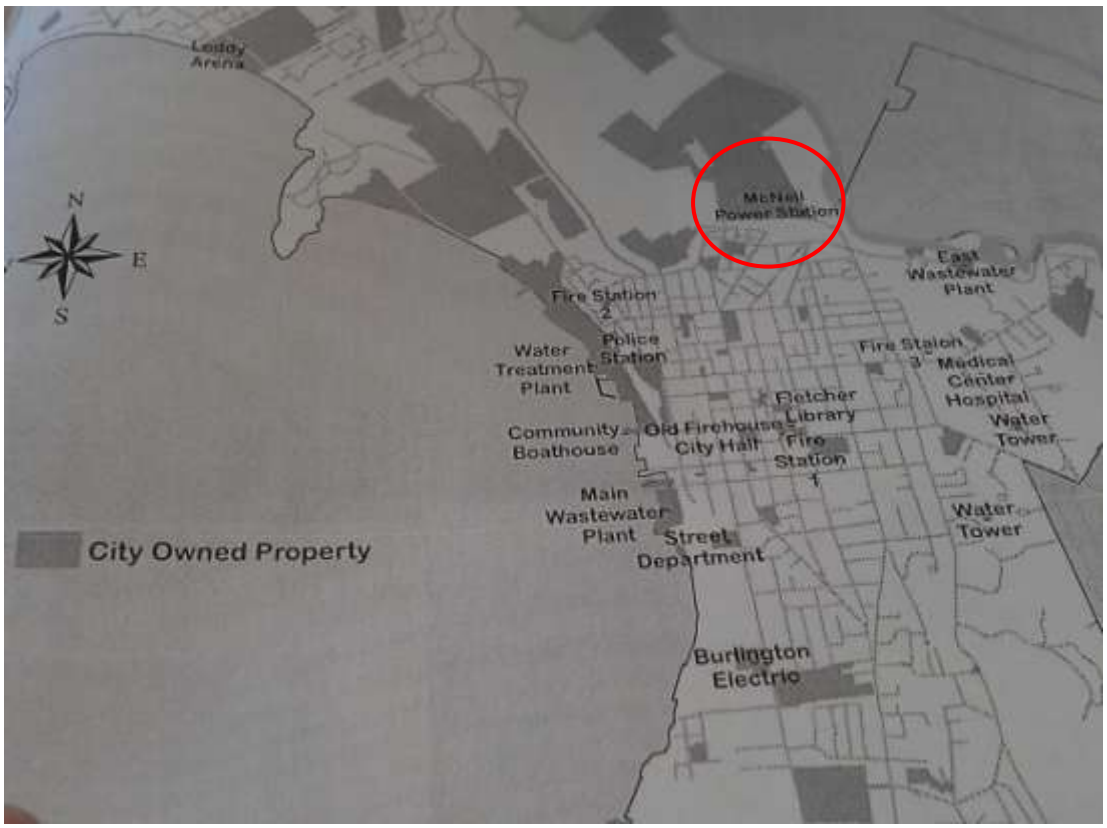

Figure 11: Municipal Development Plan showing location of McNeil Power Station, from a photograph of the 2001 Municipal Development Plan, taken by researcher in 2012

American planning and government institutional capabilities

Burlington is the largest city of the state of Vermont, located in the north eastern 'New England' region of the United States of America. In 2010 the city had a population of 42,400, with a 10,000 plus transient student population attending the University of Vermont. The city is a hub of a recognised economic area with a population of just over 200,000. The University and an associated teaching hospital are the main employers in the area.

The state of Vermont has a reputation for being politically progressive and activist, particularly concerning issues related to the environment. Burlington residents also have a reputation for being environmentally minded; two of the interviewees agreed, and felt that the interest was less about self-reliance or climate change and instead linked to concerns about pollution, wildlife, and wasting resources (InterviewC3, 2012; InterviewC2, 2012).

Relationships between local, state, and federal (national) government vary considerably across the United States; several political science research strands evaluate and describe the multi-level relations of environmental management across the US (e.g. Lowry, 1992 and Lester, 1995). On paper, federal powers enumerated in the US constitution are centred on fiscal, military and trade regulation issues. In practice, both the federal courts and federal control of fiscal redistribution have given the federal government additional powers on topics such as pollution and energy prices. The state level has significant control of energy, environment, business and daily life through regulation, incentives, and tax breaks, although state governments are fiscally constrained by statutory limits on borrowing and tax revenue.

Local government in Vermont follows 'Dillions Rule' whereby the local government is legally subordinate to the state government and whose powers are explicitly defined by state government. But this is far from a blanket hierarchical relationship; local governments are often given freedom to act outside their state mandated activities and are subject to significant influence by local politicians, particularly in the case of council-mayor municipal structures (as in Burlington) which emphasize local politics and mayoral powers. Peters and Pierre describe how local government in the US has significant governance potential, "given that it is able to govern both through traditional command and control techniques and through the less conventional formats associated with governance" (1998, p. 240).

A parallel institutional structure exists for land use planning in Vermont, with limited federal control (the 'taking clause') (Schmidt & Buehler, 2007) and enabling state legislation – linked to funding grants - providing local municipalities with mandatory but wide-ranging authority to act on land use, transport planning, and a limited range of other land use topics including energy. Vermont is relatively unique in the US in having legislation (Act 200 of 1988) which restricts large scale development outside urban centres in the name of landscape protection; this reflects the state's environmental activism. At a local level, planning is institutionally separated from mayoral or political influence, with municipal planning policies and zoning codes developed by a municipal planning commission comprised of appointed citizen volunteers and approved by vote (Vermont Land Use Education and Training Collaborative, 2007). The development approvals process is carried out by a further separate volunteer commission in Burlington (City of Burlington, 2012). While planning is a public process, the policies are not approved by politicians and individual development approvals tend to be quasi-judicial with controls over public or political intervention (Davis, 2011).

7.1 The Actors, and the Absent Actors

This section introduces the primary actor set in Burlington's attempt to establish district heating (DH), describing the institutional setting, resources, and capabilities of each actor. Appendix C contains the codes and information sources which provided this understanding of actor powers and capabilities.

The City of Burlington

Burlington's local government is council-mayor form of government, where the mayor has the authority to carry out laws and ordinances, veto proposed municipal legislation, appoint department heads, recommend policy, prepare the annual budget, and chair the board of finance. The mayor is elected on a three year cycle. The council, in turn, has the authority to set city policy, pass legislation (subject to mayor's veto), approve the mayor's budget, and set the annual tax rate (InterviewC3, 2012). There are 14 elected councillors across seven wards who serve either three or two year terms. The city can raise money for investment in infrastructure through bonds (InterviewP4, 2012).

The city government has three departments or divisions which were identified as relevant for the creation of a DH system: the Community and Economic Development Office, the Planning and

Zoning Department, and the Public Works Department. The city operates its own electricity supplier, the Burlington Electric Department (see below), as well as its own local broadband network. The latter was poorly structured and lost the city a significant amount of money, lowering the Burlington's credit rating and its ability to borrow funds for other projects. The political fallout from the broadband issues resulted in a Democratic mayor being elected in 2012, and as a local journalist commented "made the public skittish about how much the city should be engaged with utilities and the duplication of private enterprise" (InterviewC3, 2012).

In 2000 Burlington published a *Climate Action Plan*, which was updated and adopted by the city council in 2012. Included in this is a graph of the 'carbon abatement value' of efficiency options, with the McNeil DH project listed as option 'D', behind new construction energy standards and low-cost energy retrofit loans (City of Burlington, 2012, p. 17).

Planning Department

Burlington's Planning and Zoning Department is structurally separate from other city departments and the department head is appointed by a citizens committee, not the mayor (InterviewP4, 2012). In accordance with state legislation, Burlington prepares a *Municipal Development Plan* every five years (White, 2011). As an example of the extent of state control over municipal action, municipal plans are required to include an energy plan to be approved by the regional planning commission. Without state approval of the plan the municipality is not eligible to receive municipal planning grants through the Vermont Department of Housing and Community Affairs (Vermont Land Use Education and Training Collaborative, 2007).

Since 1985 Burlington's municipal development plans have included explicit reference to district heating using waste heat from McNeil (formerly known as 'community energy') (Eldridge, Municipal development plan, 1985). The plans encourage city departments to get involved if feasibility studies justify their engagement. The *2011 Municipal Development Plan* reads as follows.

> BED, in conjunction with the Department of Public Works, continues to investigate the feasibility of developing district heating and cooling, or now known as "Community Energy," within portions of the city. Areas under evaluation begin with the institutions on the Hill (UVM and FAHC), but could later include the city center and waterfront. Although not under consideration at this time, the concentration of industrial land uses along Pine Street may make this area another attractive location to provide this type of service.
>
> The concept for community energy is to replace natural gas and fuel oil as heat sources with hot water. Such a plan will utilize excess city water capacity, combined with energy and excess heat produced by McNeil Station, with an expansion to possibly include a small gas turbine in a later phase. Energy would be distributed underground to either heat or cool buildings within the district. If feasible, district heating and cooling is expected to provide a viable energy alternative, make use of existing water capacity, diversify the city's energy mix, and make the city a more attractive and competitive location for business.

> Establish an energy district if justified by the positive result of BED's feasibility study of district heating and cooling. Lead agency: BED Secondary: Public Works. (Muncipal development plan 2011)

Potential customers

Two large institutions located within two miles of McNeil have historically been suggested as 'anchor loads' or primary customers whose large energy demands can support initial investment in the pipes and connection infrastructure of DH (Eldridge, 2001; InterviewC2, 2012). The University of Vermont operates a large campus adjacent to the business district with over 11,000 students each year. The University's website states that it is "strongly committed to conserving electricity, fuel, and water as part of its goals to become the "leading environmental university of the nation" (University of Vermont, 2012). Fletcher Allen Hospital is located slightly closer to McNeil and is both the major local hospital with 562 beds and the teaching hospital linked to the University (Fletcher Allen Hospital, 2012).

Citizen activists - BURDES Committee

The Burlington District Energy System (BURDES) Committee is a group of citizen-volunteers who are committed to taking advantage of the underutilized heat from the McNeil power station. Their explain their interest as follows:

> There is enough underutilized heat available from McNeil to heat most of the buildings in downtown Burlington with very little additional energy required. This would mean we could shut off all the furnaces, boilers and hot water heaters in downtown Burlington - homes, businesses and public institutions - and provide the heat to these buildings from the underutilized energy that is now expelled into the atmosphere at the McNeil Station. (Burlington District Energy Service, 2012)

Founded in 2007, the group includes former electric commissioners, the manager of McNeil station, interested residents, and representatives from Burlington's Community and Economic Development Office (Burlington District Energy Service, 2012). They have raised grant money from foundations and funds to do technical feasibility studies, meet regularly, and have hosted discussions with potential customers and local politicians to share the idea and potential of district heating (InterviewC2, 2012).

Burlington Electric Department (BED)

The city operates a local electricity distribution network serving almost 20,000 customers, called the Burlington Electric Department. BED is a municipal department of the city, governed by a five-person board of volunteer commissioners, who in turn are selected by the city council and mayor (Burlington Electric Department, 2012). BED is also partial owner of the McNeil Generating Station, a 50MWe wood-fired generating station located adjacent to downtown. One of the world's largest wood fuelled energy generating facilities, McNeil was constructed in the early 1980s following the 1970s' energy price spikes in the USA (Burlington Electric Department, 2012); it was built with the physical capability to supply a district heating system (Baird, 2011). McNeil's ownership is split between BED and other utilities; BED owns 50% but

does not have sufficient power to unilaterally make major decisions about the future of the McNeil Generating Station. (InterviewC2, 2012).

Figure 12: Photograph of McNeil Generating Station (Cary, 2012)

Ever-Green Energy

In 2010 BURDES appointed Ever-Green Energy to advise on the technical feasibility of a heating system and the potential organizational structure. Ever-Green Energy are a non-profit consultancy associated with a community biomass scheme in St Paul, Minnesota; they exist to promote efficient district heating or cooling systems. They were hired by BURDES to evaluate and promote options for DH in Burlington (InterviewA4, 2012). Their work in Burlington was funded through a $70,000 federal stimulus grant (Baird, 2011).

Absent actors

A comparison of Burlington's primary actors for DH with other case studies highlights there are three categories of actors who are potentially absent from participating in discussions about district heating in Burlington: local elected representatives, and state, or national (federal) actors. The absence of local elected officials can be partially explained by their weak stature in Burlington's mayor-council government, but their absence from active participation in what is generally accepted to be an ‘environmentally minded’ town is noticeable.

State government agencies are not primary actors, being neither directly nor necessarily active. Interviews with the BURDES committee (InterviewC2, 2012) and a local journalist (InterviewC3, 2012) indicated that the primary actors saw state agencies as loosely supportive and interested, with a minor role envisaged was through a regulatory function - the approval of a DH system as a ‘public good’ utility and potentially as a customer of the DH through state owned buildings. The state government owns a number of office buildings in downtown Burlington and has a 2020 target to be on renewable fuel for those buildings. Federal agencies are also absent;

interviewees suggested national policy focused on electricity distribution at the large scale to the detriment of district heating and cooling (InterviewC2, 2012). The Vice President of Ever Green Energy explained, “Energy policy in the US is primarily focused on the electric sector to the exclusion of all else" (InterviewA4, 2012). Another potential reason is more institutional: the lack of federal energy planning in the USA discourages incentives and regulation for DH at the state and local level.

Market	Government	Civic
Ever-Green Energy Consultants	City of Burlington: Community Economic Development Office	BURDES Committee
FA Hospital	City of Burlington: Planning Department	University of Vermont
City of Burlington -BED		

Table 22: Set of primary actors for DH in Burlington

7.2 Analysis of Actors and the Actor Constellation

This section describes the self-identified and collective actor analysis. Appendix C contains the detailed stakeholder analyses matrices which are described here.

7.2.1 Self-identified actor capabilities and preferences

Turning to understand how the actors understand their role and each other, the self-identified actor analysis finds that on balance the actors in Burlington understand the benefits of DH, but none of the actors prefer to connect or prefers to build a DH system. There is a level of shared orientation about energy use and the potential for DH in Burlington, but this not matched by any self-identified preference by any actor to provide or develop DH or an explicit preference to purchase heat from such a system by potential customers.

As an example, the City of Burlington is represented in the primary actor set by its Community and Economic Development Office (CEDO) which has a representative participate in the BURDES working group and has provided small funding to support the group (Burlington District Energy Service, 2012). While BURDES felt that previous CEDO representatives contributed political knowledge and astuteness to the BURDES activity (InterviewC2, 2012), the department does not have a responsibility to look at energy or infrastructure needs except from an economic perspective and it was not intending to lead on the creation of a DH system.

The two potential major customers, the university and the hospital, have participated in conversations over many years about the potential of DH. But according to the BURDES committee, to date their facilities managers have preferred to operate a gas or oil fired heating systems within their respective campuses and have not accepted the economic or environmental cases for connecting to a DH system fuelled by McNeil.

The Planning Department has supported the concept of district heating in the city plan since 1985, calling more recently in plan to “Establish an energy efficiency district where appropriate; a ‘mini-utility system" that serves the electrical and thermal energy needs of one or more energy users and is scaled to match demand." (Eldridge, 1991). But as described above it does not

have the legal powers or technical capabilities to engage in negotiations with other actors who might build a DH system. Additionally, because of the organisational and legislative separation between planning and other city departments, the department does not feel it can influence city investment. The legal context of planning in the Vermont does not make the city plan legally binding, and the plan also does not determine city departmental spending. Therefore, the department sees itself as an independent ideas generator, but not as an organization that can bring other organizations and individuals together to make those ideas happen. The Director explained, "We spend a lot of time talking to people and thinking about what are some of the big ideas that we in the community out to be concerned about. And new ideas that we ought to be thinking about, how we might incorporate them here. And kind of facilitating those ideas moving forward." (InterviewP4, 2012). The Planning Department does not require new development to consider connecting to a potential DH system; it is unclear if it has that capability. The lack of major regeneration or growth near the power plant – which the city could leverage to support DH – also hinders the capabilities of the Planning Department to support DH.

The research was not able to uncover what BED preferred to do about McNeil's heat, but the organization supported previous investigations in to a heating system. As a company who exists to distribute electricity on behalf of its customers, it does not have the organizational mandate or expertise to undertake a DH system (Burlington Electric Department, 2012). McNeil's plant manager described how the shared ownership of McNeil has limited BED's interest in reusing the waste heat from the power plant.

> One thing about McNeil is that its jointly owned by several utilities. Burlington Electric owns 50% and operates the facility, but they still have to listen to the needs and wants of the other owners. Some of those are public, and some of those are private. And they have quite different priorities. The private utilities are not as interested in doing things like district heating, they just want things that will be good for their stockholders. It's an interesting balance. (InterviewC2, 2012)

BURDES exists as a citizens activist committee to promote the idea of a DH system with major potential customers such as the hospital and after several years of discussions it feels capable of performing a capacity building and promotion role. A representative commented "I'm feeling very good about where we are in terms of our understanding..." (InterviewC2, 2012). The group takes a medium-term, balanced viewpoint on the likelihood of building DH; recognising both economic and environmental benefits to the city. And while the group understands that building a DH system will require interested customers, political will, and potentially a third party energy company, it also recognizes that it does not have a preferred vision for how to bring all those actors together. A representative commented,

> We never got to the point of who would own it. Burlington Electric was promoting it, but operating it: never clear if property of city, or Burlington Electric. Some examples in the country have done it all those ways.
>
> Right now, based on what we now understand, the electricity department is going to provide the thermal energy and they will own the equipment to do that. But the district heating utility, whether its public or private, will somehow help fund, get the money from the

> electric department, to be able to provide the thermal energy. Maybe we won't have these long term contracts and we will get loans, part of the money to the electric department to building the connection, but I think it's going to be a separate utility whether its public or private. Whether its not-for profit or private we don't know yet. (InterviewC2, 2012)

BURDES sought the advice of Ever-Green Energy, a consultancy experienced in DH. In the self-identified actor analysis, they were the only actor that had a specific vision for how DH could be built out of McNeil and who should be involved. Given their background, Ever-Green Energy actively preferred a community-owned non-profit DH system; they saw this governed jointly by residents and politicians. When interviewed, the Vice President of Ever-Green Energy confirmed that they had the ability to evaluate legal, technical, and financial options for DH. Their 2011 report concluded a DH system could be built in Burlington that would provide cost-effective heat as well as a good return on investment. "This study concludes that there is an opportunity to supply competitively-priced, renewable energy from McNeil Generating Station via a district system at current and projected natural gas and heating oil prices in Burlington" (Ever-Green Energy, 2011, p. 3).

The Vice President interviewed believed that the next step in building a DH system was to engage with residents and politicians, starting with the benefits of DH: re-using waste heat, the creation of jobs, and the power of locally controlled energy (InterviewA4, 2012).

> When I say people, I'm talking government officials at a council level and at a mayoral level, councillors and their staff – help to understand why it's important, what the benefits are. And once you get them enlisted and they understand the very basics of why district energy is a misunderstood or out of their normal frame of reference, show them why that infrastructure is worthwhile and useful and can promote community development. Then you can take it out to a wider audience. (InterviewA4, 2012)

What are the actors' self-identified capabilities, orientations, and preferences?

All five interviewees recognize the lack of customer demand and the absence of political engagement as constraints on further progress. BURDES and Ever-Green Energy were actively trying to bring them both into a discussion by hosting workshops and public meetings and by meeting with individuals to discuss potential. The lack of local politician interest and support was perceived as the biggest challenge to overcome because of the recent broadband utility failure which dampened local political interest in government owned utilities.

Looking across the actors, the ACI analysis suggests that none have sufficient powers, capabilities or resources to negotiate for DH with; they can discuss options and engage others but they cannot build the a DH system with the current actor set and its limited resources. Particularly noticeable is that while one local government department was actively engaged in the BURDES committee and despite the city's history of owning energy distribution companies, there is no orientation within government departments to lead on the negotiations to build a DH system. This could be due to the orientation of local politicians who tightly control the activities

of the local government, or to a lack of interest by Burlington's government departments as they would be unlikely to directly benefit.

7.2.2 Collective perspectives: A network with gaps

The collective actor analysis continues to display this trend of uncertainty about preferences for delivering a DH system; all actors are aware of the environmental benefits but the commercial logistics and business case were found to be unclear in actor minds. Collectively, the actor set did not agree who should or could lead or own a DH system in Burlington.

For example, BURDES is perceived by other stakeholders as a group of people committed to making DH work in Burlington; the local journalist felt that given the relatively small size of the town a small group can have influence (InterviewC3, 2012). All actors interviewed were aware of their presence and their attempt to pull together people to discuss and learn about the potential for a DH system. However no interviewee suggested BURDES should initiate a company to own or manage a DH system on a community basis. The same was felt of the BURDES advisors, Ever-Green Energy; they were seen to bring useful technical input, but not as active initiators of negotiations to build a DH system.

The collective analysis also shows that Burlington Electric has a good reputation as an electricity distributor among the other actors. Its ownership of McNeil is seen as positive for the future potential of DH; with a caveat that BURDES recognised their control is limited given the other joint owners of the station (InterviewC2, 2012). A consensus among all interviewees was that Burlington Electric's support would be necessary to make DH happen, but they were not perceived as an organisation which would operate the DH system. Older feasibility studies indicated this as an option. But the most recent Ever-Green Energy study saw their role as supportive owner of the fuel source but not in control or managing the pipe network and billing operations (Ever-Green Energy, 2011). McNeil's plant manager is also hopeful that with recent changes to the ownership of the McNeil Generating Station, BED will become more actively supportive of re-using the waste heat from the power station (InterviewC2, 2012).

The collective actor analysis of city government support further illustrates the lack of power and negotiative influence of government departments. The CEDO office in Burlington's local government is seen by others as under the direction of the mayor, and as a potential source of funding for the coordination of discussions about a DH system (InterviewC3, 2012; InterviewC2, 2012). Interviewees recognised that mayoral or further city support would be needed before they could do more than attend meetings and support feasibility studies. The BURDES representative commented, "We know the guy who runs the public works department, if the city If the city wanted to take it on it would make a hell of lot of sense. They already have the expertise in house. But it isn’t at all obvious that the city has the stomach to do this" (InterviewC2, 2012). In contrast to its self-identified role, in the collective actor analysis the Planning Department is not seen by other actors as engaged in the promotion of DH. When asked, other interviewees acknowledged that the Planning Department had included the

concept in the plan and would need to be involved to manage rights of way for pipework in the street.

Interestingly, the two potential customers are perceived by BURDES to be at the point of potentially changing their mind about connecting. Historical discussions with the university and the hospital had not been positive due to technical barriers and concerns about significant changes to estate engineering departments (InterviewC2, 2012). Therefore the 2011 study had prioritised a route which sought out multiple downtown businesses as customers before reaching the university and the hospital. But the same report had highlighted that if either the hospital or the university (or both) to be long-term anchor tenants and committed to purchase heat, this which would give certainty that up-front investment in pipework could be repaid. The report also concluded that the heat could be provided 30% cheaper than their current gas supply (Ever-Green Energy, 2011).

The BURDES committee representative said that recently they heard of renewed interested in a DH solution from the university and hospital, after staff changes within the facilities teams and after the university purchased additional buildings (InterviewC2, 2012). Therefore BURDES is seeking to re-engage with the university and the hospital, approaching various employees about DH. "There are some personnel changes at university which makes it sound like they'd be more open minded and willing to do something like this." (InterviewC2, 2012).

Market influences: Pushing and pulling a system into life

The collective strategy analysis of market influences, regulation, and interventions confirms that the strongest market intervention to date is the capacity building by BURDES and their consultants, Ever-Green Energy. There is a marked absence of medium or significant influence through market mechanisms such as taxes, regulation and grant stimulation; to date such interventions have been in support of feasibility studies. Both BURDES and the planning department see their roles as having medium-levels of market shaping interventions by introducing and supporting the idea of re-using waste heat from McNeil.

Significantly, in all four categories of market interventions mapped by this research there is a gap between expectations of other actors and actual implementation. This illustrates that, while actors perceive they could do more to influence the negotiations or market for DH, very few are acting on that potential. Also, when compared to other cases, Burlington's actors have a weak level of market regulation and market stimulation activity; fiscal interventions in support of DH are limited. These strategy analysis findings support the collective actor analysis which also presents a picture of extended engagement and knowledge sharing but an absence of clarity on who would purchase or build or own a DH system in Burlington.

Summary of the actor constellation

One defining feature of this case is its lack of change over 20+ years. The constellation is static and not aligned; strategies and preferences do not match and it requires change to be successful. Those who want to build the DH system (Planning Department, CEDO, BURDES, the manager of the McNeil power station) do not have the resources or power to leverage

engagement with others, and they have not yet figured out how to create those resources or inspire other actors. Also, among those who prefer building DH and are working towards doing so, there is no consensus on a strategy for investing or owning the DH system. There is a discussion of community vision but no agreed preference for what other actors should do. Despite the concept of DH existing in planning policy and the public press for many years, there is still uncertainty about who would need to be involved to establish a DH system.

The collective actor analysis demonstrates that the actor set lacks both organisations who are interested in leading on the construction or management of a DH system, and customers who are interested in buying heat. While the local government has influence over the heat source, they are unable or unwilling to take a more active role in promoting DHC. However, despite the concept failing to gain traction since the mid 1980s, the BURDES group maintains hope that changes to the context will bring new actors into more supportive alignments. They expect that changes to McNeil ownership and personnel changes at the university and the hospital will lead to more interest in becoming customers. But the question still remains: a customer of what organisation?

Figure 13: Photograph of entrance to McNeil Wood and Yard Waste Depot (Cary, 2012)

7.3 Mode of Interaction: Talking not Negotiating

How can the interactions be characterized?

While case lacks active negotiations towards the construction of DH, it also lacks hierarchical or unilateral modes of interaction among the actors and can more accurately be characterised as 'attempting to negotiate'. The BURDES committee and Ever-Green Energy are approaching district heating with orientations of altruism, hosting workshops to educate and interest other actors in 'problem solving' mindset where the discussion is about the best way to build a DH

system. Others such as the hospital and university have a more competition based orientation, and can be expected to be concerned about obtaining heating at a lower cost than currently through exchange-based negotiations. The city and BED can be described as more of a neutral mindset; there to support the discussion but not negotiate. These variations affect their ability to understand each other and to perceive next steps for the potential of DH in Burlington.

What are the relational characteristics?

The interviews portray irregular and weak interaction among the primary set of actors. While the BURDES group meets regularly, interactions with other actors seem to be infrequent and informal. These type of interactions reflect the case's struggle to move from talking to negotiating; without something besides knowledge to share the actors lack reasons to meet. An exception to the relational characteristics were the series of workshops hosted by BURDES in June 2011 to explain the findings of the Ever-Green Energy feasibility study and the potential of district heating in Burlington.

7.4 Conclusions: the Challenge of Finding Power

Is it a governance network without negotiation?

The analysis illustrates how interactions among actors in Burlington on DH do not display governance network behaviours, at least to date. While the interactions are neither hierarchical nor unilateral, the exchanges described above are also not between interdependent actors. For example, local government officers can to some extent ignore BURDES because it does not seem to have local political support and it does not have other resources to enable significant activity. Likewise, BURDES lacks a strong lever of influence over potential customers without local political support. The case thus fails the first aspect of Sorensen and Torfing's definition of a governance network. They are stable, operationally autonomous actors, but not all agree that DH is a policy problem they must work together to address; there is no sense of common purpose.

The remaining three aspects of the definition are met. Actors are interacting in a stable regulatory and conceptual context, they are self-regulating in that no authority is forcing the interactions, and the interactions are aimed at establishing DH as a solution to environmental concerns. Network behaviours are visible in the interactions, but the interactions have not been sufficient to create an constellation whereby action is taken to build the DH system.

How can the role of planning be described?

The Planning Department considers that it was instrumental in getting the city interested in climate change and the idea of district heating. "We manage a process that came up with a bunch of these ideas" (InterviewP4, 2012). However there is a disconnect between planning's preferences (DH is a good thing for environmental reasons) as set out in formal policy, the current director's idea generation role, and the department's political and institutional capabilities to either support interactions, direct the market or direct other city departments. While it has a market setting intervention through city plans, it does not and other actors do not feel it has

legal, development or other financial resources to support creation of a DH system. There is a noticeable gap between planning authority's self-identified capabilities and preferences and other actor's identification of the Planning Department's capabilities and preferences. This can be at least partially attributed to the institutional context of the planning commission as separate from mayoral control, and to a general perception of planning as development control not forward planning.

Summary

The concept of using waste heat from McNeil power station to fuel a district heating system has been discussed since McNeil's construction in the late 1970's. While the physical capability for DH was built in, the political and organisational capability never evolved to enable installation and operation of the pipes or system, despite regular attempts by the planning authority and others arguing on energy efficiency grounds. Despite a very positive recent study, significant local press and a series of open workshops, the actor constellation has not yet shifted from talking about the idea to negotiating its construction. There is uncertainty about the preferences of potential customers and about general preferences for organisational control and management. There are two significant features which are slowing delivery of DH: absence of local political support, and the lack of market regulation or market incentives at state or local level.

As of 2012, the concept of district heating using waste heat from McNeil remains dependant on the interest of a small group of individuals, lacking both institutionalization of the concept within departments and political engagement with local parties or elected officials. It is in danger of disintegrating without formal regulation or incentives, capacity building, and a greater preference to be involved from institutional and government actors. Because DH is not a common urban infrastructure in the US, delivering DH would require actors to change their preferences and actions. The Ever-Green Energy Consultant argued "I really think it’s an issue of leadership. Someone who understands how beneficial it can be and who persistently advances the cause." (InterviewA4, 2012). Nevertheless, while the network has not created a constellation where the DH system is built, it also has to be understood as not succeeded *to date* – conversations still continue between actors and the potential still exists to change their perceptions and preferences

Chapter 8. Lerwick: Where Actors Wear Many Hats

Lerwick is the capital and main port of the Shetland Islands, located more than 160km off the north coast of mainland Scotland. In the mid 1990s the Shetland Islands Council (SIC) was faced with the problem that its existing waste incinerator was aging and was unlikely to meet emerging European Union waste incineration and pollution directives.

SIC commissioned a number of investigations into their options for waste management. The idea of using waste heat from the incineration was put forward and investigated by the council. In 1997, SIC decided to proceed with a waste-to-energy incinerator, with heat recovery from the incinerator for use within the town centre. SIC also contracts with oil companies operating in the area and with the Orkney Islands to burn their waste.

The Shetland Islands Charitable Trust (SICT), which manages the compensation money from North Sea oil activities, along with European grants, provided the capital needed for a district heat pipe system and pumping station. Shetland Heat Energy and Power Limited (SHEAP), wholly owned by SICT, was created to own and operate the district heating system and interface with customers. The heat system commenced operating in 1998, and ran on heating oil for a year until the council owned incineration plant was completed and supplied heat to SHEAP. By 2009 approximately 1000 customers were connected, primarily residential but with 110 non-domestic connections. In 2011 the heat capacity of the waste to energy incineration plant was reached; SHEAP continues to search for heat sources to enable the district heating system to expand further.

A timeline of district heating in Lerwick is provided for reference.

Timetable of Lerwick District Heating	
1991	Shetland Islands Council (SIC) began investigating options for waste management (InterviewG3, 2011).
1996	Old Incinerators shut down (InterviewG3, 2011).
1997	SIC decided to proceed with the Energy Recovery Plant (InterviewG3, 2011).
1998	Shetland Heat Energy and Power started operating (Martin & Spence, 2010).
2007	Numerous streets with 100% of properties connected to district heating (Martin & Spence, 2010).
2009	1000 customers (Martin & Spence, 2010).
2011	Have to stop taking customers as no more excess heat (InterviewS1, 2011).

Figure 14: Timetable of Lerwick District Heating

Figure 15: Location of Shetland in the North Sea (OpenStreetMap, 2013)

Cultural and government context

Lerwick is the capital and main port for the Shetland Islands, located off the north east coast of Scotland. The Shetland Islands are a region within the country of Scotland, currently managed through Edinburgh under a devolved administration within the United Kingdom. They are culturally influenced by Norwegian, Danish, and Swedish cultures and traditions, due to the Island's fishing economy, prevailing sailing winds, and tides. The Islands are currently home to approximately 22,000 people, with 7,500 residents in Lerwick.

Shetland Islands Council is a unitary authority without regional oversight. Both local and the regional government follow the British planning system, with strong land use control policy direction from the Scottish Parliament. The local plan has no binding legal status and while drafted by the local council and approved by local politicians, it must be in conformance with Scottish planning policy.

8.1 The Actors

This section introduces the organisations and individuals who comprise the primary actor set for Lerwick, describing their institutional setting, resources, and capabilities. Appendix C contains the codes and information sources which provided this understanding of actor powers and capabilities.

Shetland Heat Energy and Power Limited

The Shetland Heat Energy and Power Limited (SHEAP) operates the district heating system as a for-profit trading company. It was founded with this purpose in 1998 (Shetland Heat Energy and Power Limited, 2011). All shares are owned by the Shetland Island Charitable Trust, acting as a social investor, who also own the pipes and distribution plant; SHEAP lease this on favourable terms, effectively serving as the management and customer interface company for the Shetland Islands Charitable Trust. SHEAP have also received grant funding from EU Thermie Fund, the Shetland Islands Council via the regional development agency and the European Regional Development Fund (InterviewS1, 2011).

Neville Martin as District Heating Manager has led SHEAP since its inception, and currently manages a staff of approximately five administrators and technical support (Shetland Heat Energy and Power Limited, 2011). The company buys heat from Shetland Islands Council's waste incineration as well as irregularly generating heat through backup or peaking plant, and sells heat to businesses and residents across Lerwick (Martin & Spence, 2010).

Scottish and Southern Electricity

Scottish and Southern Energy (SSE) is the local power generator and supplier to Shetland. It is also part of the SSE Group, United Kingdom's largest non-nuclear energy generation company, a FTSE 100 company publicly traded on the LSE (SSE, 2013). SSE owns and operates an oil fired 67 MWe power generation station in Lerwick, which 'dumps' heat from the electricity generating process into Lerwick harbour (InterviewS1, 2011).

European government

The European Union is an actor in this network because of the influence of its environmental directives and the funding it provided to the council for a new incineration plant. Three council directives in the late 1980s and early 1990s affected existing waste incineration plants, setting air and pollution limits and establishing a series of deadlines in the mid 1990s for improvements to existing waste incineration plants. These were an impetus for Shetlands Council to revisit their waste strategy and build a new incineration plant (InterviewG3, 2011). The European Union also provided funding through a ERDF and Thermie grants towards a heat supply element of the new incineration plant (InterviewS1, 2011).

Local government

The Shetland Islands Council (SIC) is the local authority for Lerwick, and a major employer of the town with over 3,000 employees. It is responsible for establishing environmental standards, providing waste collection services and controlling new building development, among other typical local government services not relevant to this research (Shetland Islands Council, 2012). The council raises funds through locally administered council tax and harbour management fees, but is primarily resourced through national government funding, supplemented by European grants (Shetland Islands Council, 2012).

There are 22 elected councillors which govern the council through a committee system, all of whom are classed as politically independent. Elections follow the Scottish local government cycle with four year terms (Shetland Islands Council, 2012).

Shetland Islands Council Planning Department

The council has a Planning Department, which operates policy making, development control, and has specific heritage and marine functions within it. In 2011, the department worked to a Shetland *Structure Plan* (Shetland Islands Council, 2000) as well as *Shetland Local Plan* (Shetland Islands Council, 2004). Both documents mention and are supportive of the district heating system (which has been operational for 12 years), although there are no policies which explicitly protect the system or recommend or require connection to it. The department does have a level of regulatory control over district heating through local plan policy IND9 which requires non-public utilities to submit an application for pipe installations (Shetland Islands Council, 2000; InterviewP2, 2011).

Shetland Islands Charitable Trust

Shetland Islands Charitable Trust (SICT) is a charity established in 1976 through a £81m investment from oil companies as compensation for basing the Sullom Voe terminal in Shetland. The Trust's aim is to provide public benefit in the areas of social care, culture and sports, environment, natural history, and heritage. It does this through grants with the dividends on it its investments in global stocks and by operating three subsidiary companies on a commercial basis; SLAP which invests in property, SHEAP the focus of this research, and a third company Viking Energy which invests in a renewables project (Shetland Island Charitable Trust, 2012). As of March 2012, SICT holdings totalled £217 million, and it distributes around £10 million annually (Shetland Islands Charitable Trust, 2013).

At the time of establishing the district heating system, several SICT Trustees were also local councillors. Historically the relationship between SICT and SIC was close, with staff and programmes often shared between the two organisations.

Wider non-primary actors

Table 23 lists the primary actors; non-primary actors included a limited number of private sector consultancies who advised SHEAP and SIC. None are currently retained on a regular basis according to SHEAP (InterviewS1, 2011). An engineer at Gilbert Bain Hospital, was also interviewed to understand the perspective of a non-residential customer to SHEAP. The Hospital is one of two general hospitals in Shetland and a prominent building in the town. Hjatland Housing Association, the local social landlord, while not a major actor in establishing District Heating (DH), was contacted via email for this research. Hjatland have coordinated with SHEAP to extend heating pipes toward new housing development – they built over 117 houses in the late 2000's, in which DH system connections are installed as standard.

Scottish and United Kingdom government organisations were not identified as primary actors for the research. Scotland as a semi-sovereign country within the United Kingdom is responsible for most day-to-day issues such as health, education, justice, spatial planning, and transport.

Foreign affairs, fiscal policy, and defence are managed in London through the UK parliament. Energy policy after the 1998 Devolution Act is predominately created and enacted in London but energy efficiency and renewables policies were devolved to Edinburgh (Murphy, 2007).

Government	Market	Civic
Shetland Islands Council – Councillors	Shetland Heat Energy and Power Limited	Shetland Islands Charitable Trust
Shetland Island Council – Waste to Energy Plant	Scottish and Southern Energy (Hydro)	
Shetland Island Council – Waste Services		
Shetland Islands Council – Planning Department		
European Union		

Table 23: Set of primary actors for Lerwick

Figure 16: Photograph of harbour from central Lerwick (Cary, 2011)

8.2 Analysis of the Actors and Actor Constellation

This section describes the self-identified and collective actor analysis. Appendix C contains the detailed stakeholder analyses matrices which are described here.

8.2.1 Self-identified actor analysis: Where's the conflict?

In the self-identified actor analysis, three actors self-identify as actively engaged in building the Lerwick district heating system: SIC, SICT, and SHEAP. SIC see themselves as leading the development of the DH system, supporting the concept off the back of the waste incineration review (InterviewG3, 2011). They did have to actively learn more about DH and admitted that their original orientation was one of interest in the idea but no idea how to deliver a system. They turned to European examples to learn more, and council staff visited existing systems in Denmark (InterviewS1, 2011). The current SHEAP manager, formerly of SIC, said "someone

said what's district heating and then the next thing myself and one or two others got instructions to go to Denmark and find out more about it, that was in 92 or 93 .... because I must admit that at the time being a water engineer with the coal board, the idea of pumping hot water around the town it was, I had never heard of it before and I must admit I thought it was ludicrous." (InterviewS1, 2011). Once SHEAP was established the council transferred the staff who had commenced the DH system over to be employed by SHEAP.

With the redevelopment of an aging waste incinerator to meet European pollution standards, SIC sought to keep managing the waste for Shetland, the Orkneys, and the oil ships as this keeps jobs in Shetland. The Energy Recovery Plant manager explained "At that time really we had a major supply base with the off-shore industry here, and one of the key elements in keeping them here was incineration of waste. So it had an economic viewpoint as well as a waste management viewpoint, with trying to keep jobs on Shetland." (InterviewG3, 2011) The council's perspective was not led by an explicit local strategy or policy for incineration or DH. Formal policy support for DH came only in 1998 when the SIC Energy Unit published an *Energy Plan* which encouraged a more coordinated approach to energy management in Shetland, promoting renewable resources and the DH system (Shetland Islands Council, 2000).

Further drivers behind incineration (as opposed to landfill or shipping waste off island) are stated by SIC to be both waste policy and environmental reasons (InterviewG3, 2011). Aware of European Directives for air quality and pollution control from incinerators, SIC also pursued an incinerator capable of DH supply. And because they struggled to find funds to build incinerator from within the council, they sought grants for DH as a further source of funding for the incinerator (InterviewG3, 2011).

The orientation of the SICT is to support initiatives which benefit residents of Shetland; it is therefore interested in the environmental (waste, carbon), employment (job creation), and cost saving (for consumers) benefits of DH for Lerwick. SICT were willing to invest in SHEAP as a grant, and while they originally hoped to make a small profit from the investment in 2000 they conceded the capital investment in pipework as a grant; "If you do a sort of Shetland plc calculation it probably stacks up" (InterviewS1, 2011).

SHEAP, as an organisation formed to build and operate the district heating system, would prefer to expand the system to serve more customers if additional heat sources could be found (InterviewS1, 2011). They are proud of the benefits DH brings to Lerwick.

> About £1,000,000 per annum of the income from sales stays in Shetland rather than paying for oil which would go straight out of the economy. Just as importantly, local businesses are cushioned from the fuel price uncertainty helping to provide some stability. Up until recently we were creating around £700,000 of civil engineering works a year of which around 75% was local input with the remainder being materials. The district heating scheme directly employs six people. It out sources most of its maintenance works to the private sector. (Shetland Heat Energy and Power Limited, 2011)

Turning to the orientations of the Planning Department, an interview with a planning officer indicates that the general planning ethos is development friendly; the department sees its role as guiding people towards policy outcomes and being supportive. They perceive local plan policy IND9 as an information gathering and coordination policy rather than development control, as it enables them to help the various authorities combine roadworks. "As far as the development plan went, and the implementation of the scheme, it was coordinating everything to make sure that if you dug up king Harold street, it was once, and put in new sewer pipes, new water pipes, new district heating pipes, new electricity cables... everything went in one great big hole." (InterviewP2, 2011). However, the council's *Structure Plan* does have as an indicator of success the number of properties connected to DH (Shetland Islands Council, 2000). The same planning officer described how the council in 2005 coordinated DH pipe installations with a re-flagging and improvement project in the town centre (InterviewP2, 2011).

Both SSE and the European Union government were identified by other interviewees as primary actors. SSE participated in the initial discussions for setting up the DH system in Lerwick (InterviewS1, 2011) but did not engage further by, for example, arranging for the waste heat from the power station to be used in the DH system. The EU government provided policy direction which encouraged incineration and use of its thermal output in DH through Environmental Directives, as described above.

What are the actors' self-identified capabilities, orientations, and preferences?

There are four ways in which the set of actors has a discernible effect on the construction of the heating system. One, through the existence of the SICT, SHEAP received substantial financial investment through a grant. Two, the council's desire to continue management of waste and preference for incineration provides a source of 'free' heat to the system. Three, several individuals have dual responsibilities between the council SHEAP or SICT; e.g. trustees of SICT were also local councillors, SIC staff were transferred from SIC into SHEAP to run the DH system. This sharing of roles among private, government, and civic organisations reduces transaction costs in knowledge exchange and encourages shared preferences among actors

And finally, the absence of a private sector energy company. While the council uses external (often Danish) consultants to investigate options and provide advice, they did not seriously consider contracting with a private energy company to run the heating system. Instead they trained existing council staff and created a non profit organisation to run the system (they are legally prohibited from doing so themselves). This strategy was influenced by individual orientations about large energy companies (negative experience with SSE, trips to other DH systems in the UK) and organisational orientations towards self-reliance on the island.

Figure 17: Photograph of the central pumping station for Shetland Heat and Power Limited (Cary, 2011)

8.2.2 Collective analysis: Identifying small conflicts

The collective actor analysis identifies additional points of conflict, change, and consensus within the small actor set. A main point of conflict, which remains unresolved, is SSE's lack of agreement to supply heat to SHEAP from the adjacent large oil fired electricity power plant. Despite initial involvement by SSE in SHEAP, efforts to push SSE to provide low cost heat from the power station have been unsuccessful "Neville has been badgering them for the last 12 years…one way or another." (InterviewS1, 2011). The perspective of the council and of SHEAP is that "They [SSE] realised the district heating isn't a commercial activity in terms of the cost of laying pipes and what they'd recover from the heat." (InterviewG3, 2011). SHEAP would prefer SSE to get involved because with the additional heat they could expand the system to further customers, but no direct mechanism exists by which the local council or community can force a large energy utility to get involved in a local DH system.

On the other hand, there is strong consensus among all other actors about the socio-economic value of the DH system, and the appropriateness of SICT providing grant funding for it. SICT was seen, particularly historically, as an "arm of the council" (InterviewS1, 2011) and interviews indicate that they work closely together, sharing knowledge and strategies together (InterviewG3, 2011; InterviewS1, 2011; InterviewP2, 2011). The Energy Plant Manager perceived the situation as

> So we had to look at an alternative, so we went to Shetland Charitable Trust, to look at them viewing it as a sort of local economic development, under the Trust they can contribute to things that encourage the local economy, they can invest in things of that nature, so we went to them for them to build the network and lease the pipe. (InterviewG3, 2011)

The Waste Services Manager described the Trust's involvement as "The only way it could have been established" (InterviewG3, 2011) and noted that the trust has had to write off initial £2m as a grant, although the system breaks even now (InterviewS1, 2011).

The council's preference towards DH was identified by others as initially quite mixed. While the council pushed for incineration, there were some individuals within the council who did not believe that DH would work. SHEAP's Manager remarked in an interview "One of the council officers, the technical officers, decided the district heating scheme was not going to work here … and to prove himself right he wouldn't let the council offices connect…" While they did eventually connect, it was buildings owned by SICT such as the leisure centre which were first to be connected (InterviewS1, 2011).

The collective actor analysis illustrates that over time the council and others have come to value and respect the service SHEAP provides. Customers are happy with the service; from the interviews and local newspapers, it is clear that residents and businesses generally prefer to connect where they can (Robertson, 2008). This was understood by interviewees as primarily due to fuel costs, where DH is generally cheaper than electric or other fuel sources (there is no gas supply). The engineer at Gilbert Bain Hospital also explained that DH makes his life easy; there are rarely any problems and if there are problems, he can ring up Neville, the manager at SHEAP (InterviewU1, 2011).

When queried, interviewees recognised that the Planning Department plays a market regulating role through its requirement of application for and approval of pipe network installation. But this is seen as positive in that the council uses those powers to help coordinate with both other customers and with other streetworks such as repaving (InterviewS1, 2011). The benefit was detailed by the Energy Recovery Plant Manager;

> And District Heating had to apply for planning for all their routes because it's still not classed as a utility, so it doesn't have that legislative backing, and therefore it needs planning permission for everything it's doing. In fact it was probably more contentious, the district heating than the incinerator to be honest, because the roads were going to get dug up for years. (InterviewG3, 2011)

Market influences

The strategy analysis of market interventions highlights that, on the whole, there were more market shaping and capacity building influences than market regulation or stimulation influences. The exceptions to this are the two main funders of the system – SICT and the EU Government - who played market incentivisation roles. The only regulation of DH comes in the form of European incineration controls and through the nominal local planning approvals for control of pipe laying. Overall all four of Tiesdell and Allmendinger's types of market regulation are active in the case, although regulation is weak and predominately focused on the incineration plant. The biggest gaps between expected and actual activity lies with SSE; other actors expected SSE to be more engaged in market shaping type of activity.

Summary of the actor constellation

In summary, the collective actor analysis uncovers two significant changes in actor orientations and preferences during the establishment of Lerwick's DH system. Initial reactions to incineration supplying DH were mixed due to a lack of knowledge about DH infrastructure and uncertainty about technical feasibility. This became more favourable over time, following knowledge-gathering visits to Denmark and several public consultations. Secondly, following initial expectations and engagement with SSE as a secondary heat source or system partner, the council proceeded with DH without the SSE heat and with SICT as the funding body.

8.3 Interactions and Negotiations: Problem Solving not Positive Coordination

How can the mode of interaction be characterised?

The actor constellation in Lerwick can best be characterised as problem solving in Scharpf's categorisation of negotiation types. The discussions and preferences between actors tend to ignore distribution of monetary resources (who benefits or profits from investment) to focus on how to create value – how to address environmentally sound waste management and job creation while provide heating efficiently and cheaply. This is particularly demonstrated in SICT's acceptance of the investment in the district heating system as a grant – the organisation is not there to maximise profit, but to benefit the Shetland community, and they are willing to 'lose' money through grant funding infrastructure to do this. This kind of problem solving negotiation "depends on maximum openness, good communication skills, and mutual trust" (p 131, Scharpf 1997); Lerwick's small island setting and multiple responsibilities by individuals across organisations enabled this approach to negotiations.

What are the relational characteristics?

The set of actors responsible for DH in Lerwick is comparatively small, with a lack of direct national engagement and the absence of a private sector DH company to operate the system. This is reflective of the 'small island' setting, isolated from larger political and economic centres.

All interviewees commented on how Lerwick's small size supported the creation of the DH. Neville Martin, the SHEAP manager, was known by name to all those interviewed and comments such as "it is easier to ring up Neville and explain if there's a problem" (InterviewP2, 2011) and "everybody knows everybody here" (InterviewS1, 2011) were frequently made in response to queries about why the DH succeeded. Neville himself made the point that once SHEAP started digging the pipes in a neighbourhood, new DH connections "sold" through word of mouth (InterviewS1, 2011).

Another distinct feature of Lerwick's governance network is that several individuals wear 'many hats'; e.g. simultaneously a local councillor, governor of a local school, and as a trustee of the SICT. As the planning officer remarked, "if you're going to wear hats, wear a lot" (InterviewP2, 2011). Wearing 'many hats' not only means that information sharing and capacity building about

the concept of DH was reduced within the network, but that organizational orientations tended to evolve together, reducing the potential for conflict.

Shetland is not only a small place, but it is a fairly static place; the interviews showed that generally the same individuals were involved over time. As a result of this, long-term relationships are important and decisions were often made between people and personal relationships, rather than between companies and contracts. But it also increased pressure on delivery; as the financial controller for SICT commented,

> There were some stressful meetings, but we have now got the point where the scheme is sufficiently established, that the charitable trust will fund ahead for 3 years at a time on the basis of the business plan, but for about certainly 8 or 9 years, it was an annual funding rigmarole with the charitable trust and if Neville had upset too many people by digging up too many holes in front of councillors...It wasn't always easy to get the money out of the trust. (InterviewS1, 2011)

Figure 18: Photographs of heating pipe installation in Lerwick (Shetland Heat Energy and Power Limited, 2011)

8.4 Conclusions: Tight Networks for Public Benefit

The SHEAP system has been operating for 12 years and currently services over 1000 customers in the town. The system is recognised locally for reducing fuel bills and maintenance costs, as well as creating employment and construction works for the local economy; SHEAP's own estimates are that it has repaid (to the local economy) its investment within seven years: "The cost of the district heating to date is about £13m. The benefits of the above amount to between £2m and £3m annually depending on the price of oil." (Martin & Spence, 2010). The challenge now for SHEAP is to find additional fuel or heating sources so that it can expand further and serve a larger portion of the town.

Is this network governance?

Returning to Sorensen and Torfing's definition of network governance, the process of building and operating SHEAP meets the majority of their criteria. The network is relatively stable, with almost no change to individuals and organisations. It is more horizontal than hierarchical in that it is not responding to policy or strategy from above but arising as a local response to a discrete challenge. The actors are technically operationally autonomous, but all admit that SIC and SICT were very closely linked when the network was conceived. The actors are self regulating in that that they continued negotiations over funding and behaviour, and given the small island setting were regulated through peer-pressure rather than national organisations. And very clearly they built the system for a shared, normative, concept of public purpose: cheaper heat for Lerwick businesses and residents, nineteen jobs from incineration, and five jobs in the management of SHEAP (Spence & Martin, 2011).

Thus the governance network can be characterised as a very tight, influenced by daily interactions among a small set of actors over long periods of time, and by "policy solving" negotiations aimed at public benefit rather than a network where exchange of monetary resources predominated. Both aspects resulted in low levels of conflict between actors and a focus on delivering the DH system.

The governance network building SHEAP had to overcame two barriers to establish a DH system. First an absence of strong market drivers (regulation, policy, incentives, etc) from Scottish or national actors. This was overcome by the formal institutional structure of the island with the engagement of SICT, support of European funding, and a more informal setting of the council's orientation towards self-reliance and responsible service provision on an island. The second barrier, which while downplayed by the actors during interviews, was the lack of previous experience with district heating and the effort and investment required to learn how to build and operate it. As a local councillor said, "I mean politically it was quite visionary, technically and financially as well, there was a fair bit of suck it and see in the end, there had to be…" (InterviewS1, 2011).

How can the role of planning be described?

The Planning Department can be described as only mildly market regulating, with planning permission required for pipe connections on a utilities control on a coordination basis. The department did retrospectively support the installation of the system in policy and practice, helping to coordinate streetworks in the downtown streets through development control. Compared to other cases, this is a fairly weak use of planning powers and tools, with no use of forward planning or spatial plan coordination of utilities or energy infrastructure to initiate the DH system.

Chapter 9. London, Elephant and Castle: Policy Entrepreneurs Amidst Conflict and Change

In 2004 Southwark Council approved a masterplan for the Elephant and Castle area of London, in the form of a *Supplementary Planning Guidance Development Framework*. This document served as the basis for negotiations with a private sector developer to deliver a major regeneration programme in the area, demolishing an existing estate of 1,100 homes and shopping facilities, to be replaced with circa 5,000 homes, a new park, re-designed streets, and public realm. The regeneration programme is ongoing.

Included in the *Development Framework* and based on a detailed environmental resource flow assessment was a goal to promote a zero carbon growth strategy within the confines of the development. This was envisaged to be partially achieved through the establishment of a public-private joint venture company to provide district heating, cooling, water, and waste processing using renewable or low-carbon fuels. This multi-utility services company (MUSCO) would invest in the necessary energy centre and infrastructure in return for income from consumer sales, based on a 30 year concession to supply the area. Southwark Council's goal and the MUSCO system proposal deviated significantly from conventional masterplanning and precluded national planning policies on DHC, effectively placing this case at the forefront of UK energy planning.

In 2006 Southwark Council launched a European procurement process with the aim of appointing a private sector utilities company to operate the MUSCO. Dalkia, a multi-national energy services company was selected in 2008 as the preferred MUSCO partner through a European negotiated procurement procedure. However, with the 2008 recession the timetable for redevelopment of the area collapsed, and a renegotiation of the concession commenced, based on the revised forecast for housing and commercial development. In early 2011 Southwark Council took the decision to withdraw from the negotiations for the procurement of the MUSCO.

For context, a timeline of the attempt to develop a district heating and cooling system in Elephant and Castle is provided in Figure 19.

Timeline of Elephant and Castle Case Study	
2003	Work begins on the Elephant and Castle masterplan (InterviewG1, 2011).
2004	The London Mayor's *Energy Strategy* announces a policy intention to increase the use of community heating in London (Greater London Authority, 2004).
	Southwark Council under liberal democrat control approves a development framework in the form of supplementary planning guidance (London Borough of Southwark, 2004) for Elephant and Castle which proposes to deliver heat, cooling and power through local generation and distribution, and sets at target of zero growth in emissions despite a development masterplan which increases building floor space by 300% (London Borough of Southwark, 2011).
	The GLA publishes *the London Plan*, with policies explicitly promoting CHP led heating and cooling systems (Greater London Authority, 2006).
2004 - 2006	Detailed work on technology deployment and carbon savings for the MUSCO (InterviewP1, 2011; InterviewG1, 2011) .
2006	May – Southwark Council elections result in no overall control, with a tie between Liberal Democrats and Labour.
	July - Southwark announced plans to provide locally generated heat, cooling, and electricity for the development through a MUSCO approach. MUSCO procurement procedures are launched (London SE1 website team, 2006).
2007	Lend Lease appointed as regeneration partner.
2008	A consortium led by Dalkia was selected as the preferred commercial partner for the MUSCO. The financial crisis resulted in a review of the regeneration programme (London Borough of Southwark, 2011).
2009	Regeneration Department reorganised within LB Southwark's executive structure (InterviewP1, 2011).
2010	May - Southwark elections result in Labour gaining overall control of the Council.
	June - A revised offer from Dalkia, with a new proposal for the MUSCO concession (London Borough of Southwark, 2011).
2011	February – Southwark Council takes decision not proceed with procurement of MUSCo (London SE1 Website Team, 2011).

Figure 19: Timeline of Elephant and Castle case study

Context: multi-level government and planning frameworks

Elephant and Castle is an area of central London within the borough of Southwark; it is located south of the river, approximately two kilometres from Westminster and the City. Southwark is both the name for a neighbourhood in London and the name for a local government unit within London – the London Borough of Southwark.

London's complex multi-level governance arrangements are well documented, with Pimlott and Rao (2002) a useful text. Specific institutions and powers relevant to this case are explained below but in outline, civic functions are divided between a pan-London Greater London Authority run by an elected mayor, and 32 smaller area-delineated boroughs that operate on a council committee system with elected councillors. At a borough level, all but three boroughs operate a leader and executive system where the mayor's role is symbolic (Newman & Thornley, 1996) and the leader of the council is an elected local councillor chosen from within the party. Both levels of elections tend to be fought according to UK national political party lines, with Ken Livingstone's 2000-2004 term as an independent mayor a notable exception.

Control of development and land use in the UK is structured through a plan-led system, with local or metropolitan plans required to be in conformance with national policies(ODPM, 2005). Local authorities have higher levels of autonomy in making planning decisions than elsewhere in Europe, but within a clearly defined scope by national policy. The British planning system is characterised by Newman and Thornley (1996) as system based not on a firm legal grounding of government control of land but case law of negotiation between public and private organisations. At a national level, Department of Communities and Local Government (DCLG) is responsible for planning policy, housing and building regulations and DCLG policies influenced the backdrop to the Southwark masterplan in two ways. One, by mandating minimum energy standards for new housing their policies encourage developers to perceive DHC systems as a cost-effective way to address efficiency requirements in large developments. Secondly, through national planning policy document PPS1 supplement published in 2007 DCLG explicitly supported decentralised energy systems, including district energy fired via CHP or CCHP, and required local planning authorities to consider DHC in masterplanning future developments (CLG, 2007).

Energy policy is spread across a number of national departments, and the UK government has instituted a patchwork set of targets, measures, and policies in support of CHP, community heating, decentralised energy, and renewables. Hinnels (2008) describe how the division of policies between departments and the trend to focus on individual technologies has failed to deliver market movement on CHP or DHC. Policy documents such as DEFRA's *Strategy for Combined Heat and Power* (2004) and the DTI's *White Paper on Energy* (2007) generally expect private sector large energy companies to deliver national energy policy aims and seek to influence the market by removing barriers, creating incentives, and setting targets.

This case is also notable for spanning the late 2000's global financial crisis, which had a significant impact on the capacity and outlook of local, regional, and national government, private businesses, property developers, and financial institutions.

9.1 The Actors

This section introduces the organisations and individuals who comprise the primary actor set for the attempt to establish a MUSCO concession in Elephant and Castle, describing their institutional setting, capabilities, and resources. The research uncovered additional non-primary actors, such as law firms Grant Thornton and Herbert Smith, who advised Southwark Council on the procurement process, and Tibbalds Planning and Urban Design, who advised Southwark on the 2004 development framework. Notably absent are local residents and national government organisations; they were not identified as participants in discussions or negotiations for the proposed MUSCO. Appendix C contains the codes and information sources which provided this understanding of actor powers and capabilities.

Greater London Authority

The Greater London Authority (GLA) is the civil service body which supports the Mayor of London’s policies and the elected London Assembly. The Assembly consists of 25 members

who exist predominately to scrutinise and veto the mayor's policies and budget. The Mayor of London is directly elected with responsibility for strategic direction of London, with specific powers over fire, police, planning, and transport. The mayor also has a duty to establish policies on transport, planning and development, housing, economic development and regeneration, culture, health inequalities, and a range of environmental issues including climate change, biodiversity, ambient noise, waste disposal, and air quality (Pimlott & Rao, 2002).

The mayor's planning powers are unique in the United Kingdom. The Greater London Authority Acts 1999 and 2007 require the boroughs to consult the mayor on planning applications that are of potential strategic importance to London, as defined by the government. The London boroughs also consult the mayor on their Local Development Frameworks (local plans). As of 2007, the mayor has the power in major applications of direct refusal, to take over the application for his own determination or allow the planning authority's decision to stand (HM Government, 2008). Prior to that, the mayor only had the power to refuse applications, but could not take them for his own determination (House of Commons, 1998).

Figure 20: Map of London with Elephant and Castle identified (OpenStreetMap, 2013)

London Borough of Southwark and its elected local politicians

At a local level, the London Borough of Southwark follows a leader and executive structure, with elected councillors determining major decisions and an executive or officer management function coordinated under a Chief Executive via series of committees headed by councillors. Councillors are elected every four years; the attempt to establish a MUSCO lasted over the course of three election cycles, through which the council leadership changed three times.

The council owns almost 50% of the housing in the borough area (London Borough of Southwark, 2006), and a large proportion of the land near the Elephant and Castle area (London Borough of Southwark, 2004). This ownership increases the councils authority over plans for the area. However the council's ability to spend and invest is constrained and directed by legislation and funds are handed down from national government (which comes from various sources but includes a redistribution of business rates and property taxation) rather than local taxation.

Within the council, the primary department responsible for the Elephant and Castle regeneration project was the Regeneration Department (London Borough of Southwark, 2010). It established the goals and vision for the redevelopment and regeneration of the area, led the search for a private sector regeneration partner, and it was also responsible for planning policy and implementation within the project boundaries (InterviewP1, 2011).

Southwark's Planning Department sits within a 'Regeneration and Neighbourhoods' Department, alongside the Economic Development Department (London Borough of Southwark, 2010). Southwark's Planning Department has the authority to create a local spatial plan and local policies for development and physical investment; however their policies must be in conformance with national planning policy and the regional *London Plan*. The Planning Department approves or denies applications for changes of use and significant building alterations; through this approval process the authority can negotiate conditions on the private sector developers (Newman & Thornley, 1996).

Interviews identified that the Finance Department was also important to the decision making for the MUSCO (InterviewP1, 2011; InterviewA2, 2011). The Finance Department reports directly to the Chief Executive of the council, although a 2010 organisation chart identifies the main role of the department as providing assistance and guidance to the council and other departments (London Borough of Southwark, 2010).

Private sector actors

A number of private sector consultancies advised all parties to the MUSCO negotiations. Interviewees identified Inventa Partners and Brian Dunlop Associates as particularly influential; both are SME consultancies. The former specialises in developing and delivering strategies for the funding of sustainable energy, electricity, waste, water, and telecommunications infrastructure (Inventa Partners). It advised Southwark Council on the MUSCO development and tendering process (InterviewA2, 2011). Brian Dunlop Associates is an engineering consultancy firm run by Brian Dunlop, a civil engineer. Brian advised Southwark Council on general sustainability, energy, and water aspects of the development framework masterplan for Elephant and Castle in 2003. He was subsequently retained until 2010 to advise on the procurement of the MUSCO (InterviewA1, 2011).

The preferred MUSCO partner, Dalkia Bio-energy, is an international company which manufactures energy infrastructure and engines, and offers multi-utility services to private and public customers globally. In 2010 it had over 50,000 employees and annual revenue of £6.8

billion. It has a significant UK presence with over 1,000 employees. It is owned by Veolia environment and EDF, both global energy and environmental services companies with offices and a significant presence in London (London Borough of Southwark, 2011).

Lend Lease is a global construction and development corporation, who was appointed lead regeneration partner for the Elephant and Castle Scheme in 2010 (Leader of the Council, 2010), following initial selection process in July 2007 (London Borough of Southwark, 2010). In June 2009, at the time of signing the Regeneration Agreement, the company was valued at $3.9b USD (Leader of the Council, 2010). The Regeneration Agreement gives Lend Lease the responsibility to submit a planning application for the regeneration area, and then deliver the development in line with principles agreed with Southwark and an outline masterplan. In return, they receive a share of the profits and ownership in the area. (The details of the agreement are not publicly available.)

Civic

The Clinton Climate Change Initiative (CCI), was mentioned by press and several interviewees (InterviewD1, 2011; InterviewP1, 2011) as a participant actor seeking to establish the MUSCO system. The CCI created a 'Climate Positive Development Programme' which assists development projects to address the dual challenge of rapid urban growth and climate change. In May 2009, Elephant and Castle was designated as one of only 16 founding projects of the Climate Positive Development Program (Clinton Foundation); in this sense its role was to create international expectations for the project and to support the project with information sharing (InterviewC1, 2011).

Market	Government	Civic
Brian Dunlop Associates	Southwark Councillors (Elected)	Clinton Climate Change Initiative
Dalkia	LB Southwark Planning Department	
Inventa Partners	LB Southwark Finance Department	
Lend Lease	LB Southwark Regeneration Department	
	Greater London Authority and Mayor of London	

Table 24: Set of primary actors for London

9.2 Analysis of the Actors and the Actor Constellation

Following the methodology described in Chapter 5, this section describes the actor analysis for the attempt to establish a MUSCO system at Elephant and Castle and develops the actor constellation by considering the degree to which actor aspirations were compatible or incompatible with each other. The detailed matrices described here can be found in Appendix C.

9.2.1 Self-identified actor capabilities and preferences

The self-identified actor analysis identifies there is wide if not unanimous initial support for the MUSCO approach to addressing energy demands in the regeneration of Elephant and Castle. The environmental benefit of a MUSCO is recognised and championed by the Regeneration

Department in the council. Across the actors, no organisation feels they have the ability (knowledge, certainty of return on investment, or political support) to deliver the proposed MUSCO singlehandedly and they accept the need for exchange-based contracts to deliver the system. The concept of procurement of MUSCO as concession offered by Southwark through European Union procurement procedures to a private sector energy company was not contentious and actors understood their roles and responsibilities in this approach.

The Regeneration Department perceived themselves as leading on the concept and the procurement of a MUSCO system to achieve dual aims of lowering infrastructure costs and achieving environmental goals. However this perception took time to build and the department's ability to act was constrained. They first leveraged their regeneration strategy (in planning policy) to include the MUSCO as a market shaping strategy, and then discussed the concept with their preferred regeneration partner, Lend Lease. The former Regeneration Project Director noted that Lend Lease "were quite sceptical" about the MUSCO (InterviewP1, 2011) and instead the Regeneration Department approached private sector energy companies to build the MUSCO through a tender process, offering the council's social housing demands for heating as consumers and some land for an energy centre (London Borough of Southwark, 2011). The Regeneration Department took responsibility for initiating the MUSCO but it also had other objectives for the Elephant and Castle project which took priority over environmental goals: financial returns, legal obligations, economic regeneration. These restricted its capabilities and strategy options for negotiations to build the MUSCO (InterviewG1, 2011). A further complication to the preferences of the Regeneration Department was the re-organisation of the council in 2009, which changed the structure of the department and resulted in the departure of the project director (InterviewP1, 2011).

Southwark's Planning Department, influenced by the Regeneration Department, established a goal of 'net zero carbon' growth and explicit support for a MUSCO solution within the 2004 *Elephant and Castle Development Framework* (London Borough of Southwark, 2004) and subsequent local policy documents (London Borough of Southwark, 2008). The wider *Southwark Plan* (London Borough of Southwark, 2007) established the principle that the planning approvals process should be used to regulate energy performance in new buildings.

Both the Planning and the Regeneration Department were influenced by national and regional policy goals for local decentralised energy; in particular the 2004 *London Plan* policy 4A.5: "Boroughs should ensure that all DPDs identify and safeguard existing heat and cooling networks and maximise the opportunities for providing new networks that are supplied by decentralised energy". Formal national planning policy support for a MUSCO concept in planning policy only followed in 2007 (CLG, 2007). Mayoral policies were repeatedly supportive of CHP-fuelled district energy in new large developments in London (Greater London Authority, 2004) (Greater London Authority, 2006). And the mayor's preferred strategy was to use planning powers to influence developers and local boroughs, supported by two dedicated organisations to provide advice and funding.

Despite this external policy support for decentralised energy, Southwark was effectively learning as it went; every councillor and officer interviewed described an initial lack of knowledge or awareness about DHC or MUSCO procurement (InterviewE1, 2011; InterviewA1, 2011; InterviewP1, 2011).

As a private energy company, Dalkia's strategy for building and operating the MUSCO reflected their evaluation of upfront investment against expectations for long term income. Through the procurement process, it emerged that Dalkia was willing to take on some risk for future customers, but not all risk about security of future income; Southwark would have to stay involved politically and somewhat financially. This was accepted by the Regeneration Department but seen to be a problem by the Finance Department (InterviewP1, 2011). Also, when the economic recession reduced number of homes to be built as part of the regeneration, this negatively affected Dalkia's income calculations and therefore ability to source funds for capital investment. Their preferred MUSCO shifted to have higher levels of government-owned housing and one larger energy centre instead of two linked ones (InterviewA1, 2011).

What are the actors' self-identified capabilities, orientations, and preferences?

The attempt to establish a MUSCO which included DHC was initiated by the Regeneration Department, who originated the idea and embedded it into the planning framework for Elephant and Castle. As a group, actors felt they had sufficient organisations involved; they did not identify significant gaps or roles in the delivery process. For example, there was no lack of a private sector energy company who was interested in contracting to build and operate the system, and no lack of consultants to advise the public sector. However, the absence of active national government actors actively supporting the MUSCO through regulation, funding or political resource is noticeable given national policy goals to promote DHC.

Secondly, several of those interviewed identified the capability of actors as a factor in the failure to establish the MUSCO. The Regeneration Department spent significant time and costs learning from European systems such as Stockholm and Copenhagen; interviewees from the department believed the process could have been smoother and quicker if they had an existing template to replicate. In particular, the councillors did not have sufficient understanding of the MUSCO commercial set up or physical output to be comfortable negotiating a 30 year contract or promoting it to residents. A local councillor described his position as: "I ask, what is a MUSCO? How can I explain this to residents? Does it smell?...What is the benefit to the council?" (InterviewE1, 2011).

Finally, over the course of eight years of attempting to procure and build a MUSCO system, the council staff and the councillors changed, and so did their preferences around Southwark's responsibility in offering the concession. The length of negotiations weakened their support for long-term risk and in particular for the construction of an energy centre near the development area. In interviews, a councillor describes being conflicted between their responsibility to steward the council's money wisely and the environmental goals of the MUSCO, which they eventually perceived to bring significant financial and political risk. He said "I thought it was

going to be a box underground somewhere in Elephant and Castle; now it was a nine story thing on a major road. Quite innocently, it grew... but ended up too big and I didn't have political support for larger centre with more visual impact but with less profit" (InterviewE1, 2011).

Figure 21: Indicative proposal for Heygate Street in Elephant and Castle (Moseley & Dunlop)

9.2.2 Collective perspectives: Identifying conflicts

The collective actor analysis shows that there was eventual agreement of Southwark Council as the appropriate organisation to lead on the concept and procurement of the MUSCO; however this agreement took time to build. Southwark used the planning process to formally set out the MUSCO goal and used the regeneration strategy and the public housing heating demands to create resource (land and customers) which could be exchanged with a MUSCO provider (London Borough of Southwark, 2011). Lend Lease remained a side participant to the MUSCO procurement process (InterviewP1, 2011) and the development agreement with Southwark required Lend Lease to connect their developments to the system if it was financially viable (Leader of the Council, 2010; InterviewD1, 2011).

The Planning Department supports the Regeneration Department by conditioning permissions for development in the area to require connection to the MUSCO where technically and financially viable (InterviewA1, 2011); effectively regulating development to build a stronger customer base for the MUSCO. This was accepted by those actors interviewed as appropriate. This reflects the institutional setting of Southwark, where the council had created a separate Regeneration Department reporting directly to the Chief Executive to establish a masterplan and deliver development in Elephant and Castle; the Planning Department was only responsible for

development application determination and development control. The council's project director for the Elephant and Castle regeneration explained that the planning permissions were granted on the basis that the new developments would be able to connect to the MUSCO but could not be compelled to do so. In return, the council would provide the MUSCO system; a council report on the procurement of the MUSCO describes the organisation they would like established: “The general intention is that the company should operate commercially in such a way as to discharge the planning obligations created by the council’s adopted supplementary guidance” (London Borough of Southwark, 2011).

However one department within Southwark did not share the Regeneration Department’s environmental goals or agree with the terms of the MUSCO contract: Southwark’s’ Finance Department, which had the power to support or approve such contractual obligations. The department did not understand the MUSCO or perceived it as financially risky for the council and were actively obstructive in the procurement process (InterviewP1, 2011). Interviews uncovered that this conflict was based in the conceptualisation of the role the Council should play in delivering the MUSCO and the level of financial risk or investment Southwark was prepared to take in infrastructure development. The former Regeneration Director described the conflict of orientation as “The politicians were being told by the finance team that we (regeneration) were now playing commercial development with the council’s resources and money, and putting the council potentially at risk” (InterviewP1, 2011).

Compounding this preference conflicts between departments, the analysis detects a lack of understanding or visible support by local politicians for the MUSCO. This was acknowledged by the councillors as well as identified by the Regeneration Director as a factor in strategy evaluations. He said “They (the elected councillors) were never terribly clear what legal entity of MUSCO was. They understood the profit share with the development partner, but for the MUSCO they were less clear on council benefit” (InterviewP1, 2011).

The perception of Lend Lease by other actors changes over time from initial neutrality, then to supportive, and then with the recession and the revised MUSCO proposal back into a neutral and then into a perceived non-supportive position. The original constellation was one in which Lend Lease were to take responsibility for delivering the MUSCO as part of their duties as regeneration partner. Once that was discounted and no actors expected them to be responsible for the delivery of the MUSCO, there was an expectation they would be supportive of a council-led procurement on financial grounds, despite it being a ‘new’ approach to delivering infrastructure. However when the system evolved to require more land and a larger, more prominent, energy centre, other actors perceived that this affected Lend Lease support as Lend Lease assessed the change to have negative impacts on the financial performance of the development (InterviewD1, 2011; InterviewP1, 2011).

Limitations and expectations of local and regional authorities

The strategy analysis of market influences, regulation, and intervention revealed how all the actors, with the exception of Lend Lease and local councillors, identified 'market capacity

building' as a strategy towards delivery of the MUSCO system. This reflects the novel nature of the technology in the London context, where actors are still learning about how to procure and negotiate to build the system. Lend Lease and local councillors both only used market shaping strategies; they did not see a need to influence creation of the MUSCO further than provide authoritative support. Other market shaping forces were largely limited to the GLA and the councils local departments. Across all actors there is a marked lack of market stimulation and regulation activities (e.g. incentives, grants, land assembly or customer-bringing activity) which would have shared and reduced the financial risk and encouraged the actors to build the MUSCO.

The analysis finds a significant amount of self-identified market capacity building which is not recognised by other actors as influential; this implies that the actor set is not learning from each other. While not included as a primary actor, national government departments continued this trend - they had self-identified capabilities and intentions to support shared infrastructure systems like the proposed MUSCO, but the research identifies they were not involved or influential at the project level.

The mayoral authorities had more potential to influence a MUSCO than capacity building; they could have funded or applied political pressure to support the system (Greater London Authority, 2009). However, the analysis identifies that the role of the Mayor of London and the GLA is an area of strategy conflict, where mayoral organisations self-perception and other actors' external perceptions differ. While published documents state the mayor's organisations had the capabilities and intention to play a strong supportive role by establishing policy, providing some seed funding, and sharing information, the mayoral organisations were perceived to be neutral and unsupportive by Southwark's Regeneration Department, local councillors and the external consultants. The Regeneration Department at Southwark instead relied on international case studies and consultants for information and capacity building (InterviewP1, 2011).

It was suggested by several of the actors interviewed that the MUSCO would have had more political will and understanding within Southwark if national or London political or organisational activity in support of the MUSCO had been stronger (InterviewP1, 2011; InterviewE1, 2011; InterviewG1, 2011). An exception to this was in the area of approving major planning applications, where the GLA's planning policies for on-site energy use and support for district energy required prospective developers, the GLA and Southwark to agree on technical heating and cooling specifications which would support future connection to the proposed MUSCO (InterviewA1, 2011).

How can the actor constellation be described?

At a strategic level – what is the main role for each actor – there are no main conflicts between the aspirations and preferences of all actors. The private sector expects the council to formally procure the MUSCO from the private sector; the local authority expects that the mayoral and civic bodies can provide information and capacity support.

However, three types of discord can be identified within the overall constellation. One where actors are perceived to not deliver on their stated roles, effectively requiring other actors to pick up the slack within the constellation and do more to achieve the same result. The mayoral organisations mentioned above serve as one example; a second is the change in councillor support for the MUSCO as despite backing the idea initially, they did not understand or support the procurement or the final decision to commit to the contract.

A second type of discord in the constellation is where a conflict in expectations led to a change in strategy by specific actors, but the governance network was sufficiently connected and resilient that the project continues. This was seen at the beginning of the MUSCO procurement process, where the initial thinking was that the regeneration partner could deliver the MUSCO as part of their activities. It quickly became apparent the council was better placed to lead, as the partner had little experience with MUSCOs and the council had better control of the public sector heating demand, access to road rights of way, etc. The roles and responsibilities of various actors changed, which required time and energy in negotiations, but in a way which enables the MUSCO delivery negotiations to continue.

A third, and potentially more influential, source of conflict in the constellation is where a conflict of expectations is not resolved, and actors continue to disagree on their roles and responsibilities and preferences for achieving the policy goal. The interviews identified clear conflict in expectations between different departments within the council. The discord was not expressed over the strategic goal of a zero carbon development (i.e. not environmental versus financial), but over the level of fiscal investment and risk and political risk the council should take to deliver the MUSCO. The internal conflict over the level of risk and investment the council could make became both a barrier and a negative influence: because the council would not guarantee timing and amount of new housing (and therefore levels of heating demand), Dalkia proposed a revised MUSCO which had a larger more prominent biomass energy centre. This very visible infrastructure raised further political and investment (and knock-on effect on land value) concerns within the council about the system and ultimately led to the Southwark's decision to withdraw from the project.

9.3 Interactions: Formal Negotiations and Unstable Networks

How can the mode of interaction be characterised?

In a strict interpretation of the ACI framework, the policy solution for the MUSCO in Elephant and Castle is played out in a negotiated mode of interaction, neither hierarchical nor unilateral. But this overarching categorisation masks the variation of interactions within the case and a general trend from what Scharpf classifies as positive coordination and informal bargaining towards distributive, formal bargaining with veto powers.

In establishing the concept of a MUSCO, the interaction between the regeneration department and design consultants can be described as a regular, fluid, and non-hierarchical design process aimed at solving a problem. Then as the interactions extended to include local councillors, Lend Lease, other Southwark departments, and local land developers they became

more structured knowledge-sharing and bargaining interactions, although they retained a non-hierarchical direction. The Regeneration Department did not have sufficient power over other departments, councillors or external actors to instruct them to support the MUSCO system. This is attributable to the structure of local government in the UK and the officer-councillor relationships, and to the legal context of the planning system. While the UK planning system provides hierarchical direction and policy, the approval of development plans and development applications has significant room for bargaining. As an example, Southwark could not force potential local developments to agree to connect to the MUSCO, but they could negotiate alongside planning permission for agreement to connect if financially viable, and require an energy performance level which encouraged connection.

The format of the MUSCO concession negotiations is determined largely by the formal EU procurement process. Interactions includes formal consultation on a published planning policy and the masterplanning vision, council meetings both public and private, and a range of bespoke meetings and reports to support the EU staged procurement tender. All these interactions are normal practice for a UK local authority which operates to national planning policies and to EU and UK financial, legal, and procurement rules, but they drive higher transaction costs for engagement, with private energy providers potentially spending several years in risky negotiation before securing appointment.

What are the relational characteristics?

The interviews indicate a high level of information sharing and frequent communication among a core set of actors directly involved in designing and procuring the MUSCO. The strengths of the communication within Southwark and with the development partner (Lend Lease) seem to be weaker. Communication within Southwark between different departments and with the officers is generally channelled through the former Regeneration Director and he admitted their communication on the topic of the MUSCO with councillors was irregular and low priority compared to other topics, such as social housing redevelopment (InterviewP1, 2011).

The pattern and quality of negotiations – in particular the complexity and length of the EU procurement process, and the weak communication on the topic of the MUSCO between LB Southwark officers and the elected councillors – is likely to have been a causal factor in the decision not to proceed with building the MUSCO system. Both were identified as such by more than one interviewee. Also, the concentration of communication and knowledge through one individual led to less resilient negotiations, with the other network connections unable to continue functioning when that actor left.

9.4 Conclusions: The Challenge of Changing Conditions

The officers and consultant team at Southwark's' Regeneration Department attempted a novel form of infrastructure provision on a large regeneration programme in central London. They used the planning framework to establish a challenging environmental goal in the 2004 *Development Framework*: "Promote a zero carbon growth strategy within the confines of the Elephant & Castle Framework Area" (p. 82) which necessitated a disruption of traditional

infrastructure provision and the engagement of new provider and financial structure. It was never going to be easy to build a new utility considering the novel nature of the MUSCO in Southwark, the scale of finance required and the number of actors involved.

The challenges of network governance

The set of interactions and actors for the attempt to establish a MUSCO at Elephant and Castle does not meet the first aspect, stability, of Sorensen and Torfing's definition of network governance. The case is characterised by change in individuals (e.g. the project lead leaving, political elections) and in organisations (e.g. the Regeneration Department was disbanded) which negatively affected the negotiations and decision making processes.

Apart from this, the network appears to fulfil the remaining aspects of Sorensen and Torfing's definition of network governance. The network was more horizontal than hierarchical in that while there was planning policy direction it did not unilaterally determine the council's decision making process or negotiations. The interactions between the actors are negotiations of framework agreements and concessions where the public sector needs the private and vice versa, making them interdependent but operationally autonomous. The rules of European procurement and the UK planning process determined much of the regulative, cognitive framework, providing the boundaries for self-regulation. And finally, the aim of the MUSCO concession was clearly in the public purpose – to deliver economic growth and housing without causing additional carbon emissions.

However at least six major influences on the failure of the governance network are identified through the research analysis. One, the concentration of knowledge and willpower in one individual; this weakened the network over time. Two, the lack of knowledge and capability within the actor set; this goes beyond the entrepreneurial nature of the policy goal and is linked to more structural challenges of capacity within a local government normally divorced from energy and utility infrastructure management. Three, the lack of 'house rules' led to instability in actor preferences and strategies, and to delay in action. There was eventual agreement across all actors that Southwark Council was appropriate organisation to lead procurement of MUSCO, but this required a change of preferences and strategies which took several years. Four, conflicting strategies and changing preferences within the council departments and by local councillors created barriers for interaction and negotiations within the actor set. Five, the constraints of the formal European procurement procedure which became extended and cumbersome when applied to a changing financial context, changing regeneration scope, and changing political goals. Finally, the wider context of a dramatically changing economy influenced the scope and timing of the regeneration programme and had a knock on effect on the proposed scale of the MUSCO system as well as actor orientations towards large scale financial investment.

How can the role of planning be described?

The role of Southwark's Planning Department is perceived by other actors as limited in relation to the Regeneration Department and the influence of the councillors. However the Regeneration

Department used planning procedures and interventions such as formal spatial policies, the masterplanning process, and planning application approvals to establish the relatively novel MUSCO concept, secure Southwark's financial stake in the potential MUSCO company, and encourage customers to connect. The powers of the Planning Department are used in both a ‘market shaping’ sense (to establish the environmental goal and MUSCO principle in planning policy) and in a ‘market regulation’ sense to build a potential customer base by requiring new developments to meet specific technical standards or else connect to the heating and cooling elements of the MUSCO system.

Chapter 10. Toronto’s Deep Lake Water Cooling: Hierarchy in the Shadow of the Network

Between 1972 and 1976, the City Council of Toronto connected six small separate district heating (DH) systems in expectation of building a downtown waste to energy incineration plant to fuel the combined heating system. The incineration plant was never built, but in 1982 the Toronto District Heating Corporation (TDHC) was formed as a non-profit entity wholly owned by Toronto City Council to manage the combined DH system.

In the early 1980s the idea of using adjacent Lake Ontario as a source of cold water to cool buildings in downtown Toronto was proposed by Robert Tamblyn of Engineering Interface Ltd. Coinciding with a significant environmental movement in Toronto’s political parties, civic society, and civil servants, the concept was well received and discussed for many years; various organisations and individuals kept the idea alive and evolving.

With the city-led redevelopment of downtown railway lands in the early 1990s, there was an opportunity to start a district cooling system by forcing the developers to build a small system. A few years later, the capacity of the initial district cooling system was expanded by joining it to the need to replace Toronto’s drinking water intake pipes. The railway lands are adjacent to the main water pumping station and the city's water intake pipes needed replacing. Toronto’s water is drawn from deep in Lake Ontario, where there is a cold and stable temperature of 4ºC.

A restriction on council spending authority required the capital investment for the water pipe and district cooling expansion to come from outside the city government. In 1997 Toronto City Council restructured the TDHC as a for-profit entity. In 1999 it the Ontario state pension fund, OMERS, invested $35 billion CD for a 57% ownership and the TDHC was renamed Enwave. The city has since sold its ownership in Enwave to private infrastructure company.

In 2002, following a environmental impact assessment, the replacement of the water intake pipe was undertaken and the first building outside the railway lands, 1 University Avenue, was connected to Enwave's district cooling system in 2003. By 2011 the DLWC system served 68 buildings in downtown Toronto, operating alongside Enwave’s retained district heating system.

A timeline of the development of the Deep Lake Water Cooling (DLWC) system is provided in Figure 22.

Timeline of Deep Lake Water Cooling Case Study	
1972 -1976	District heating networks connected together (InterviewS3, 2012)
1979	Councillors went on study tour of district heating in Denmark (City of Toronto, 1979).
1982	TDHC was created as an act of parliament as a not profit entity (City of Toronto Executive Committee, 1988)
Early 1980s	DLWC Idea emerged from Robert Tamblyn (InterviewE3, 2012).
1985	Official Plan for Railway Lands redevelopment approved, including 'encouraging' district heating and cooling within the Lands (City of Toronto Executive Committee, 1988).
1988	Toronto became the first city to adopt the target of reducing CO_2 emissions by 20%from 1988 levels by 2005 (Sustainable Energy Workgroup of the City of Toronto, 1999).
1991-1993	DLWC Investigation group hosted by the Canadian Urban Land Institute (Canadian Urban Land Institute, 1993).
1993-1994	DLWC idea evolved to link with drinking water (InterviewS3, 2012) (Sustainable Energy Workgroup of the City of Toronto, 1999).
1996	Railway lands development commenced, chiller plant built (InterviewS3, 2012).
1997	Environmental Task Force formed to provide advice to Council.
1997	Both former City and Metro Council approve plan proposed by TDHC to develop a district cooling piping system downtown, providing cooling through use of DLWC (City of Toronto, 1999).
1998	Amalgamation of City and Metro Toronto.
1999	OMERS and City of Toronto agree to be 50/50 shareholders in TDHC (City of Toronto, 2000); renamed Enwave.
2003	First building connected -1 University Avenue (Canadian Press, 2003).
2006	Metro Hall, the City's 27 storey office building in Toronto, connected (City of Toronto, 2006).
2012	DLWC serves over 68 customers with cooling (InterviewS3, 2012).

Figure 22: Timeline of Toronto's Deep Lake Water Cooilng case study

Context: Shifting local capabilities

Toronto is Canada's most populous city and the provincial capital for the state, or province, of Ontario. While the national political capital is Ottawa, and cultural capital in Montreal, Toronto is Canada's main financial and business centre, and a 'global city' in the GaWC (Alpha) and Global Cities Index (2012, #16). As of 2011 the city has over 2.6 million inhabitants, with the greater metropolitan area over six million. Located on the north shore of Lake Ontario, the city has an extended waterfront with the business district located approximately one kilometre inland.

The political and local government context is both clouded and defined by 'amalgamation', when in 1998 by provincial law the City of Toronto was created through the merging of six smaller municipalities. Driven by neo-liberal policies of provincial Ontario politicians who controlled local authority rights, amalgamation significantly affected electoral structures, public finances, planning policy and the civic relationships among city stakeholders. Janiero's 2012 article *E*

Pluribus Unum: Municipal Amalgamation and the City of Toronto and Frisken's 2008 book *Public Metropolis* provide useful recent overviews of amalgamation's procedures and effects although neither discuss energy utilities. While provincial legislation defines local authorities and planning capacities, interviewees were clear that national and provincial government departments were not active participants in the creation of DLWC or active promoters of DH or decentralised energy in urban areas (InterviewC4, 2012; InterviewE3, 2012; InterviewG2, 2012).

10.1 The Actors

This section introduces the primary actor set in the delivery of DHC in Toronto, describing the institutional setting, resources, and capabilities of each actor. Appendix C contains the codes and information sources which provided this understanding of actor powers and capabilities.

Toronto City and Metro government

The amalgamated Toronto government operates a mayor-council system, with the mayor elected by popular vote as a Chief Executive. Local councillors are elected on the same four year timetable from geographical city wards and influence decision making through a ranked committee system, with the mayor leading the executive committee. No mayors were mentioned as directly engaged in the decisions around DLWC, however David Miller, mayor from 2003 – 2010, is publicly recognised for his support of environmental 'cleaner and greener' initiatives (Boudreau, Keil, & Young, 2009).

The city government has a number of departments which have been mentioned in relation to DLWC, including the Environment Office, the Budget Office, Toronto Water, the Facilities and Real Estate Division, and the Planning Department (Community Planning Office, 2006; City of Toronto, 2006; InterviewG2, 2012). The interviews indicate that while the Toronto Environment Office and Energy Efficiency Office are supportive of DLWC, they were not actively engaged (InterviewP5, 2012; InterviewG2, 2012) in the decision to invest and build DLWC.

The Planning Department of the City of Toronto has the responsibility for developing and enacting the *City Plan* which provides both a growth development strategy and a land development approvals process for the city (InterviewP5, 2012). These are accompanied by more structured and codified 'by-laws' which control land uses, design, and the relationship to the public realm. The institutional context can be characterised as 'metropolitan land use management, building on literature comparisons with American cities (Frisken, 2008). Planning powers and context are defined by provincial laws, not at a national level. The general legislative structure requires municipalities to prepare a general plan, a land use zoning and subdivision by-law, and an approvals process. Special or specific plans can also be permitted. General plans include transport and civic infrastructure. Building regulations around health and safety – and to some extend energy efficiency – are set at provincial Ontario level (InterviewP5, 2012). Filion (2002) and Boudrea, Kiel, and Young (2009) both provide relevant context and history on the powers and orientation of Toronto's Planning Department, documenting how the department follows a post-fordist pattern in municipal powers, away from rational comprehensive planning in the 1960s to a project-based approach with severely lessened

resources in both staff and regulatory power by the mid 1980s. Filion emphasises how the planning documents of the 1980s took a “powerful environmental stand” (p. 432) which continued through the 1990s.

Toronto Water merits specific mention as the city department responsible for the supply of and the quality of water in the city. It acts as both a regulator and a utility, with oversight by provincial law (InterviewG5, 2012).

Figure 23: Photograph of Toronto's downtown skyline (Taxiarchos228, 2008)

Elected local officials

Three councillors are repeatedly linked with DWLC in reports, interviews, and press statements or articles. Richard Gilbert served as first a city and then a metro councillor from 1976 to 1991, and is mentioned throughout that period in council reports, particularly when he served as Chairman of TDHC from 1982 to 1989. He later became president of for the Canadian Urban Land Institute, where he initiated the Deep Lake Water Cooling Investigation Group (InterviewE3, 2012). Jack Layton was councillor from 1982 until 1991, before he became the local member of Parliament in 2004 and head of the national opposition party. He was outspoken on environmental issues, chairing task forces and championing causes such as DLWC, which he supported through charettes, conferences, and public promotion (InterviewC4, 2012). Dennis Fotinos was a local councillor from 1991 to 1999 who became Chairman of the TDHC before leaving politics to become Chair of and then Chief Executive of Enwave, the company which operates DLWC (Enwave Energy Corporation, 2011).

Public utilities

During the course of this case, the Toronto District Heating Corporation was restructured and became Enwave, the provider of DLWC. It began as a non-profit cooperative in 1982 (City of

Toronto Executive Committee, 1988); it was formed from smaller district heating systems at institutional complexes (City Services Committe, 1982) at the instigation of Toronto's Commissioner of Works, eventually growing to provided steam-source heating via six plants serving over 100 institutional customers. The connection was made not for environmental reasons, but in expectation of the construction of a waste to energy plant which was under detailed consideration by the Council as a way to address Toronto's landfill shortage (InterviewE3, 2012).

Toronto Hydro is the municipal electricity distributor for Toronto; it was also enlarged through the merging of six municipal distribution companies in the 1998 Amalgamation. While incorporated, the sole shareholder is the City of Toronto (Toronto Hydro, 2012). Despite its name, Ontario's provincial electricity supply is generated via mix of hydroelectric, coal, nuclear, and wind.

Private sector actors

The main private sector is Enwave, originally established as the TDHC non-profit cooperative. In 1998 it became a private, for profit entity, owned jointly by an arm of the Ontario Municipal Employee Retirement System (OMERS) with 57% shares and the City of Toronto with 42% shares. The privatisation of Enwave brought the funds need to invest in the city water pipe intake and cooling equipment to establish the DLWC system. The total cost of the Enwave project in Toronto was over CD $235 million, including $175 million in capital costs and $55 million for a new city water intake (Newman & Herbert, 2009).

The Chief Executive was previously city councillor on the board of the previous TDHC. Enwave runs a seasonal business supplying chilled water and hot steam to downtown Toronto businesses; in the winter it pipes hot steam and in the summer it pipes cold lake water in a system which is linked to the city's main pumping station for sewage and drinking water. In total, the "company owns and operates three modernized steam plants and a new state-of-the-art cooling plant in downtown Toronto. Enwave also manages a large district energy plant in Windsor, Ontario" (Enwave Energy Corporation, 2011).

Unique to this case study, the Ontario government employee pension or retirement investment organisation is a significant actor. Known as the Ontario Municipal Employee Retirement System, the OMERS pension fund has over CD $55 Billion assets as of March 2012. The pension fund is an actor relevant to DLWC in two ways: primarily as an owner of Enwave jointly with the City of Toronto (Enwave Energy Corporation, 2011), and secondly as a customer of the DLWC system through its real estate investment arm, Oxford Properties (InterviewU2, 2012).

Other private sector include the coolth customers of Enwave, the buildings and their owners or operators. These include the Steam Whistle Brewery, the Air Canada Metro Convention Centre, 1 University Avenue, the Tridel residential development, and the Toronto-Dominion Centre.

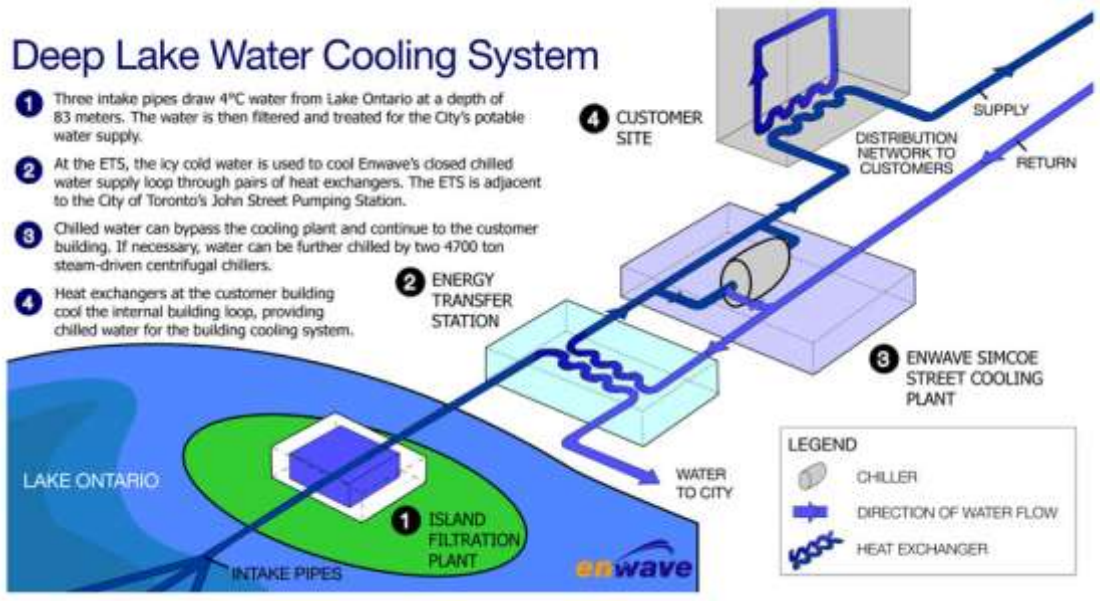

Figure 24: Diagrammatic illustration of DLWC cooling system (Enwave Energy Corporation, 2011)

Civic actors

The research uncovered a civic actors supportive of the DLWC system, such as the Ontario Clean Air Alliance, a campaigning group which raised air quality as an issue in the city and indirectly supported DLWC (InterviewC4, 2012). Of worthy note were a series of civic environmental roundtables hosted by the city and metro governments. The roundtables consisted of city councillors, city staff, representatives from environmental agencies, citizens, environmental groups, and schools and were responsible for preparing an environmental plan for the city.

Alongside these publicly posted discussion forums, the Urban Land Institute's Deep Lake Water Cooling Investigation Group served as a civic forum to discuss DLWC outside City Hall. This latter group was formed by Richard Gilbert, a former councillor and Chairman of TDHC, in the mid 1990s to investigate options for the DLWC idea and involved representatives from local businesses, local environmental NGOs, city departments, and provincial ministries. (Canadian Urban Land Institute, 1993).

Table 25 provides a list of the primary actor set for reference.

Market	Government	Civic
Building Owners (customers of DLWC)	City of Toronto (generally)	Canadian Urban Land Institute- Deep Lake Water Cooling Investigation Group
Enwave	City of Toronto: Planning Department	
OMERS	City of Toronto: Toronto Water	
Toronto Hydro	Elected Councillors	
Toronto District Heating Corporation (TDHC)		

Table 25: Set of primary actors for Toronto

10.2 Analysis of the Actors and Actor Constellation

This section describes the self-identified and collective actor analysis. Appendix C contains the detailed stakeholder analyses matrices which are described here.

10.2.1 Self-identified analysis: Apparent agreement

The self-identified actor analysis of how the actors collectively understand their role and each other finds consistently strong interest in DLWC as part of support for environmental quality in the city; this orientation cut across political, business, and city actors. Interviewees cite a public interest in the environment and the city's civic environmental advisors (there were several official groups) as important in shaping actor orientations, such as councillor interest in DLWC (InterviewC4, 2012; InterviewP5, 2012). The city's environmental roundtables supported DLWC and saw district heating and cooling is a cost-effective and efficient way to heat and cool buildings (Toronto Environmental Task Force, 2000). They both formed and reflected a supportive civic awareness of environmental issues among residents, businesses, and city staff (InterviewP5, 2012). A typical early 2000s city committee report on the DLWC proposals reads as follows:

> Using deep lake water as a cooling source will reduce the demand for electricity and enable removal of ozone depleting refrigerants from existing building cooling systems. Based on the estimated peak cooling capacity of 40,000 tonnes, carbon dioxide emissions would be reduced by approximately 30,000 tonnes per year, along with reduction in nitrous oxides, sulphur dioxide and fine particle emissions. There would also be economic benefits to consumers to the extent that district cooling using deep lake water is less costly than conventional cooling using electric chillers. (City of Toronto, 2000)

After twenty years of discussions and options investigations, DLWC is understood by the actors as a good environmental goal. The focus of the actor set at therefore was not should the city build DLWC, but how should it be built; how to negotiate how to build it, where to find the capital investment required, and how to best leverage existing control over utilities, customers, and downtown land. The following paragraphs discuss the actor orientations to this problem; they describe a consensus for city leadership on creation of a DLWC system, supported by an institutional context of local government authority over local utilities.

A history of city government ownership and control of utilities such as the electricity distribution utility, Toronto Hydro, and the TDHC help establish a conceptual precedent for direct action by the city in major utility infrastructure. But the municipal government's ability to build and operate DLWC was constrained by financial capability, particularly following the stresses of amalgamation in 1998 (InterviewE3, 2012). Instead, the city's ownership and ability to masterplan the railway lands during the late 1980s in downtown Toronto provided a source of power over resources DLWC. By establishing the potential in the masterplan and then requiring the developers of those lands to invest in and use a central chilling system, the city raised funds and created the first customers for the DLWC system (InterviewS3, 2012).

While the city government used its planning powers to support DLWC, the Planning Department within Toronto admitted their policies or spatial planning activities did not actively promote it. "Planning was made aware and we participated but we weren't a driver at all" said a current project manager in the Planning Department (InterviewP5, 2012). A search of the city's committee minutes unearthed at least one grant of building permission in 2006 which has a requirement of the permission that the building connect to DLWC (Community Planning Office). While supportive of the concept, the department's staff capability to act was constrained by staff cuts and amalgamation's significant technical exercise of merging six city plans and bylaw codes into the new *City Plan* (Boudreau, Keil, & Young, 2009; InterviewP5, 2012). This changed after DLWC was constructed; the 2010 *City of Toronto Official Plan* explicitly supports the DLWC in policy and encourages development to connect 'where feasible'. And the city now employs a DHC specialist to support the planning and environment offices in developing new systems (InterviewP5, 2012).

An interview with the Director of Toronto Water interview indicated Toronto Water was supportive of DLWC as a technical exercise which provides them with a larger and newer city drinking water pipe. He described the situation as

> It adds complications to our operations but being a part of the city we understand the benefits of doing it and sometimes we do things for the greater benefit of the city because we are a division of the city. So we've gotten benefits from it, don't get me wrong. There have been some documented benefits. We've gotten a new intake pipe that goes five kilometres out that gives us better cleaner water so that's a benefit and we've upgraded the island plant that was a seasonal peaking plant now it's a full year plant. (InterviewG5, 2012).

Toronto Water sees their role as mildly regulating Enwave's building and operation of plant to ensure clean drinking water, particularly the interface where cooling is removed for use in DLWC (InterviewG5, 2012). Another city capability not explicitly outlined above but which the Environment Office highlighted in interview was the city's ability to sensitively manage the environmental permitting and assessment process required for new Lake Ontario pipeworks (InterviewG2, Director, Toronto Environment Office, 2012) on behalf of DLWC.

The perspective of local elected officials was mixed. While influenced by civic and mayoral action for the environment, not all councillors were explicitly supportive of public sector investment in a district cooling system (Moloney, 2003). In the end they voted for investing and supporting DLWC, but this was after they saw additional benefit in an improved drinking water pipe (InterviewS3, 2012). The three former councillors interviewed for the research all preferred a public private partnership approach (compared to public only or private only); they felt that a fully private entity would not have risked building the system, and that a fully public entity would not have had sufficient upfront investment (InterviewS3, 2012; InterviewE3, 2012; InterviewE2, 2012). One also believed that political (i.e. their) support was needed to make Toronto Water and Enwave share the pipe through a transfer agreement (InterviewE2, 2012).

The private sector actors were also supportive and brought valuable skills and resources towards building and operating DLWC. TDHC had experience with building and operating a

district heating system in the downtown core, but recognised that its customers were not particularly happy with their financial management and billing approach (InterviewE3, 2012). There is a gap in understanding the full extent of OMERS resources and orientations towards DLWC over time, however they operate a specialist division to fund large scale infrastructure, and were publicly supportive of their initial investment. The company's real estate division (Oxford Properties) was also the first private sector customer of the system, with senior staff enumerating the benefits;

> Oxford is proud to lead our industry toward the use of renewable energy sources in office towers; however, the decision to adopt Enwave technology was also good business for our customer-tenants. This energy supply will add value to the property in the long term. Our decision will also contribute towards the Kyoto targets for emission reduction, as well as eliminating the use of CFCs, avoiding significant capital outlay for equipment, and freeing up operational resources to focus on serving our customers. (Canadian Press, 2003)

It is not just OMERS who cites a range of benefits for both property owners and occupiers; quotes from historical Toronto Star articles and press releases indicate other property owners and occupiers have historically been supportive for reasons of energy efficiency, air pollution and cost savings (Canadian Press, 2003). A Vice President of Oxford Properties sums the customer orientation up as: "There was our opportunity to act responsibility, there was our opportunity to have as it were guilt free air conditioning. So that that appealed, and....fixing future costs " (InterviewU2, 2012).

Finally, the DLWC Investigation Group final report set out a clear recommendation for the city to lead and 'carry' the creation of the DLWC system, coordinating federal and provincial agencies. The Group comprised a wide spectrum of potential actors, building owners (potential consumers), environmental NGO's, TDHC engineers, various city departments, and provincial organisations. The report considers options such as implementation by existing utilities and private sector property companies, but recommends that city should have the responsibility to coordinate DWLC and other cooling efficiency measures (Canadian Urban Land Institute, 1993).

What are the actors' self-identified capabilities, orientations, and preferences?

In the negotiations about how to implement DLWC, the actor set is a well rounded mix of public, private, and civic actors and contain a strong breadth of experience, funding, and political support. The analysis identifies five specific actor capabilities which supported the eventual creation of the DLWC system, alongside an institutional setting which was explicitly positive about changing the city to have less environmental impact. The history of city-supported district heating in Toronto gave customers, funders, and engineers' an awareness of the concept, as well as a grasp of the technical aspects of connections to buildings and the level of infrastructure and cost required to build the DLWC. This lowers the 'barrier to entry' for negotiations and discussions in the network.

Similarly, the city council retained a level of control over the local electricity and water distribution utilities which overcame potential barriers. With Toronto Hydro, the council positively

influenced the potential competition for DLWC. The retention of Toronto Water as a public department of the council effectively meant the city owned a free source of cooling, although there was investment needed to upgrade the intake pipes and establish a coolth transfer plant.

The fourth supportive characteristic of this actor set is the three local councillors who persisted in supporting DLWC over many years. This long term support by local elected officials effectively constituted the set of interactions which formed the governance network: recurring conversations, meetings, investigations which forced others to discuss their orientations and preferences about the DLWC concept. Finally, the introduction of a 'friendly' actor to provide investment and finance in the form of OMERS is important in overcoming constraints on capacity within the actor set.

10.2.2 Collective perspectives: Negotiating a successful constellation over time

When the analysis turns to look at the collective perspective it uncovers additional conflicts in preferences and expectations between actors. Two areas where potential conflict could have appeared but did not are also noticeable: part-privatization of TDHC from a government non profit, and involvement of Toronto Hydro. For the first, despite an acknowledgement from the Chief Executive of Enwave, that "one of the big challenges was convincing the city councillors to privatise the company" (InterviewS3, 2012) there was a clear picture of the positive expectation from a number of actors, civic groups as well as local politicians for the city to work with the private sector. Two interviewees voiced explicit distrust in provincial and municipal capability to handle such projects such as DLWC (InterviewC4, 2012; InterviewE3, 2012). But local councillors did find the approach easier when the funder was OMERS, effectively acting with the same values as the government; the Chief Executive explained it was communicated as, "We're not really privatizing, we're selling it to our pension fund." (InterviewS3, 2012).

The collective actor analysis also uncovers a direct conflict among actor preferences about DLWC with Toronto Hydro initially preferring to compete with the DLWC concept and create their own DHC system. The electricity distributor sought to form their own cooling system before being instructed to desist by the city council (City of Toronto, 1999; InterviewG2, 2012), and then, allegedly upset at the council's support of Enwave, Hydro used the Environmental Assessment process to force a change in the management structure at Enwave (InterviewG2, Director, Toronto Environment Office, 2012). From Toronto Hydro's perspective, the city (who officially owns Hydro) was supporting a competitive venture, taking away potential customers. It required both hierarchical direction and distributive bargaining between 'summit' level staff to resolve this conflict, with Toronto Hydro quietly putting aside its competing cooling system.

As for the remaining actors, their perceptions tended over time towards an alignment of preferences, but demonstrated some changes during the development of the DLWC idea into reality. On the whole, city councillors were consistently identified as important to the creation of DHC in Toronto. Interviewees recognised the benefit and contribution of individual councillors who were supporters of the idea; Richard Gilbert and Jack Layton were mentioned explicitly by

almost every interviewee as long-term advocates. Other actors also reiterated the need for general councillor support of investment in environmental programmes and policies. Councillor participation in the Environmental Roundtable and Canadian Urban Land Institute discussion group helped, but in the end it was not an environmental goal but a drinking water solution that brought wide-ranging support and the political will for the city council to direct Toronto Hydro and the Toronto Water department to support DLWC (Moloney, 2003; InterviewU2, 2012).

Building owners were perceived as generally supportive and interested in the environmental benefit and long term cost savings of DLWC, but others recognised that they would need encouragement and fair negotiations about the costs and benefits of DLWC (Canadian Urban Land Institute, 1993). The contracts for cooling and or heating connection are twenty year contracts of significant value, and owners would be cautious because of the tradition of mis-management by TDHC (InterviewU2, 2012). The Chief of Executive of Enwave explained,

> When I went out to the marketplace to start selling deep lake water cooling, there was massive customer resentment...The right thing was greater transparency on contracts, customer transparency involvement in the decision making process in terms of getting involved and understanding how district energy worked...That our efficiencies were better than theirs, and reliability. (InterviewS3, 2012)

The city government as a whole was perceived to be interested in environmental measures, and recognised that property and buildings should be a focus for environmental resource and pollution policy alongside transport and consumer behaviour (Sustainable Energy Workgroup of the City of Toronto, 1999). There was a strong preference for the council to "lead by example" (InterviewE2, 2012) on the DLWC system, although with recognition the city was limited in its ability raise money due to provincial controls and therefore a joint venture approach was acceptable. However after privatization of TDHC into Enwave the city did not actively pressure building owners to connect, nor did it seek to connect all municipal property (InterviewS3, 2012).

There was no significant opposition to DLWC and Enwave from other city departments. Toronto Water was perceived to be supportive because it needed a new drinking water intake, although several interviewees commented on the length of the coolth transfer negotiations; the department was concerned to protect the water quality. As Richard Gilbert a councillor remarked, "There were tough negotiations around water because the water people were fanatical...but they were eventually resolved" (InterviewE3, 2012).

Enwave also deliberately changed the way it marketed and contractually provided heating and cooling to encourage customers; once cooling prices were fixed against inflation, the 'price hedging' proved very attractive (InterviewS3, 2012). “The vast majority of my counterparts who have had the opportunity to sign up to this have signed up to it” (InterviewU2, 2012), commented the Senior Vice President at Oxford Properties.

The Planning Department was perceived by others as not as involved as it could have been; two interviewees suggested department could have used planning policy and energy masterplanning to encourage connection. Eventually connection to DLWC was recognised as a

social benefit and encouraged through development policies (InterviewS3, 2012). While it was recognised the department could have been more involved, its absence was also not seen as a barrier to development of DLWC.

Market influences: The city influences the market

The strategy analysis identifies that the primary actor set included all four categories of regulation – market shaping (councillor), market regulation (Toronto Water over the pipes), market stimulation (campaigns and price restructuring by Enwave), and market capacity building (Urban land institute, city-convened environmental experts, and the District Heating Corporation). Regulatory market intervention was the weakest of all four, with only a mild veto form arising from Toronto Water on water quality standards and a small number of planning development approvals which require new buildings to connect. Market shaping activity and strategies were the strongest categories displayed, with some incentivising pull strategies and these were mostly post creation of Enwave between potential customers and Enwave. Finally, capacity building activity could be found by almost all actors, this reflects Toronto's civic and environmental awareness as well as the long gestation period for DLWC.

In the collective strategy analysis there are no major gaps in what was expected of actors and what was actually delivered. Both interviews and publications such as the *Environment Task Force Report* (2000) saw a clear responsibility for the city council to lead, and the city eventually created a constellation of resources and orientations to succeed. And while a retrospective view of a successfully operating network is less likely to highlight failures, there was no mention of attempted regulation by the wider actor set – i.e. provincial regulation or incentives – which could have existed and failed to influence the creation of DLWC.

How can the actor constellation be described?

The actor constellation can be summarised as three separate arrangements over time. Starting in the mid 1980s, local councillors were inclined to support a technical idea because of their interest in the environment and they saw a potential benefit to an existing city-owned heat system. However the council lacked financial resources to build what was then envisaged to be a larger cooling system, and could not see immediate benefit for such an upfront cost. There is no sense that occupiers or others were publicly encouraging DLWC.

Then in the early 1990s, the city used its land ownership to force developers to pay up front for a small portion of the cooling plant and to connect to the cooling system. At the same time, the DLWC investigation group and environmental roundtables place a more public expectation on city leadership to address cooling demand in Toronto. The benefit of the DLWC concept, however, is still assumed to only accrue to potential customers and the environment.

In the late 1990s, the concept of linking DLWC with the city's water intake brought a second benefit to city departments and the wider population, which local councillors recognised. However the city's resources are further constrained by amalgamation, in which provincial responsibilities were handed to the city without parallel budget support. City councillors and city departments then privatise TDHC to raise financial capital from OMERS, and use their control

over Toronto Hydro and Toronto Water to direct their support and engagement. Enwave then negotiates with interested building owners for connection and long term supply.

The actor constellation changes in response to conflict in preferences and strategies in at least two ways. One, Enwave adopted a more transparent and market sensitive pricing approach, which encouraged customers to participate in DLWC. Two, the city council went from being partially supportive of district cooling in Toronto to actively shape the market by instructing Toronto Hydro to desist from creating their own system. This overcame a conflict between Toronto Hydro as distributors of electricity and DLWC which replaces electricity used for chilling buildings with cold water distribution.

10.3 Interactions: Hierarchical Direction to Positive Coordination

How can the mode of interaction be characterised?

Across the case there are several types of interactions visible: hierarchal direction through to positive coordination negotiations. The city's instruction in the railway lands development to fund the initial network was hierarchical, instructing the developers 'if you want to build, you must pay up front' (InterviewE3, 2012). The city's conversion of TDHC into Enwave with OMERS is a mix of styles in itself. It controlled the TDHC and effectively gave it no choice in the move to partial privatisation; while Enwave was officially a joint venture, with risk and value shared, this was a judgement call by OMERS on the potential value of the system, not a fair exchange of resources on a guaranteed income. OMERS saw the potential of a functioning cooling system and agreed a partnership as appropriate for them to bring in sufficient funds to build the pipes and the transfer station.

While that value-based negotiation was occurring with OMERS, the city council exercised its control over other utilities to protect the potential value of Enwave. The council instructed Toronto Water to negotiate an energy transfer agreement with Enwave, which the council then approved (City of Toronto, 2001). These negotiations between Enwave and Toronto Water were described by interviewees as positive coordination: both parties wanted to achieve outcome, and both were concerned with fair settlement. But the city council's intervention was needed to start negotiations (InterviewE2, 2012). The city also formally instructed Toronto Hydro to stop competing with Enwave (City of Toronto, 1999); this was on paper an instruction, not negotiation, as the city is sole shareholder of Toronto Hydro. However Toronto Hydro's management threatened to make the environmental impact assessment (EIA) process difficult and "that led to a power play and the head of Enwave..was terminated his job and Toronto Hydro dropped their appeal for a bump up to a full EA" (InterviewG2, Director, Toronto Environment Office, 2012). This type of exchange, what Scharpf terms 'distributive bargaining' with side deals, are more characteristic of policy network exchanges within governments (Scharpf, 1997, p. 129).

And finally, the way in which a newly formed Enwave negotiated with customers, incentivising them through inflation linked contracts and service commitments (InterviewE3, 2012) can be

characterised as positive coordination, without hierarchical direction from the city. Both sides recognise problems and issues, and are concerned with fair settlement, but they are inclined to engage and find a solution.

What are the relational characteristics?

While an exchange of resources – you pay this, I'll build that - is central to building a district heating or cooling system, this case study demonstrates the importance of non-exchange interactions in building a DHC system to support policy goals.

The establishment of DLWC is characterised by a long gestation period with wide-ranging actors engaged in discussing options for a lake cooling system, and by the support of specific individuals over the period. Five specific individuals, two councillors, one commercial landlord, and two engineers, were consistently mentioned as promoters or champions of DLWC, working overtime to find a coalition that could build the system. Knowledge was shared and orientations shaped through non-political dialogue, with discussions hosted outside government (the Canadian Urban Land Institute working groups) and without forcing a decision through formal policy (and policy negotiations). When policy did emerge, via a civic environmental roundtable in 2000, it was supportive of the approach taken by the city to establish Enwave (Toronto Environmental Task Force, 2000). "The City of Toronto had a special advisory committee on the environment which produced a number of reports on how Toronto could meet its greenhouse gas reduction targets. I joined about 1989, and that about the time those few years that we issued reports and I know Deep Lake Water Cooling was one of the solutions we supported." (InterviewC4, 2012).

And those interviewed believed this individual support from all sides was important to making DLWC and Enwave happen. As the CEO of Enwave said, “So a lot of credit goes to Andrew MacAllan, you really need champions in all these organisations. You can’t make district energy work without champions, you need champions politically – there’s Jack, then Richard. When we created Enwave I was working on the inside. And they were working on the outside. You need political champions; you need business champions” (InterviewS3, 2012).

10.4 Conclusions: Hierarchy in the Shadow of the Network

On reflection, this case provides insight into the significant challenges of large investment in communal infrastructure in a modern policy context. DLWC had many supportive contextual factors and governance behaviours: the practice of collaborative policy making in CULI and the Environment Roundtables, a significant degree of public control over local utilities, advocating local politicians, a civic green movement, and a history of district heating. And a successful governance network would have not been built without supportive customers and supportive finance through OMERS. But nevertheless DLWC took approximately 20 years to go from idea to reality and in the end it required the city council to employ hierarchical powers (in development agreements and a straightforward mandate to departments) and political bargaining (with Toronto Hydro).

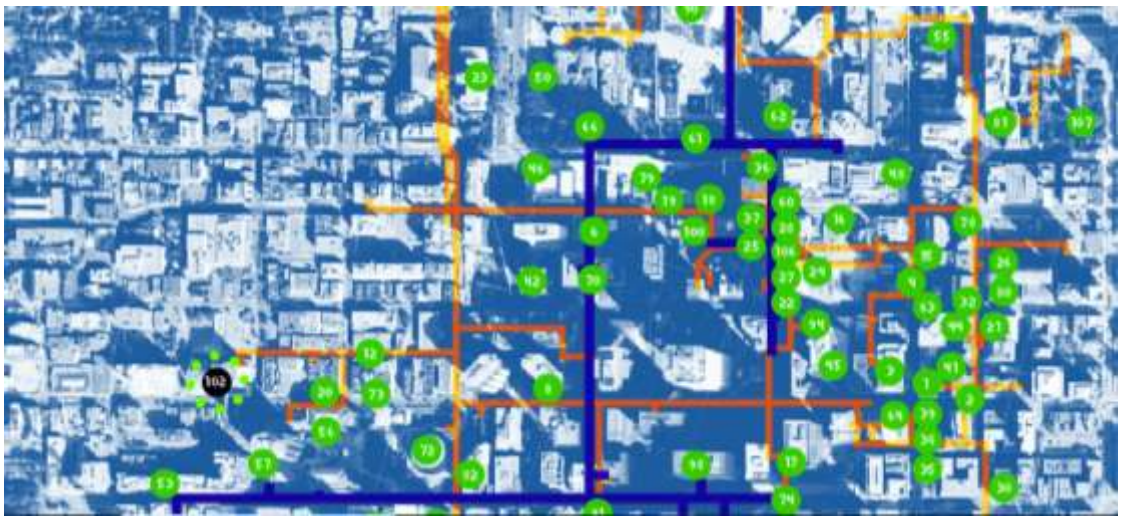

Figure 25: Screenshot of Enwave website illustrating the DLWC and steam systems (Enwave Energy Corporation, 2011)

Is this network governance?

Reflecting on this case in light of Sorensen and Torfing's definition of network governance, the set of interactions and actors fulfils all of their defined qualities. The primary set of actors is relatively stable, including those councillors who did leave politics staying engaged through other organisations. Amalgamation created major change in the formal government reporting lines and functionalities; however individuals remained. The network interactions are more horizontal than hierarchical, particularly outside city council ownership, and the interactions are operationally autonomous. The city did not establish a grand plan or force customers to connect to Enwave but sought out an equal partner for investment and encouraged connection through the masterplanning and planning policy. The set of interactions displays numerous negotiations, (not only value-based negotiations) between the city council and OMERS, the city and Hydro, between Enwave and every customer for the price and conditions of connection but also negotiations of perspective – discussions about why DLWC should be supported. All actors operate within a similar normative framework, particularly the backdrop of amalgamation and shrinking public finance. Finally, the concept of DLWC as an environmental policy goal is recognised by all as providing not only cheaper energy but also public benefit in reduced electricity usage and carbon emissions.

Looking at this case superficially, one could argue that the approach taken to deliver DLWC was simply part of a wider trend towards public-private partnerships in the face of reduced public sector power and financial capability. And clearly the political backdrop of Amalgamation and neo-liberal politics supported partial privatisation of TDHC. But to focus on the more hierarchical powers used by the City of Toronto would ignore and discredit the 20 years of open discussion, charettes, working groups, environmental advisory groups and council committee reports which influenced and in many cases structured the set of interactions between the city council, Toronto Hydro, Toronto Water, OMERS and TDHC which finally built the pipes into Lake Ontario, the transfer station, and the customer servicing system. If governance describes "a practice of coordinating activities among citizens, activist organisations, lobby groups, the private sector, and other stakeholders" (Sorensen & Torfing, 2007) the creation and operation of

Deep Lake Water Cooling in Toronto demonstrates that when public authorities are part of a negotiated consensus which provides the basis for coordination, they can subordinate hierarchy to the goals of the network.

How can the role of planning be described?

In this case, planning organisations and planning policies are less important than political activity and civic environmental pressures. Individuals in the Planning Department admit the department was not actively engaged, both lacking in time and knowledge to support. However a one-off urban masterplanning process for development land provides a method of market shaping and regulation intervention for the city to promote district cooling through its control of public funds and public lands. Planning interventions are therefore used to create DLWC, with planning policies which provided regulatory interventions (green building policies) and market stimulation incentives (recognition as a community contribution in negotiations) emerging some years later.

Chapter 11. Comparative Analysis

This chapter compares findings and analysis across the five case studies described in Chapters 6-10. It uses the components of ACI to examine features of all five cases, comparing these with the cases' ability to implement DHC. This comparative evaluation of variables in light of the policy outcome forms the empirical response to the research questions. The chapter first considers how governance networks support DHC by evaluating if particular actors, constellations or interactions are particularly conducive to delivering urban DHC. It then turns to the second research question to consider the effect of the institutional setting on the components of ACI and the delivery of DHC. It ends with a review of trends in planning organisations and interventions to response to the third research question.

How the research employs Actor Centered Institutionalism

Chapter 5 describes the usefulness of comparative studies in qualitative research and sets out how Scharpf's Actor-Centered Institutionalism (ACI) framework informs the case study selection and the analysis within each case. As illustrated in Figure 26, there are five components which drive policy outcomes in ACI:

- A particular institutional setting, which influences the remaining variables
- A specific policy problem, which drives the
- Specified actors, capable of strategy building around
- A constellation of actor interactions, which happen with limited knowledge but rationally
- In particular styles, or characters, of interaction.

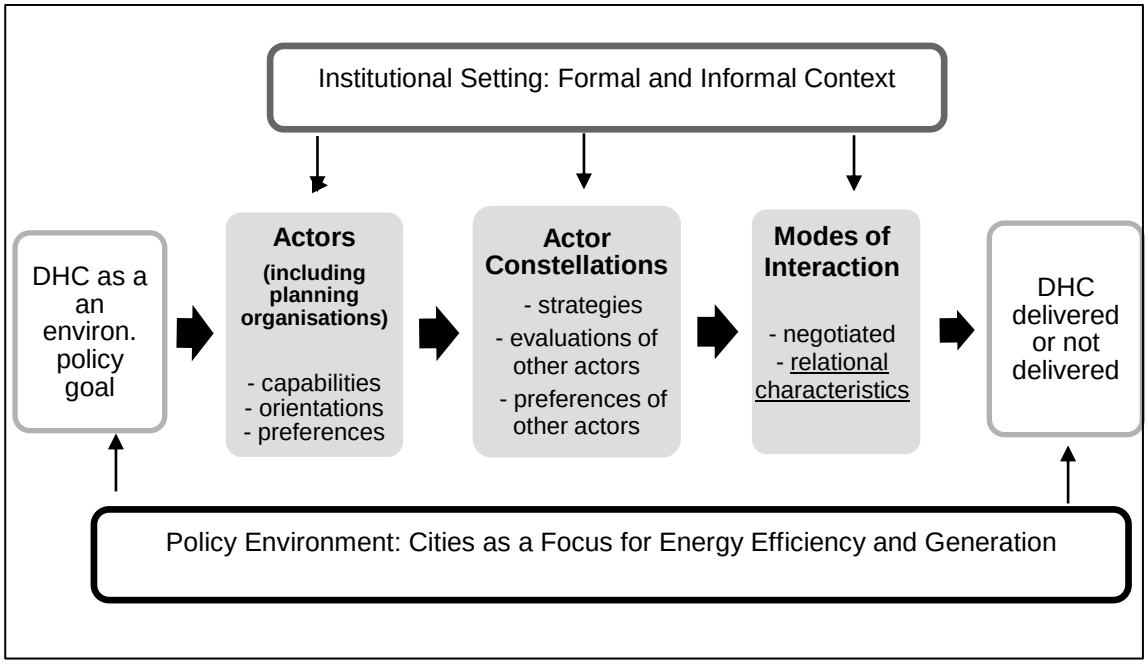

Figure 26: Scharpf's (1997) Actor-Centered Institutionalism applied to DHC, copied from Chapter 4

For this research, the problem is defined as the delivery of a DHC system in an urban area, and the outcome is the success (or failure) of building and operating a DHC system. To structure the research, the institutional setting was limited to cases with both public and private actors engaged, the actor set in all cases includes local planning organisations, and the research posited that the 'given mode of interaction' is likely to be a 'negotiated' approach based on the type of policy challenge that DHC presents.

11.1 How do Governance Networks Support DHC?

To respond to this first research question, the comparative analysis considers the relationship of ACI's actors, actor constellations, and modes of interaction to the five cases' policy outcome of DHC delivered or not delivered.

11.1.1 Is there a relationship between actors and DHC delivery?

Which actors are involved?

Comparing the primary actor sets across the cases, the similarities are more apparent than differences. Similar actors appear across the market and public sectors in all cases, while the civic actors are fewer and more variable. Table 26 below summarises the primary actor set in each case study.

Looking first at market actors, consultants appear regularly, as do some form of private utilities companies. The comparison highlights that while governance networks in London and Barcelona included private multi-national energy companies, this specific type of actor is absent in Toronto, Lerwick, and Burlington. This did not affect the ability of Toronto or Lerwick to deliver DHC; in both cases the governance network organised local companies to build and manage the system, bringing in finance and knowledge from other actors. Burlington does not have a preferred pathway to deliver DHC through public or private utility company. The existence of OMERS as a state employee pension fund in Toronto's network is noticeable. Also noticeable but expected from the literature review is the relative absence of existing private sector utility companies from the primary actor sets. While Lerwick has Scottish and Southern Electric, they refused to supply SHEAP and their absence limited the size of the DH system.

Turning to the second column and the scope of government actors, local planning departments can be expected to be involved given the research methodology and case study. National government actors are noteworthy by their absence, although actors in Lerwick identified the European Union as a primary pan-national actor. The inclusion of a public waste or water company in the government actor list tracks successful delivery of a DHC system; the implications of this are discussed below. The absence of political engagement by local councillors in Burlington's network is also noticeable; the link to network failure is described in Chapter 7.

The primary civic actors are both fewer and more varied than other actor categories. Across these five cases, civic actors are not strictly necessary for successful governance interactions for DHC but they fulfil useful roles in three cases and were the leading organisation in the

Burlington network. The absence of direct engagement by international advocacy networks in all but London is noticeable, and does not correspond to Betsill and Bulkeley's concept of multi-level governance.

Grey indicates DHC not delivered; LG indicates local government.

	Market Actors	Government Actors	Civic Actors
Barcelona	• Advisory consultants • Multi-national DHC and services company	• LG - Planning Department • LG - Barcelona Energy Agency • Local councillors • Regeneration company • Metropolitan waste company	
Burlington	• Potential institutional customers • Advisory consultant • Local electric utility, partially LG owned	• LG - Planning Department • LG – Community Department	• Citizens advocacy group
Lerwick	• Local DH company • Nationwide energy company	• LG – Waste Department • LG – Works Department • LG – Planning Department • Local councillors • Pan-national government	• Local Charitable Trust
London	• Regeneration partner – multi-national company • Multi-national DHC company • Advisory consultants	• LG - Regeneration Department • LG - Planning Department • LG – Finance Department • Local councillors • Metropolitan government	• Global city environment network
Toronto	• Large commercial customers • State employee private pension fund • Local electricity utility (LG owned) • DHC company • Pre-existing DH company (LG owned)	• LG - Water Department. • LG - Works Department. • LG – Planning Department • Local councillors • LG - local government generally	• National land use think tank

Table 26: Summary of primary actor sets in the five cases

Through this cross case analysis, an argument emerges that the understanding and preferences of local councillors have an influence on the outcome of governance networks for DHC. Local councillors are primary actors in all successful cases. In two cases they actively led the idea by searching out funding or finance or convening discussions about options. And local politician support was absent in the two unsuccessful cases, in one case despite active leadership from a local government department. In London the lack of understanding by councillors came through clearly in the interviews as contributing towards antagonistic preferences and the collapse of negotiations; in Burlington the councillors are not yet engaged. In the successful cases the local councillors are either pro-active lobbyists for the system (Toronto) or became aware and supportive following sustained discussions with municipal employees (Lerwick and Barcelona).

Challenges to engaging local elected officials in governance networks for DHC include the technical complexity of DHC and the particularly local nature of the systems. While DHC systems can be city-wide, they are constrained by the amount of fuel and cost of installation and tend to be smaller than city boundaries and likely to clash with existing 'territories' such as borough or ward boundaries. Even in the cases of Barcelona and London where DHC systems are envisaged as integral to a regeneration programme they were not expected to serve all residents in the regeneration area. The nature of DHC as an environmental goal helps gloss over its uneven distribution, but DHC can be a challenging goal for local politicians to support when it is not intended to be available to all.

A second finding from this comparative analysis is that the successful cases explicitly sought organizations to provide the financial investment necessary to build the DHC pipework. In Barcelona it was the multi-national DHC company, in Lerwick the Charitable Trust and in Toronto a private pension fund. The literature review highlighted how the large upfront costs of DHC is a significant barrier to policy implementation and this need for specific finance is borne out through the case analysis.

Does the shape of the actor set make a difference?

Considering the actor sets across the case has shown that there is some, but not considerable, variation in the type of actors engaged in DHC delivery. There does not also seem to be one 'right' collection of actors which will lead to a successful governance network outcome of building and operating a DHC system. There are also no patterns of groups of actors which repeatedly correlate with success or failure. However there are discernible trends and important individual actors. The network needs active local government and supportive local elected officials. Knowledge of DHC is also a very helpful aspect of actor sets; all the cases sought out consultants, other knowledgeable actors, or actively self-taught to enable sufficient knowledge and understanding of DHC infrastructure and procurement options. Civic actors can be helpful, but they do not need to be advocacy or community groups; friendly or supportive private sector firms can play similar roles. And finally, governance networks for DHC do not seem to need multiple 'levels' of actors: national or multi-national support is not required; this point is discussed further below.

While there is no right actor set, successfully building DHC is linked to key actors having sufficient resources or capabilities to have a stake in the governance network. A recurring theme in the case studies was how important resources and capabilities are across all primary actors for successful negotiations. Sorensen and Torfing mention this quality in the supporting text to their definition of governance networks, writing that "In order to become part of a particular governance network the political actors must demonstrate they have a stake in the policy issues at hand and that they can contribute resources and capacities of a certain value to the other actors" (2007, p. 9); the cases suggest this quality is important and should be explicit in their definition.

Burlington and Barcelona are informative, but by no means the only cases which demonstrate how important it is that actors who ‘convene’ the network and promote DHC are in possession of some kind of resource, capable of not only setting the market, but regulating, incentivising, or bargaining into it. The absence of resources to negotiate with hinders the BURDES committee in Burlington; they can only convene discussions, not offer something of exchange value to potential customers or DHC operators. In Barcelona, the city council used planning interventions and the Forum of Cultures project to establish the concept, encourage potential customers, and raise funds for initial investment; all of this is directly attractive to Cofely (and others) as operators of DHC networks. Scharpf also describes this 'something of value' characteristic as a condition of successful governance networks. In *Games Real Actors Play* the first limit of governance networks is described as "voluntary negotiations involve only those parties that have something to contribute that is of value to others" (1997, p. 146).

11.1.2 Actor constellations: Aligning resources and benefits for success

Scharpf proposes actor constellations in ACI as "the crucial link between substantive policy analyses and interaction-oriented policy research” (1997, p. 69) but comparing across cases for links between constellations and DHC system delivery is not straightforward. Constellations are a theoretical representation of level of conflict or alignment in the actor set which incorporate both actors' powers and actors' willingness to act. (p. 84). They are a static picture of how the actor set perceives the policy problem, each other, and their potential options to achieve the policy goal, a picture of whether their aspirations and preferences are compatible with one another. It is helpful to compare how actor constellations changed within the cases to understand how governance networks overcome conflicts or successfully aligned resources.

The analysis of the 22@ district in Barcelona describes how historical traditions of low conflict and high collaboration among urban development actors continued into the alignment of resources and preferences for creating the Districlima DHC system. Once the concept was enshrined in the regional vision and masterplan, the analysis finds little conflict or significant change to actor resources and willingness to act over time.

Burlington's actor constellation has two unresolved areas of conflicting expectations; those who wish to build the DH system do not have the resources or power to leverage other actor engagement, and secondly within existing actors is there is uncertainty about preferences for ownership and management. It is a difficult actor constellation to change; the market and regulatory forces in Burlington are relatively neutral (they do not push or resist DH) and the orientations of potential institutional customers seem resistant to change. But the actor sets' overall orientations towards environmental and community concerns could sway the constellation in the future by improving customer perceptions and elected governmental actors’ willingness to negotiate.

Toronto's constellation changes over time; originally the actors positively approached DLWC as a purely environmental goal, but lacked resources to negotiate the construction. Some activity occurred through this constellation in the railway lands; but it was when the councillors

perceived other benefit (a new water intake pipe) from DLWC that significant change to the governance network occurs. Resources were found by bringing in new actors and orientations became more supportive, with willingness to negotiate spreading to additional actors.

In Lerwick, despite the failed attempt to engage a local power station in supplying heat to SHEAP, the remaining constellation was successful; a tight network of actors using existing relationships who are not overly concerned with achieving fair value negotiations. Actor orientations tend towards solidarity and altruism, therefore once the concept of DH is accepted through knowledge sharing, the network coordinates to find a solution.

The analysis of the proposed MUSCO in London describes three aspects of change and conflict within the constellation. There was discord between preferred strategies and expectations of several actors, some elements of which were overcome through knowledge sharing. Then Southwark's resources to negotiate with changed, requiring new approaches to negotiation. And the conflict of preferences about the MUSCO within the council, built on different orientations about of the purpose of a local authority in such negotiations, was a key aspect of the failure of negotiations.

What do the actor constellations show about governance networks?

The five cases show the variety of conflicts that can happen within governance networks, but also demonstrate the potential of governance networks to evolve towards success. The cases underscore that altruism does not drive governance networks and that aligning resources and benefits is important to successful negotiations; those who have the capability to make DHC happen should benefit from its construction. Actors begin negotiating when benefits accrue to specific organisations rather than being dispersed across the network or city. London and Burlington in particular show that conflicts of expectation need particular care and attention. When conflicts are based in beliefs about the purpose of that actor, it is unlikely that altruistic or even 'you will see a small benefit' arguments will suffice to change orientations; not all institutional barriers can be overcome through negotiations.

11.1.3 Mode of interaction

This section turns to the final factor in ACI, considering if there are kinds of interaction which are particularly conducive to the delivery of DHC infrastructure in cities. Scharpf recognises four modes of interaction, of which negotiated agreements are only one. Chapter 4 explains how Scharpf describes and characterises negotiation types. The research design selected for cases with negotiations between public and private actors, and while the cross case analysis confirms this selection, it also shows there is variation within negotiation, from a public sector-led hierarchal direction with bargaining to a very loose negotiation based almost purely on contractual exchange.

The case study analyses describe how Toronto and Barcelona contain significant 'positive coordination' negotiations, which require transparent 'fair settlement' discussions to recognise the existence and legitimacy of the benefits and negatives on all sides. In Toronto, the local

government also uses a hierarchical mode of interaction to intervene in other actor behaviours and a ‘distributive bargaining’ mode with side deals to address interdepartmental concerns. In Barcelona the main interactions to build the network between Cofely and the city council are 'positive coordination' negotiations with regulation and package deals to control distributive issues. However this is supported by a public sector mandate on property developers to build and fund the infrastructure in return for additional floorspace.

Chapter 8 classifies Lerwick as 'problem solving' negotiations, focused on creating shared value where some actors are willing to lose out for the sake of the whole set of actors. London started out with 'positive coordination' negotiations through the EU procurement procedures, but retreated over time to 'distributive bargaining with veto powers', where projects have to be equally beneficial to both sides to succeed. Burlington is more difficult to characterise, as the actors are not yet at the state of negotiation over resources. The activities of BURDES are trying to generate a positive coordination state, where benefits to individual actors as well as an overall value to the city is recognised.

Table 27 sets out the type of negotiations seen in the cases; unsuccessful case are shaded in grey.

Case Study	Negotiation Type
Barcelona	Positive coordination
Burlington	Attempting positive coordination
Lerwick	Problem solving
London	Positive coordination, then distributed bargaining
Toronto	Various

Table 27: Summary of types of negotiation seen in the case studies

Overall, this cross-case comparison of the modes of interaction in these cases show the promise of 'positive coordination' negotiations in governance networks for DHC. This trend can be said to define network governance; 'positive coordination' negotiations which seek both a shared value and a fair exchange of resources sit between pure contractual exchange and hierarchical direction. The cases therefore show that governance network negotiations correlate with successful creation of DHC systems, although other types of interaction and negotiation are needed to generate the actors powers and resources behind the 'positive coordination' negotiations to build DHC.

The challenge of 'positive coordination' negotiations is that they are not a quick solution and the "battle over distribution is likely to interfere with the mindset that is conducive to joint learning" (1997, p. 133). Scharpf describes how it is helpful for negotiations in governance networks to try and separate out discussions of purpose and discussions of exchange. This is effectively what the actors in Toronto and Barcelona were able to achieve through charettes and the ideas competition, respectively. The importance of creating spaces for information exchange without negotiations is described further in the next section.

11.1.4 Relational characteristics

Chapter 2 discussed how network governance theorists propose that there is link between quality of network patterns and policy outcomes; that the quality and type of interaction between actors has a direct influence on the outcome of the negotiations. This proposition requires further investigation; both Adger and Jordan (2009) and Lowndes (2009) call for empirical research into this causal inference as a focus of future policy research. Chapter 4 describes how the thesis incorporated this dimension of interaction quality into the conceptual framework and research design with the concept of 'relational characteristics', modifying ACI to include this within the modes of interaction component.

Relational characteristics are the patterns and quality of interactions among purposeful actors; e.g. do all actors negotiate with all other actors? Are some actors at the centre of negotiations? Do the actors negotiate or exchange more than once? This section of the comparative analysis examines the relational characteristics exhibited in the case studies to understand if they are linked to the ability of the governance network in each case to deliver DHC. Characteristics of size, duration, density, and centrality are explored through a qualitative comparison among the five cases. Table 28 provides a summary of the following comparison.

Size is a straightforward characteristic to explain; based on the number of actors in the primary actor set for each case study. Table 12 in Chapter 5 provides a list of the primary actors engaged in each case. Using this, Lerwick and Burlington are considered small networks compared to Barcelona and London at a medium size with Toronto a large network. Smaller networks can benefit from lower transaction costs and smooth knowledge sharing, as Lerwick demonstrates. However unless they are able to grow, as Toronto did, they may struggle to find sufficient resources to build infrastructure.

Duration as a characteristic of cases in this research refers to the length of active knowledge exchange and negotiations before the DHC infrastructure is built. Graded against each other, Barcelona and Lerwick are considered to be of short duration as both took less than seven years. London is considered to be medium duration at eight years before cancellation of the negotiations. Toronto and Burlington are both considered to be of extended duration as the creation of DHC systems was discussed for over 15 years.

Density and centrality are characteristics of networks whose definitions come from Social Network Analysis (SNA). Density, a ratio of the number of interactions in a network with total possible ties (Marsh, 1998), is a measure of frequency of interaction against the maximum interactions possible. A quality of low, medium, and high is judged from interview responses regarding the number of meetings and interactions which were held, compared with a theoretical maximum based on the size of the primary actor set. Burlington and London are considered to have low density. Barcelona and Toronto are considered to have a medium density of interactions. Lerwick is considered to have a high density of interaction, which is to be expected given the multiple roles of actors in a small island setting.

The SNA characteristic of centrality attempts to capture the property of actors in terms of their links with others (Freeman, 1979). For this characteristic the cases are ranked against one another on a simple 'central' or 'dispersed' judgement. Barcelona, Lerwick, and London are considered to be 'central' networks which displayed a significant concentration of knowledge and power in an individual or organisation. Toronto and Burlington are considered more dispersed networks. While centrality can indicate strong useful leadership, it is not always a positive thing; networks where knowledge and power are centralised in one individual can lead to a block of progress, or be vulnerable to changes in that individual's circumstances.

Deliberate non-negotiation space

A further influential relational characteristic which emerged during the interviews through interviewee comments is the existence of conceptual spaces for detailed discussions about DHC delivery options without exchange-based negotiations. In Barcelona this took the form of a knowledge gathering 'ideas competition' to discuss policy implementation, hosted by the 22@ development company before embarking on a formal procurement process.

> When the 22@ started, before the Forum, we did what we call an ideas competition. We told the world market "Gentlemen, we would like to create a network of central heating and cooling but we do not know if the business plan it's going to work and how it should be done." Thanks to the idea competition we realized that we could not go for the "all-or-nothing" approach. In this competition we received about twelve or fourteen bidders, and three or four of them were very good. (InterviewA3, 2012)

Toronto's DLWC evolution included a series of similar non-negotiation 'spaces': small design charettes held by councillors, large working groups hosted by think tanks, and energy roundtables hosted by the city. The purpose of all of these was to convene a diverse set of organisations and individuals who would be affected by or supportive of DLWC and discuss options for the engineering, ownership, and investment in the system. These parallel the Barcelona 'ideas competition' in that the discussions are not about forming DLWC as a policy goal but about options for implementation. For example, the Canadian Urban Land Institute working group evaluated before discounting (among other options) an approach where the DLWC system would be owned and managed by landlords and developers.

In Burlington, Barcelona, and Toronto, interviewees recognised the benefits of such 'non-negotiation' spaces as contributing towards network formation by engaging new actors and providing interaction spaces where the preferences and strategies of actors could evolve and change. While non-negotiation spaces did not lead to direct solutions or agreements, the activities increased the problem-solving capacity of the network by sharing knowledge among actors. In two of the cases, the discussion formats were hosted by local government officials or local councillors.

Analysis of Lerwick and London did not uncover these kinds of interactions. In Burlington the 2011 workshops hosted by Ever-Green Energy were intended to lead towards these 'non-negotiation' interactions, but were at the stage of discussing whether district heating was

feasible and should be a policy goal, not yet discussing options for implementation. It is likely that Lerwick's trust-based, small, and stable network served as a substitute for non-negotiation discussions about implementation options; the characteristics of the network seems to have provided both problem-solving and knowledge consolidation functions.

Do network relational characteristics influence policy outcomes?

This section has compared the case studies against one another on a spectrum of relational characteristics, searching for normative patterns of interaction in network governance. Table 28 summarises the comparison. The analysis is comparative rather than absolute, but the cases investigated in this research suggest that the network governance literature hypothesis is correct and that the quality and type of interactions within governance networks can influence their outcome.

Size and duration do not seem to be significant in the cases studied. But density does appear to be important in creating a successful network for building DHC infrastructure; the two unsuccessful cases are considered to have low density. While this characteristic could be a straightforward reflection of the importance of positive collaboration, where low density indicates conflicting or uninterested interactions; at a minimum it suggests a pathway to successful networks: actors could support the policy goal by meeting or speaking frequently. A challenge of governance networks is how to generate this density of interaction.

As for centrality, while there is not a pattern which correlates with successful delivery, it can be either a challenge or an opportunity. In Lerwick the interviews indicate that a highly centralised network was a positive factor, with trust-based relationships facilitating both the system setup and its operation. In London the concentration of knowledge and coordination into one individual was ultimately a challenge; not everyone understood what was going on which created resistance, and then when that individual left, the network collapsed.

	Size	Duration	Density	Centrality	Implementation discussions
Barcelona	Medium	Short	Medium	Central	Discussions before negotiation stage.
Burlington	Small	Extended	Low	Dispersed	
Lerwick	Small	Short	High	Central	
London	Medium	Medium	Low	Central	
Toronto	Large	Extended	Medium	Dispersed	A series of discussions leading to negotiations.

Table 28: Comparison of relational characteristics across the case studies

Another type of interaction which seems to correlate with successful networks is the existence of a deliberate 'non-negotiation space' for discussions and exchange of knowledge about options for implementation. This was cited as important in both Toronto and Barcelona; it is what Burlington is trying to create. This 'space' seems to have been absent in London. Creating such 'non-negotiation' spaces are not low cost or easy to do but they provide a time and a place for actors to learn about each other's preferences, and to gather more resources (or further actors) if needed. Such interaction spaces effectively lower transaction costs in negotiating incorrectly during formal bargaining. These spaces also help overcome the 'positive

coordination' problem described above, of needing to have both shared value and fair value negotiations by providing space for shared value discussions.

11.1.5 Summary: How do governance networks support implementation of DHC?

Overall the comparative analysis findings support the literature review in demonstrating governance network behaviours as an empirical phenomenon in policy delivery. The cases show that government policy tools such as regulation, incentives, and capacity building are not sufficient in and of themselves for delivering DHC and it requires governance networks which include collaborative negotiations between the public and private sectors at a local level within cities to deliver DHC.

Governance networks are demonstrated to be a flexible form of policy implementation: different arrangements of governance networks seem to work and types of actors change across the case studies. There is no one right actor set or structure to negotiations for building DHC systems in an urban context. This flexibility allows for change in network strategies and for the introduction of new actors or new resources so that those with resources to construct DHC systems align with actors who wish to see it constructed and who will benefit. When the benefit of DHC accrues to specific organisations or actors rather than being dispersed across the network or city, the governance network moves from talking to negotiating. This exchange of resources is at the heart of governance networks for DHC and implies that for actors require resources to bargain with if they are to have influence in structuring or driving governance networks for DHC.

The comparative analysis also highlights the importance of support from local elected officials. All three successful case studies had supportive local councillors or politicians over time. The case studies also demonstrate how the format and quality of exchange and negotiations influences delivery of DHC. Positive coordination negotiations, dense actor networks, and the existence of non-negotiation spaces can be correlated with successful implementation of DHC.

While this section has highlighted how the actors, actor constellations, negotiations, and relational characteristics of governance networks support implementation of DHC, the findings are difficult to extrapolate to all cases of network governance. For example, the relational characteristics which correlate with successful delivery of DHC could be particular to governance networks for urban infrastructure and fail to correlate with other policy goals.

11.2 How does the Institutional Setting Influence the Delivery of DHC?

While Scharpf explicitly developed ACI to link actor and institutionalist approaches, his 1997 book *Games Real Actors Play* does not give the institutional setting the same level of detailed explanation or focus as he does for the other three influencing variables. For him, the institutional setting is not a theoretically defined set of variables, but instead is a "term to describe the most important influences on the actors, actor constellations, and modes of

interaction" (p. 39). For this research, institutions within ACI are understood as rule systems that structure actor behaviour; they can have a more formal character as rules sanctioned by legal framework or public authorities as the 'administrative systems' of Newman and Thornley (1996), or a more informal character as norms, conventions, and expectations: the social conventions of Lowndes (1996).

Chapter 3 introduces important institutional influences in the context of planning and DHC systems. This section develops this understanding further by examining the significant formal and informal influences in the case studies. It begins by comparing the effect of actor experience and cost of fuel before turning to compare the influence of institutional context on local government and planning organisations across the five cases.

11.2.1 History and cost of fuel: Effect on actors and negotiations

Two institutional contextual influences discussed in Chapter 3 on the formation of actor preferences and orientations emerged as particularly important through the case study analysis: the relationship of the proposed DHC system to existing heating or cooling fuels, and previous experience with DHC among the actor set. These influences were identified in the literature described in Chapter 3, and their importance was borne out through case study interviews.

The relationship of the proposed DHC system to existing fuels has two aspects: the source of fuel for the DHC system, and the consumer price of the DHC system versus other options for heating and cooling buildings. In Barcelona, Burlington, Lerwick, and Toronto the source – or a significant source – of heat or coolth for the DHC system exists, but negotiations were needed with the actors who control that fuel to build the infrastructure to connect the source to the DHC pipework, and negotiations were needed over the price the DHC operator would pay to use that fuel. In Barcelona, Lerwick, and Toronto the local government owns or significantly controls access to this fuel, and the negotiations were inter-departmental. While in Burlington, the local government's non-majority stake in the biomass power generator hindered development of a DH system. In London the MUSCO concession negotiations required the private sector energy company to build the power generator and provide the fuel. The need to build a generating plant as part of the DHC system contributed to the complexity of the negotiations and to negative local councillor preferences about the system.

The five cases suggest that the pre-existence of a government fuel source for DHC does not in and of itself define the actor constellation nor drive the success of delivering DHC. However government ownership or control over the fuel source influences government and other actor preferences for DHC and can provide a resource for government to bring to negotiations with the private sector to build and operate a DHC system.

The relationship of the cost of DHC to consumers versus other sources of heat and coolth also appears to affect actor preferences and strategies; however the effect tends to be on the growth of the DHC system rather than the negotiations to build it. In Lerwick and Toronto, DHC organisations are able to offer cheaper and more fixed prices to their customers compared to

other fuel options available. This has been attractive to customers and supported system expansion. In Barcelona the municipality supports DHC by regulating the heating to be cheaper than a gas reference case. This encourages private businesses and homes to connect, supporting network expansion. In London and Burlington, the relationship of proposed DHC prices to existing fuels is unclear. This is due in London to multiples changes to the proposed DHC network and in Burlington to the lack of detailed negotiations on the DH system to date.

As for experience with owning and managing infrastructure, Toronto is the only case study where actors have previous experience with DHC. Toronto's existing DH system provided a reference point for DLWC and brought at least two supportive influences to the governance network: technical engineering expertise about the potential for a cooling network, and a positive preference for a cooling network among many councillors. A lack of experience or awareness of DHC was explicitly identified by interviewees in the remaining four cases as a barrier to creation of DHC. In Burlington the lack of general awareness about DHC as a feasible solution affected progress; the BURDES group regularly cited the need for further studies and expert advice to convince potential customers and local government that it is a viable, profit-making solution. The Ever-Green Energy consultant in Burlington remarked on the issue of technical complexity and experience with DHC.

> It’s part of the challenge. It’s not an interesting subject I'll say. Until you really – people don’t understand the benefits, the why do I care about it. In St Paul we hosted over 700 people for tours. And a lot of them are just people that are not industry experts or professionals in any way – just community development folks or politicians or members of the community that are interested, what is this here in the entertainment district. And time and time again you see the lights go on. We just have a standard talking point. And at some point they say “This is really brilliant, why don’t other communities do this?" (InterviewA4, 2012)

The lack of knowledge results in political resistance to new infrastructure, increased 'transaction costs' for the governance network and longer timescales for negotiation. Actors in all four cases bought advice on DHC from consultancies or brought in new individuals to work within local government.

Table 29 summarises how fuels and history shaped the orientation of actors for reference. Cases which were unsuccessful in establishing DHC systems are shaded in grey.

	Fuel	Relationship to other fuels	History with DHC
Barcelona	• Heat from waste incineration. • Existing. • Low cost. • Municipal influence. • Gas CHP; purpose built.	• City mandate that price from DHC network is cheaper than reference case. • Significantly cheaper than fuel oil.	• Very minor – one small scheme.
Burlington	• Heat from wood incineration. • Low cost. • Municipal influence.	• Gas only recently arrived. • Not that cheap for domestic, unclear if DH cheaper for institutional customers.	• None. • Recent telecoms crisis reduced preference by voters for city to get involved in infrastructure.
Lerwick	• Heat from waste incineration. • Low cost. • Municipal control.	• No gas. • Cheaper than electric boilers and radiators.	• None.
London	• Gas, then biomass CHP. • To be constructed.	• Confused and changed through project. • Unclear if DHC cheaper.	• None.
Toronto	• Lake cooling. • Free and renewable. • Municipal influence. • Also gas CHP; purpose built.	• Gas cheap. • Electricity prices rising fast. Therefore fixed price cooling attractive.	• TDHC experience; councillors, customers understand the idea. • Customers perceived DH reliable if expensive.

Table 29: History and fuel: institutional influences on actor orientations and preferences

11.2.2 Government actors

Chapter 3's discussion of the institutional context of DHC proposes that the formal institutional structures and informal 'house rules' of government actors would influence actor resources and powers as well as patterns of interaction in governance networks for DHC. In each case studied, there are formal limits on local government resources and powers which preclude the local government from building DHC themselves; these demand governance network patterns of behaviour. Those limits vary from operational controls over the remit and powers of local government to fiscal controls over government borrowing and spending. Within a broad context of private ownership of power, gas, and water utilities and public management of waste, the level of local government influence over utilities varies considerably across the cases. The following text discusses how the institutional context affects local governments across the five cases and considers how such context supports or hinders DHC.

Chapter 6 demonstrates how Barcelona's informal tradition of multi-level and cross-agency collaboration for events-based planning supports the creation of DHC in the 22@ district. The consortia approach and the creation of an independent regeneration company pulled together planning, housing, and development powers. Mayoral and political support was still needed to give authority to the arrangement (the mayor is the chairman of 22@ regeneration company) but this is not a formal role which influenced orientations or brought resources. Instead the mayor and his deputy mayors provide glue to the network to ensure collaboration between local government departments and other government organisations involved in the DHC system. For example, a deputy mayor of Barcelona City Council is also the vice president of the regional

company which manages waste in the Barcelona area. This facilitated the 22@ regeneration company to negotiate with the waste incineration plant for the use of waste heat for the DHC system, and consequently that the initial fuel source was cheaper in price than gas or electricity. The informal institutional glue results in the DHC system being more attractive to potential energy company operators.

Burlington's local government structures are very different picture, with a comparatively limited set of capabilities and resources. In the USA, local government is legislatively restricted to a narrowly defined set of capabilities by Dillon's Rule and an the absence of state or national policies supporting DHC results in little access to government funding for Burlington to connect the McNeil power station to a DHC system. Potentially, Burlington's mayor could use his influence over local taxation of land and energy to create incentives to connect, or raise money through a public bond, but these are weaker market influences than an ability to procure a concession for DHC, and they require explicit voter support. Chapter 7 also describes how the mayor's ability to direct local government staff restricts municipal support for DHC. Without mayoral support it would be difficult for Burlington's local government to actively support DHC with money, knowledge or the exercise of procuring a new utility.

Even if the mayor did want to procure a DH system, Burlington's local government has limited resources to support this ambition. It does not have significant ownership of local property or strong connections with the two largest local energy consumers. The city has only partial ownership of the McNeil electricity generating station. And the city's recent attempt to establish a local telecoms company resulted in a negative perception of local government influence in utilities and restricted the fiscal borrowing capabilities of the city.

In Lerwick, Chapter 8 describes how the informal house rules of 'doing it ourselves' and 'wearing many hats' underpinned the resources available to Shetland Council and the positive coordination mode of interaction that supported the DH system. For example, the 'do it ourselves' orientation meant that the council preferred to directly manage waste and own the incineration plant; this provided a fuel for the DH system. Alongside this, the councils' ownership or influence with of many commercial and civic buildings in the area meant large customers were encouraged to connect. A further supportive informal context was the stable and non-party politics of councillors, which underlined the consistent preferences of the council. There are limits though; the council's lack of control or influence over the privately owned electrical power generation and distribution in Lerwick has limited the size of the DH system.

Chapter 9 describes how metro-level knowledge and environmental policy influences Southwark's local government and consultants to support DHC, but also describes how the mayoral powers are legally limited to approval of large developments. Both the metropolitan government and the local council do not own or significantly control existing utilities, nor potential fuel sources such as outputs of waste streams. However Southwark owns a large amount of land and housing in the regeneration area, including social housing, whose heat demands were attractive to potential MUSCO operators in concession negotiations. National

government controls over capital spending and European regulations about large scale government procurement also constrained local government resources, preferences, and modes of interaction within MUSCO negotiations. Finally, because the negotiations for the creation of the MUSCO spanned eleven years, the council's statutory four year election cycle also acted against a consistent local government approach as councillors and political leadership changed.

With Toronto, the post-amalgamation municipal government had informal support through an environmentally minded mayor and selected councillors who influenced government departments through public campaigns and council instructions. This political support survived across election cycles in the form of two consistently re-elected councillors. Chapter 10 also identifies other formal institutional contexts behind the council as influential on the DLWC system: the city could control local utilities in a way not seen in all other cases; the water company was a division of Toronto's municipal government, the city owned 100% of the local electricity distribution company, and it controlled a existing non-profit DH system.

Local and metropolitan government on their own

Another feature of the cases was the weak influence from actors above the local level: from metropolitan, regional, national to multi-national. There was some multi-level knowledge sharing and mutual support through local and metropolitan government in London and Barcelona. Lerwick also had EU financial support. The case of Barcelona was the most connected at a metropolitan level, as individual politicians provided a connection between regional waste management and the regeneration company.

But looking beyond the metropolitan government actors, the engagement of multiple scales drops to a low level. London had the Clinton Climate Change Institute, Lerwick had European Union funding, and Barcelona had nominal support from the national government through minor capital investment but on the whole government policy, capacity building, or financial support is absent.

11.2.3 Planning organisations

Chapter 3 suggests that the formal, legal context of planning organisations should have a strong influence on their participation in governance networks. On the whole, the cases support this, but also illustrate that informal influences have an effect. The following text evaluates the influence of the institutional setting on planning organisations across the five cases.

Chapter 6 describes how historical conventions of planning behaviour as well as existing local government, legal, and technical planning actors in Barcelona are instrumental in shaping the capability of the actor set and the mode of interaction towards a successful outcome. The 'urbanisme' tradition of detailed forward planning and plan-making in Barcelona, existing for over 30 years against a backdrop of major events, meant that the city and its advisors had individuals and organisations with the legal mandate and the technical capability to set detailed infrastructure requirements and tightly control the volume and design of real estate being built in

the 22@ regeneration district. The existence of Barcelona Regional as a neutral, technical organisation informally linked to the city council also brought crucial knowledge of energy infrastructure and masterplanning capacity to the local municipal planning department and to local politicians.

Alongside the creation of real estate value and infrastructure finance through detailed control of growth, the mandated development control process required discussion about district heating and cooling connections with developers that helped reinforce city investment in the network. And the urbanisme context of focusing growth and investment activity around large events drove the structure and terms of engagement for the initial DHC system, increasing the capacity of the 22@ public regeneration company. The existence of the Forum of Cultures became a public reason to direct government investment in the initial pipe network and the connection to the Tersa waste facility. As a result, the 22@ company possessed a DHC system that was attractive to a private sector energy company in tendering the concession to extend the network. The strong market shaping and market regulating features of planning in Barcelona have a significant positive influence on the capacity of planning to support DHC and on the perceptions and responses of other actors.

And the influence of the institutional setting on planning in Barcelona goes beyond this formal structure into significant informal influences. As Chapter 6 describes, Barcelona's history of planners becoming politicians or politicians becoming planners generates local political capacity in the form of masterplanning knowledge which supports large scale regeneration investment. These informal conventions of strong physical planning enabled the city to publicly promote the policy goal (the DHC network should be built) and through planning policy and development control created resources (likely DHC customers, initial DHC infrastructure) for city government to negotiate with the private sector with to build Districlima.

Burlington has a radically different planning system, roughly characterised as state-defined and focused on zoning of land uses. Chapter 7 describes that the city is required by state law to include energy plans in the municipal development plan; this public mandate creates a form of planning capability for the local planning commission to discuss climate change and energy issues. This is where the concept of district heating has remained in the consciousness of the local government. However the development of planning policy is organisationally divorced from local political leadership and local government strategy and, in comparison with other cases, the planning system brings very little else to the actor set and to the capacity for interaction. Public control of development design and function within the development plan is not as strong as in the other cases, based in a looser land use zoning categorisation. And the lack of strong development control policies mean that even if there was major new development near a DHC system in Burlington is unlikely that the planning commission could require the development to connect.

London and Lerwick, while both operating under a broadly similar legal planning framework, have different planning traditions which affect the strategies pursed in each case. In the British

planning system, local authorities are encouraged to create local spatial plans to guide development and protect heritage and the environment; and while the norms of plan creation encourage discussion and negotiation between public and private sector on the content, the plans are legally a vision for land use which is contestable.

Despite this context, the British planning system is used to create both market capacity and local government 'resources' for negotiations for the MUSCO in London. Chapter 9 describes how the council's significant ownership of land use in the area gave the regeneration masterplan weight. The large amount of residential development proposed in the masterplan for the area provided the resource of potential customers to the local authority in its MUSCO concession negotiations; residential heating demands are valuable to potential private sector energy companies. Traditions of masterplan formation also created a requirement for discussion and interaction between local authority planners and local councillors about environmental issues such as DHC, providing an opportunity for the regeneration officers to establish environmental goals in policy. Development approval processes enabled the local planning department to require of private developers a limited commercial commitment to connect to the proposed MUSCO system.

In Lerwick, despite a similar legal context to London, the planning organisations and processes did not provide the same level of influence on actor capacity or governance network interactions. The lack of large scale development in the town and tradition of a development friendly attitude meant that planning neither acted as a process to create a preference for district heating nor created capacity or potential customers for the heating system. However, Chapter 8 describes how the local authority used the development control process and planning policy to support extension of the DH system to new customers. The comparison with London demonstrates that formal institutional context does not have a straight parallel to success; despite similar legislative and planning contexts the different outcomes in London and Lerwick are determined by network relational characteristics and external influences.

The institutional context of Toronto's planning system is quasi-British, with an established and legal process for strategic land use management but with a more rule-based approach to development control. Building on literature comparisons with American cities (Frisken, 2008) it can be characterised as 'metropolitan land use management' to highlight Canada's greater concern with metropolitan growth. Chapter 10 describes how civic activists and politicians (rather than the Planning Department) used city ownership of land and the development approvals process to raise finance and require the first customers to connect. These funds and customers become resources for the city council when they approached OMERS pension fund for a further expansion of the system.

The shape of planning: The limits of formal and informal context in a governance network

The case studies demonstrate how planning's formal institutional context is a strong influence on the capabilities, orientations, and modes of interaction of planning and local government actors. In Barcelona, London, and Lerwick there is formal, legal capacity for planning to 'market

shape' and strategically plan for DHC infrastructure, supplemented by a varied ability to regulate or incentivise other actors in negotiation. In Burlington, the legal framework discourages regulation of DHC infrastructure by planning organisations and discourages planning organisations from engaging with political and local government actors.

As the literature review suggested, planning's formal and legal capabilities (e.g. masterplanning and development control) are shown to be a significant influence the governance network's ability to build a DHC system. The formal institutional context of planning shapes governance networks for DHC in at least three important ways. It shapes the content of plan (e.g. does it need to include energy) and the ability of planning organisations to initiate governance networks for DHC through planning for energy infrastructure. It shapes the range of topics that can be controlled through development approval; this influences the local government's ability to negotiate with the private sector to build DHC. Finally, formal institutional context shapes organisational relationships with other actors, particularly local politicians and the ability of planning procedures to align with local government activity and political leadership. While the formal, legal context of planning is influential it cannot be singled out as a causal factor in the ability of networks to deliver DHC, as Lerwick suggests a case where the DHC system could have proceeded without planning organisations or planning interventions engaged.

The informal setting of planning practices also proves to be influential on the ability of the governance network to deliver DHC, as Barcelona and the difference between the difference between London and Lerwick cases show. In all cases, the informal context shapes the use of formal planning interventions and the technical capacity of actors. Informal settings tend to influence actor orientations and modes of interaction more than they influence actor resources and powers. While it is difficult to extrapolate on such a small set of cases, these five suggest that formal institutional settings are more influential than informal context on planning's influence on governance networks for DHC. Control of land is central to conceptions of government and society; changes which affect control of land in support of DHC are likely to need to be formal. The next section explores how the influences affect the roles of planning in delivering DHC.

In summary, Table 30 outlines how the institutional context influences the role of local government and planning organisations, listing broad planning typologies and key points about the structure of local government. Cases which were unsuccessful in establishing DHC systems are shaded in grey. The table summarizes content from the case studies in the previous chapters and reflections above.

	Planning Typology	Structure and capability of local government
Barcelona	Napoleonic – 'urbanism' tradition	• Powers defined in national law • Mix of control between city, metro and state; dual political / executive structure with strong mayoral oversight • Partial ownership of waste incineration
Burlington	Land use zoning	• Fiscal federalism: national dictate capability of local • Mayor- council form of government • Organisational boundaries between planning and management • Partial ownership of local electricity generation and distribution
Lerwick	British	• Powers defined through national legislation • Council committee system • Ownership of waste incineration
London	British	• Powers defined through national legislation • Mix of control between borough, mayor; council committee system • No utility ownership or control
Toronto	Metropolitan land use management	• Metro constrained by provincial legislation and funding • Mayor-led ranked committee system • Control electricity distributor, water company and district heating

Table 30: Significant contextual influences on planning and local governments

11.2.4 Summary: How does the institutional setting influence the delivery of DHC?

The analysis finds that governance network patterns of interaction alone do not drive successful implementation of DHC, and institutional context strongly influences the ability of actors to successfully build DHC systems. For planning organisations, formal institutional setting influences such as the scope and enforceability of development control seem to be more relevant than informal influences such as historical experience with DHC. For other local government actors such as officers and elected officials, the picture is not as clear and there seems to be a fairly equal level of influence between informal and formal context.

Three institutional trends are identified as particularly relevant to DHC. First, the existence of local government control or influence over low cost fuel sources; this influences the preferences of other actors and shapes negotiations. Second, history or experience with DHC is helpful but it can also be bought or brought into the shared understanding of the actor set. Third, the existence of formal planning powers to govern land use and control development has a strong influence on other actors. Building a DHC system does not necessarily require these contextual factors, but they lower the barriers to DHC from existing institutional structures and facilitate the negotiations between customer, provider, and regulator.

The analysis also describes a significant variation in levels of local government influence over utilities across the case studies, and how national policy or regulatory support for DHC was absent or relatively inconsequential. The implications of both findings in light of existing literature are considered in the next chapter.

11.3 What is the Role of Planning in Delivering DHC?

As was prefigured by the desktop review and literature review, the five case studies demonstrate a wide range of activity by planning organisations, and an equally broad spectrum of planning interventions to support creation of DHC. In this section, the roles for planning organisations are discussed before turning to the use of planning interventions.

11.3.1 Planning organisations

The case studies demonstrate a spectrum of roles for planning organisations from a weak role of coordinating pipework installation to reduce disruption (Lerwick) up to a influential role of designing a DHC system and including it in legally binding plans (Barcelona). The most common role visible in the case studies is the establishment of DHC as a planning policy goal for specific areas within a city, followed by the spatial coordination of land use, DHC locations, and pipeworks, and development to support a particular DHC system. These can both be described as 'market shaping' interventions under Allmendinger and Tiesdell's categorisation, and in governance networks they support the formation of a governance network by bringing actors together to create the policies, and by giving other actors a technical goal to discuss and negotiate over.

In Barcelona, London, and to some extent Burlington, the concept of DHC was established as a goal for a specific area of the city during a spatial planning visioning process which engaged local politicians and other stakeholders. In Barcelona, DHC as a goal was linked to wider economic and social regeneration aims for improved urban infrastructure. In London DHC as a policy goal was positioned as an innovative environmental technology, and the links between DHC and political aspirations for the regeneration district are weaker. In Burlington, the concept of a downtown heating system had been established in spatial planning visions for the city since 1985 as an environmental goal, but the structural separation of planning organisations from city management and the weak development control powers of planning resulted in a series of plans which failed to engage local politicians and other stakeholders in DHC discussions or negotiations.

These cases illustrate how the institutional contexts such as legal and legislative frameworks or culture and tradition influence the market shaping and associated governance network formation role of planning organisations. Both Barcelona and London have local and metropolitan government frameworks where planning organisations can produce detailed masterplans and they used this to control private sector investment in development. The different roles that emerged in the two cities are a result of degrees of legal formality of their plan and the cultural traditions of planning in each case. The two cases also suggest that the level of physical detail included in the spatial planning formation process affects the outcome; this is discussed further below.

Planning organisations in Toronto played a subordinate role to visioning exercises undertaken by other actors, particularly at the inception of the network. While planning policy was eventually

developed to support DLWC and encourage customer connections and the city government used local authority ownership of land to compel connection and investment in initial plant, the initial role for planning organisations was not a market shaping one which engaged other actors in the concept and vision for DHC in the railway lands. Later planning policies encouraged developments to connect through guidance, energy efficiency requirements, and recognition of connection as a social contribution.

The ability to enforce development control polices and the use of development incentives through legal powers are also visible as a role for local planning organisations. The control of new construction is a planning intervention across all five cases, but it is used to create different roles for planning organisations in each case. In Barcelona development control powers were used to provide expert guidance for developers on what to build and used to raise funds for infrastructure, therefore reducing the city's expenditure on DHC. In London the strongest development control power resided in the metropolitan planning authority, but was used by both local and metro planning organisations to provide guidance on potential DHC connections and to encourage connection through legal agreements. In both cases while connection to DHC was not mandated by planning organisations these arrangements gave a level of certainty to private sector DHC companies about future customer demand. In Lerwick development control powers were used by the planning organisation not to control new development but to coordinate the laying of DHC pipe with other activities to reduce disruption.

Not leading, but initiating and forming governance networks?

Table 31 provides a summary of the roles of planning organisations and the use of planning interventions; unsuccessful cases are shaded in grey. It helps to illustrate that in the five cases studied, planning organisations rarely lead or participate in negotiations to build DHC, but they often play an important role in initiating the governance network. This points to a combination of roles for planning organisations which sometimes, but not always, have success in initiating discussions, exchange, and negotiations among a network of actors who can shepherd a DHC network towards construction and operation. Planning organisations which take on market shaping roles such as including DHC in spatial plans, and combine that role with supportive development control (market regulation or market stimulation) interventions support the delivery of DHC systems by initiating governance networks and creating market certainty for private sector actors.

The analysis cannot conclude that absence of market shaping planning activity or absence of plans and policies by planning organisations is a cause of failure to establish a DHC system. Nor the opposite, that the presence of market shaping activity by planners is necessary for successful delivery of DHC. In Scharpf's vocabulary, the capabilities, strategies or actions of planning organisations did not prove to be an explanatory variable on the successful creation of DHC systems. The lack of a direct explanatory correlation for planning organisations could be due to the small-n problem, the limited number of case studies. But another reason for the lack of direct connection is that in some cases, other actors took up planning roles and used planning interventions in the absence of planning organisation activity.

Case	Barcelona	Burlington	Lerwick	London	Toronto
Planning Typology	Napoleonic urbanism	Land-use zoning	British	British	Metropolitan land use management
Planning Organisation Roles	Policies for DHC with develop.; Coordination of DHC, land use & develop in plans; Creating certainty; Raising funds	Policies for DHC	Reducing disruption	Policies for DHC with development; Coordination of DHC, land use & development in plans; Creating certainty	Policies for DHC with development
Planning Interventions by planning organisations	Strategic planning process; Area masterplan process; Development Control; Infrastructure Levy	Strategic planning process; Consultation	Development control; Coordination of DHC installation	Area masterplan process; Visioning and design exercises; Consultation; Development Control	Area masterplan process; Development control; Development incentives;
Planning Interventions by non-planners	Technical masterplan; Consultation with DHC providers	Citizen-led consultation; Visioning & design exercises; Expert guidance	Coordination of DHC, land use & development; Expert guidance	Coordination of DHC, land use and development	Consultation; Visioning & design exercises; Coordination of DHC, land use & develop; Infrastructure levy
Planning roles - Allmendinger and Tiesdell	Market Shaping; Market Regulation; Market Stimulation	Market Shaping	Mildly Market Regulating	Market Shaping; Market Regulation	Market Shaping; Market Regulating

Table 31: Summary of the roles of planning in the case studies

11.3.2 The importance of planning interventions

Table 31 also summarises the range of planning interventions displayed in the case studies. The analysis found regular use of planning tools and processes by other, non-planning, civic, private, and local government actors. For example, in the case of Burlington the citizen volunteer group engaged stakeholders in consultation and drafting strategic and spatial plans for the connection of the power station and the major customers. Burlington Planning Department was not active in this process. In Barcelona, the local government's regeneration company used the infrastructure masterplan produced by the planning consultant and the city's planning department to involve potential DHC providers in discussion and negotiations about a government concession for the provision of DHC. In Toronto, the analysis indicates that the use of planning interventions by non-planning organisations was taken even further: charette style consultations, visioning, and design exercises as well as coordination of DHC infrastructure with land use and development happened outside the city's planning department, predominantly by local councillors and business interests. In Lerwick, the pipe routing plan proposed by SHEAP

was the subject of much informal discussion and coordination with private and government actors. This indicates the tools of planning are useful and valuable methods of negotiating or engaging within governance networks for DHC.

The power of spatial plans for DHC: Does quality and content matter?

Planning organisations and other actors use the development of spatial plans which included DHC as a powerful tool in forming and directing governance networks. The formation of such plans can support discussions between actors about DHC, and the publication of plans sets expectations of other actors down on paper, even if details are negotiated at a later date.

The municipal spatial plans for Elephant and Castle in London, Lerwick, Toronto, 22@ Barcelona, and Burlington are each different in the level of detail they provide about DHC and how it integrates with other land uses. Lerwick, Burlington, and Toronto mention DHC as a goal and identify in words an area of the town which could be suitable for DHC connection or extension, but they do not map this or suggest individual buildings (and by implication the private owners of those buildings as potential customers) in the plan. The Elephant and Castle 2004 *Development Framework* identifies the goal of a zero carbon growth as well as vague potential energy centre locations and a potential delivery mechanism. This spatial plan evolved into site specific plans and regeneration agreements which include detailed DHC system maps and consider potential energy centre locations. This contrasts with spatial planning for the 22@ district, where Barcelona City Council consulted on and publicly adopted a spatial plan as well as a detailed infrastructure plan which includes DHC; the latter has word-based policies as well as maps identifying pipe routes and drawings of technical connection details between buildings. This cross case comparison suggests that a technical plan of the infrastructure network which considers 'energy mapping' (determining heat or cooling loads in existing buildings) and planning for locations for DHC pipework and energy centres set into the urban fabric leads to smoother governance negotiations and a more successful outcome.

Visioning as capacity building and non-negotiation space?

The process of developing spatial, land use or strategic plans, and gaining agreement for them requires other actors, such as local politicians and local residents, to consider the implications of the plan. For example, which private sector customers might be connected, or how large the network should be. In ACI vocabulary this activity informs the orientations of other actors and influences actor strategies of action; Scharpf considers that these type of exchanges are critical for adjusting actors towards agreement.

The process of creating spatial plans is theoretically an opportunity for non-negotiation space; a platform for conversations about goals and procurement without simultaneous discussions about who pays for what. But the cases studies do not demonstrate this activity within spatial planning hosted by government planning organisations. In Barcelona and London the spatial planning process results in physical visions of how DHC could be built, but the final spatial plan is not an agreement about the ownership of DHC or what kind of organisation should build the energy centre or pipes. Further discussion, negotiation, and 'non-negotiation' spaces are

needed to refine options and strategies about how to deliver DHC. Instead, this exchange of information and refinement of preferences and strategies for other actors during the process of plan formation can be called network capacity building.

Planning regulations and incentives: Network formation and government capacity

Government control or guidance over urban development timing, form, and function (e.g. development control, development incentives, and development levy planning interventions) all prove to be useful planning interventions in many cases. These kind of market regulating and stimulation interventions have a network formation aspect in that by controlling urban development they provide local governments with resources for negotiations with DHC providers in the form of potential energy consumers and/or investment funds.

In particular, area masterplans or development frameworks which include a detailed temporal aspect to spatial planning are noticeably influential in governance networks for DHC. In London, Toronto, and Barcelona detailed plans for the size and timing of development were used to support the creation of a DHC network. In London and Barcelona, the potential new customers for DHC in the new development become a bargaining tool in negotiations with a private energy company. The extent to which both local municipalities have the capability to enforce or encourage connection to the DHC system is important in providing certainty about future income for the DHC operator. In London, the level of public housing potentially under construction, where DHC consumers could be guaranteed, became a critical aspect of the negotiations with Dalkia; when the housing numbers changed, so did the proposed DHC approach and costs. This can also be seen in Toronto, where local government officials supportive of DHC identified the development of the government owned railway lands near an existing fuel source (the water pumping station) as an ideal time to commence the DLWC network.

The government's ability to intervene in new development form and function also provides significant market stimulation or market regulating functions to planning organisations and other actors. In Barcelona the *Special Infrastructure Plan* includes a development tax on new floorspace which raised money for public infrastructure investment, as well as a requirement for developments to build in the basement structures for potential DHC connection. In London, major developments are required to meet an energy efficiency standard and DHC was recommended as the preferred solution for that. In Toronto, design controls were not initially employed to support DHC, however some years later DHC was formally recognised as a community benefit and thereby encouraged in new downtown development.

Even where there is not significant new development, the control of minor development is still used to support DHC systems. In Lerwick the planning authority used control over refurbishments or minor development to encourage connection by private building owners. They also used approval rights over pipework installation to support the DHC network by coordinating pipework installation with other streetworks to reduce disruption. In Burlington local government authorities have less ability to intervene in private development and did not exercise any powers to do so for DHC.

Patterns in use of planning interventions

Table 32 is compiled from the strategy analysis in the five cases and details the planning interventions which are used in support of DHC systems by both planning and other, non-planning, actors. Unsuccessful cases are shaded in grey. It illustrates that there are no overarching patterns in the use of planning interventions which correlate with successfully creating a DHC system. The development of spatial plans through consultation is used in every case to help establish DHC as a policy goal alongside other place making goals; this is likely to reflect the case study selection criteria for active planning activity. However, market regulating and stimulating interventions are also visible in every case except Burlington, where the cross-case analysis suggests that the lack of government influence over private development or financial incentives for DHC is a barrier to government support of DHC. Barcelona and London, which pursue a concession arrangement to procurement of DHC, show a potential link between the success of the negotiations for DHC and the existence of a detailed planning-led energy plan linking consumers and energy sources.

What Table 32 does not convey very well is the strength of planning interventions in initiating successful governance networks for DHC and in creating resources for other actors to negotiate with. The analysis of the five case studies indicates that planning's market shaping interventions (e.g. spatial planning, land use planning) are more powerful tools for initiating successful governance networks for DHC than market regulating or stimulating interventions (e.g. development control) interventions.

Key: √ used by government planning organisation; † used by other organisation

	Barcelona	Burlington	Lerwick	London	Toronto
Significant development?	Yes	No	No	Yes	Yes
Planning characterisation	Napoleonic	Land-use	British	British	Metropolitan
Procurement of DHC	Concession	N/A	Community	Concession	Joint Venture
Market Shaping					
Spatial plan with DHC as economic goal	√			√	
Spatial plans with DHC as environmental goal prior to start of network	√	√	†	√	
Land use planning which allocates land for DHC	√			†	√
Land use plan which identifies consumers	√ †	†	†	†	√ †
Discuss options with other actors in process of developing plans (consultation and visioning)	†	√ †	†	√ †	†
Market Regulation					
Development control encourages or requires	√		√	√	√
Market Stimulation					
Infrastructure levy generates funds	√				†
Capacity Building					
Technical coordination of delivery	√ †	†	†	†	†
Expert guidance on DHC infrastructure for other actors	†	†	†	†	†

Table 32: Detail of planning interventions used in support of DHC in the case studies

11.3.3 Summary: What is the role of planning, in relation to market, civic, and to other government organisations, in delivering DHC systems?

The capacity of planning organisations and processes to support DHC is rooted in their suitability and legal ability to control and coordinate land use between urban actors in specific locations. Because the research design selected for case studies with planning activity supporting DHC, the thesis cannot conclude that the absence or presence of planning organisations or interventions is in itself an explanatory factor.

However the comparative analysis illustrates the network-creating power of spatial planning processes for DHC. The market shaping interventions of planning, and particularly the process of creating land use plans which identify energy consumers and allocate land for DHC, seem to

be important for successfully delivering DHC. These interventions focus the governance network on a specific location and scale, highlighting actors (third party as well as potential providers or consumers) whose resources and orientations need to be considered. By defining infrastructure needed for environmental goals with respect to the potentials and constraints of specific urban areas, planning can shape the expectations of other actors.

Of planning's varied processes and interventions, the market shaping interventions (e.g. spatial planning, land use planning) prove to be more powerful in initiating successful governance networks for DHC than market regulating (e.g. development control) interventions. It does help to have both, but the market shaping interventions are more successful in influencing other actors, influencing their orientations and preferences and their willingness to engage in the governance network. This leads to quicker and less contested negotiations.

Planning's regulation and incentive interventions also support local government positions in exchange-based governance negotiations by providing resources to bargain with. In two of the five cases, planning regulation of development creates valuable potential customers which the local government explicitly uses to attract private sector funding and knowledge for DHC. In two further cases similar regulation supports the extension of an existing the DHC system. It is unlikely that other local government regulatory or incentive powers (e.g. citizen advice or local taxation) could have the same weight in creating a DHC system as the planning system's ability to influence the energy efficiency and energy source of new or refurbished buildings in a specific urban area. However without the absence of case studies which did not have planning policies and interventions in the research design it is difficult to draw strong conclusions in this area.

In conclusion, the case studies and comparative analysis reveal there are specific, constructive roles for planning organisations and planning practices in creating urban DHC systems. These roles are driven by the scale of DHC infrastructure versus traditional government boundaries, the association of DHC to specific locations and land uses, and the ability of governments to use planning interventions to shape future development. Planning organisations rarely lead negotiations or governance networks for DHC, but planning interventions are used to initiate governance networks for DHC and to shape the negotiations between public, and private sectors within the network. An important observation from the research is that market and civic actors also find planning interventions and processes useful in governance networks to deliver DHC; it does not have to be planning organisations.

Chapter 12. Research Contribution: Conclusions and Reflections

The objective of this research was to explore relationships between private, civic, and public actors in delivering an urban energy infrastructure, DHC, as an environmental policy goal. It was particularly focused on the role planning organisations and practices can play in governance networks for DHC. Designed to respond to a call in governance literature for research on the "concrete manifestations of policy making" (Hajer & Wagenaar, 2003, p. 10), the thesis analysed five international case studies across varied legal and institutional structures. By rejecting the notion that governance networks always succeed and including failed attempts to establish DHC systems, the research has deepened understanding of planning's capacity to support DHC systems. It has also evaluated how governance networks support capital intensive policy goals and suggested contributions towards scholarly discussions of institutional influence on utility infrastructure in cities.

Actor-Centered Institutionalism was used as a conceptual research framework to enable the analysis to distinguish between structural (institutional) and intentional (actor) effects on the governance networks and the role of planning in the case studies. Through the ACI framework, the cross-case comparison and the inclusion of failures, this thesis has been able to go some way towards what Healey calls the "difficult act of generalising about the relation between governance capacities, approaches to spatial strategy-making, and outcomes" (2007, p. 172).

This chapter summarises the research findings and reflects on the contribution of the research to policy, practice, and theory. It begins with a concise summary of the empirical findings presented in Chapter 11, responding to each research question. Section two evaluates the chosen research methods. It then considers implications of the findings for theory and future research, before concluding in section four with specific results which could be useful for policy makers and planning professionals.

12.1 Summary of the Empirical Findings of the Research

This section summarises the key empirical findings of the research as described in the case studies and comparative analysis of Chapters 6-11.

Governance negotiations for DHC

The research sought to understand how features of modern policy making and delivery constrain or enable the delivery of DHC, asking in research question one, **How do governance networks support the implementation of district heating and cooling systems?**. The research findings support the literature review in describing governance network behaviours as an empirical phenomenon in policy delivery. While the research design selected for the propensity of governance behaviours with both private and public actors engaged in delivering DHC, the cases nevertheless demonstrated that formal negotiations of cash and material

resources between private, civic, and public actors were successful in creating DHC systems. Government policy tools such as regulation, incentives, and capacity building were not sufficient in and of themselves and governance networks with collaborative negotiations between the private, civic, and public sectors were required to build and operate DHC systems.

Nevertheless, different arrangements of governance networks seem to work for DHC. Actors can change between case studies; there is no one right actor set or structure to negotiations for building DHC systems in an urban context. The comparative analysis identified a number of actor orientations and actor capabilities which support governance networks for DHC. The primary actor orientation which correlated with DHC delivery in the cases was supportive local elected officials. Two of the three cases studies also highlighted the potential capability of actors sitting in a middle ground between private and public sector to bring supportive finance for DHC to the governance network.

The literature review described how Adger, Jordan, Lowndes, Hajer, and Wagenaar call for empirical research into how governance network behaviours and network structure influence policy outcomes. The research findings suggest that the quality and type of interactions within governance networks for DHC can influence their outcome. The density of interactions among actors and the existence of non-negotiation spaces for knowledge and exchange of strategies between actors both correlated with successful implementation of DHC systems. Non-negotiation spaces facilitated evolution of the governance network by aligning resources and benefits and strengthening shared preferences among actors before they entered into fair value negotiations. The case study findings also support Scharpf's identification of positive coordination negotiations as the most promising orientation in voluntary networks: actors should have shared goals and also recognise the need for a fair distribution of resources.

The institutional setting influences the delivery of DHC systems

The research also sought to understand how formal and informal context affected actors and negotiations, asking **How does the institutional setting influence the delivery of district heating and cooling systems?**. The literature review explored how the privatisation of utilities and variation in government legal frameworks affect the ability of governance networks to form and manoeuvre to deliver DHC systems. While the comparative analysis found that institutional context strongly influences the ability of actors to deliver DHC systems, it also established that context did not dominate negotiations and actor-level factors were at least equally important.

The strongest influence of the institutional setting was through how local elected officials perceived local urban infrastructures and through the potential for municipal control over a local fuel source for DHC. Knowledge about DHC was also important to the governance network, although this was obtained through actor learning and by expanding the network to include more knowledgeable actors. The formal, legal context of planning organisations and practices was also found to be a particularly strong influence on other actors and the ability of governance networks to deliver DHC. Noticeably, national government organisations and international

knowledge networks were not identified as significant actors, directing network exchange characteristics, or influencing other actor opinions.

The roles of planning in delivering DHC

The literature review suggested that the research was unlikely to find a straightforward answer to the third research question, **What is the role of planning, in relation to market, civic, and to other government organisations, in delivering district heating and cooling systems?** The comparative analysis described a relatively similar set of roles for planning organisations which sometimes, but not always, successfully initiated or supported governance networks for DHC. Chapter 11 concluded that planning organisations rarely participated in negotiations in governance networks for DHC systems, but that interventions of spatial and land use planning were, importantly and usefully, used to initiate governance networks for DHC and to shape the negotiations between other private, civic, and public actors.

Planning organisations and interventions shaped governance networks by establishing the concept of DHC in a specific physical place and at a specific scale, thereby building a relevant actor set. They then affected the capabilities and strategies of other actors through incentives and regulation, and supported the patterns of interaction in governance networks through planning processes.

The comparative analysis also suggested that planning's role in establishing policies for DHC and aligning DHC systems with specific land uses and new development was more important than planning's ability to regulate new development. While the latter supported DHC by creating certainty about customers, or potentially raising funds for investment, those interested in creating a DHC system needed to start somewhere; they started by understanding the local physical constraints and opportunities in a changing urban context. Planning's masterplanning process and outcomes were needed to understand the place-based potential for DHC; universal incentives and regulation for DHC were unlikely to have been sufficient in the cases studied.

The variations in institutional context for planning across the cases illustrated the strong influence of formal and legal boundaries on the capacity of planning organisations and interventions to effectively support DHC. In particular, formal context affected the capacity of planning organisations to initiate governance networks by structuring the scope and influence of land use plans which coordinate consumers, fuel, and space for DHC.

12.2 Reflections on Research Methods

The use of a conventional comparative research structure and stakeholder analysis methods, paired with a rigid conceptual framework, proved both straightforward and fruitful in generating relevant findings. The rigour required to distinguish and separately code the capabilities, orientations, and strategies of each actor uncovered insights into why actors behaved the way they did. The comparative methodology was particularly helpful in illustrating the variety of ways that governance networks can begin, evolve, succeed, and fail.

On balance, the data gathering and interview approach taken proved to be effective in gathering the contextual, opinion-based information that the analysis sought. However the scale of information sought in each case was not easily obtained, and there remained minor gaps as individuals had left organisations and could no longer be reached. For example, in Toronto a key local politician who supported DLWC over many years died in 2011 before the interview process began. As described in Chapter 5, the researcher's choice to select cities where sufficient information could be obtained in the English language significantly limited the scope of case study selection and variation in the institutional setting. The trial of Social Network Analysis methods was discontinued after the challenge of establishing consistent boundary conditions proved too difficult for cross-case comparison in the large-scale 'messy' actor sets.

The benefits and limitations of Actor-Centered Institutionalism

ACI proved a helpful conceptual framework to analyse the cases. It enabled the researcher to visualise a ‘network’ perspective of how multiple actors approach interactions with each other without losing sight of the institutional effects on the network. Perhaps ACI's strongest feature was how it provided a structure to compare actor sets and actor strategies between cases, highlighting differences and similarities. Scharpf's detailed descriptions of modes of interactions and characterisations of types of negotiations also proved critical to uncovering the importance of non-negotiation spaces and distinguishing between general governance patterns and networks of negotiations. The researcher recommends the ACI framework for practice-oriented research on governance patterns of interaction, particularly although not exclusively suitable for multiple case analysis.

However, four significant limitations were encountered in the use of ACI. The first is ACI's relatively weak conceptualization of the institutional setting and its potential effects on actors, constellations, and modes of interaction. The research findings correlate with Scharpf in that institutional settings are a '5th variable' which influence all other variables. However compared to the description of actors and modes of interaction, Scharpf's treatment of the institutional setting is conceptually light and he does not define or characterise his rule systems or how they influence the actors, constellations, and negotiations. This weakness potentially stems from ACI's origin in European policy studies, where the institutional setting is roughly similar. When looking at international case studies where legal systems, histories, and ways of working are fundamentally different, the importance of the institutional setting in defining other ACI variables takes on greater importance.

A second limitation of ACI is the absence of a 'relational characteristic' variable; recognising formally that the quality and quantity of interactions can affect the success of governance networks. This was identified during the thesis literature review and the ACI framework and research design was modified to include this conceptual premise. The research findings on the importance of density and stability in interactions suggest that future use of ACI should continue this modification.

Third, ACI assumes a fairly static contextual background to policy development and implementation, and does not have an explicit mechanism to allow for significant economic, social or government changes (e.g. recession, change in political party control). Such factors shape actor orientations and behaviours and the actor constellation, but change is not included in the conceptualization of the institutional setting or any other of ACI's variables. This research dealt with change by giving room in the stakeholder analysis for actor orientations and actors to evolve; but other analysis methods may not be so flexible. Future research using ACI should be aware of this limitation and design data collection and employ analysis methodologies to respect wider social, political, or economic changes which might affect the governance network.

Finally, the research analysis finds that Scharpf's game theoretic approaches as described in *Games Real Actors Play* (1997) obscure complex real-world relationships between actors. The researcher has respect for how the game-theoretic aspects of his approach contribute to characterisations and to descriptions of negotiation types and actor arrangements. His theoretically derived characterisations proved well-founded and supported by this research findings and interpretations; for example the identification of non-negotiation space matches well with his identified need for "procedural separation of both types of interaction" (p135). And certainly such theoretical modelling of potential negotiations could provide insight into potential avenues for negotiation in a context where the policy goal itself is not certain; such as in Burlington. However on the whole the game-theoretical modelling is not explained satisfactorily in his book, and the simplification it suggests proves to be unnecessary for understanding real world situations. The games and graphs he describes are not constructive for undertaking analysis of detailed actor orientations and constellations. Instead what proves to be important is understanding, in each case, what actions could change actor opinions and at what point actors will start negotiating. Future researchers should respect Scharpf's conceptions of negotiations and his framework, but in a practical application of ACI following his game-theoretic tactics could potentially obscure understanding of governance networks.

Limitations of research on energy infrastructure for environmental goals

The title of this thesis employs the word 'capacity' deliberately, as a reminder of the ability of planning interventions to support DHC systems and of the importance of institutional context in defining the ability of planning to create, shape, and influence governance networks for DHC. Planning's capacity lies in its suitability to promote DHC as a policy goal and its legal ability to engage other actors.

But capacity also calls to mind to Earth's carrying capacity and the natural limits of an environment to sustain itself. And the research findings suggest practical and policy implications for understanding how cities can address this planet's carrying capacity. They also hint that significant change to urban energy use could require greater interventions than policy goals and public-private negotiations. But the research findings are necessarily limited by the research structure which sought to understand patterns of actor behaviour within existing institutional contexts, where DHC was a published policy goal.

12.3 Reflections on Theory and Implications for Future Research

The research design focused on empirical analysis in response to multiple calls for practice oriented research in governance literature (e.g. Jordan, 2008; Hajer & Wagenaar, 2003; Sorensen & Torfing, 2007). In the absence of extensive academic research on the role of planning or governance networks in delivering DHC systems, this thesis contributes to understanding how governance networks support DHC and describes in detail the potential influence of one actor, planning, on the ability of the network to deliver DHC.

12.3.1 Contribution to explanatory ambitions of governance network research

The research contributes to governance network research by evaluating the robustness of governance as an observed phenomenon in urban policy and investigating the link between quality of negotiations and the outcome of governance policy. On balance, the case study analysis supports Chapter 2's contention that the 'new spaces of politics' that drive governance patterns in policymaking apply equally to the barriers and opportunities of delivering DHC. Not every challenge was present in every case, but on the whole the cases contend with non-hierarchical policy development which requires positive collaboration and negotiation between public and private, unease about state power, framing of technical issues to the general public, and weak trust in political leadership. Burlington and Lerwick, both smaller cities with more interconnected personal networks, struggled less with trust and with the technical nature of DHC. The research shows that government policy tools such as regulation, incentives, and capacity building are not sufficient in and of themselves to overcome the challenges of modern policy making and delivery for urban infrastructure. Successfully building DHC needs collaborative but explicit negotiations of time, capabilities, and resources between multiple public and private actors in a local context.

A definition of network governance

Chapter 2 also introduced a definition of network governance. To inform critical discussion, this section turns to consider whether or not Sorensen and Torfing's definition provides a useful characterisation of governance networks in the cases studied. Sorensen and Torfing first posit that governance networks are "a relatively stable horizontal articulation of interdependent but operationally autonomous actors" (2007, p. 9). The unsuccessful case studies, London and Burlington, do not correspond to this first aspect of their definition. Chapter 9 describes how the changes to local authority structure, individual leadership, and local political leadership created instability and barriers to proceeding with a complex procurement process in Elephant and Castle. In Burlington, the actors are not yet interdependent; there is a heat source and there are potential customers but they have not yet agreed they need each other. The successful case studies conformed to this aspect of the definition, suggesting that stability and interdependency are critical to successful of policy delivery of DHC through governance networks.

The case analysis also uncovered two important qualities of actors which are not explicitly included in this first aspect of Sorensen and Torfing's definition. One, that governance networks

are a mix of private, semi-public, and public actors; governance for DHC still needs elected government leadership. And secondly, that functioning governance networks require actors with resources or capabilities to negotiate with; exchange of information is not sufficient. If resources are required to initiate and maintain negotiations in governance networks, this raises questions about the extended privatisation of government services; could, over time, cities lose the ability of public actors to effectively participate in governance networks? This finding also raises questions about the potentially limited role of capacity building or general 'convening' activities in governance networks. There little point in getting actors together to talk or to learn about DHC if those convening are not in possession of resources such as money, customers, or regulatory power to influence the behaviour of others.

Secondly, Sorensen and Torfing propose that actors interact through negotiations "that combine elements of bargaining with elements of deliberation" which "facilitates learning and common understanding" (p. 10). The only case which completely lacked negotiations was Burlington, as Chapter 7 describes. The remaining four cases exhibited a range of deliberation, discussion, and detailed negotiations, often several sets of negotiations. As a third aspect, Sorensen and Torfing posit that governance interactions happen within a "relatively institutionalised framework", an "amalgam of contingently articulated ideas, conceptualisations, and rules" (p. 10). This is a broad conception of an institutional framework, ranging from legal regulations through to common hopes. It is perhaps the weakest element of their definition of governance networks, as it is hard to envision any policy discussions, whether they be hierarchical government or non-exchange policy networks, that happen outside such a framework.

Sorensen and Torfing's fourth defining aspect of governance networks as "self-regulating" (p.9) gets to the heart of how governance networks differ from hierarchical policy implementation. The relative absence of direction from 'higher' government levels in all the cases studied supports this aspect of a definition for governance networks. Finally, Sorensen and Torfing define governance networks as solving policy problems which "contribute to the public purpose" (p.10). The research selected the five case studies for an explicit awareness that the proposed DHC system has an environmental benefit; therefore this aspect is not comparable in this research.

Table 33 provides a summary of case studies against Sorensen and Torfing's definition of governance networks. The unsuccessful cases are shaded in grey. This review suggests that Sorensen and Torfing's definition is a robust characterisation of functioning governance networks which achieve urban infrastructure policy goals, although it could benefit from refinement and strengthening in specific areas to enhance its explanatory ambitions. The definition should be refined to clarify that actors should have resources or capabilities to negotiate with; governance networks are exchange based. And that for DHC as a policy goal, local elected officials should be engaged and supportive in the governance network. Aside from these aspects, the research demonstrated that the definition can helpfully predict the propensity of a network to establish and achieve its infrastructure policy goal. This examination also underlines how further research could focus on the second aspect of their definition, interaction

through negotiations, as the research findings suggest there are normative interaction characteristics for infrastructure as an environmental policy goal.

Defining Aspects	Barcelona	Burlington	Lerwick	London	Toronto
1) Relatively stable horizontal articulation of interdependent but operationally autonomous actors	Yes	**Not inter-dependent**	Yes	**Not stable**	Yes
2) Who interact through negotiations	Yes	**Not yet**	Yes	Yes	Yes
3) Which take place in regulative, normative, cognitive, and imaginary framework	Yes	Yes	Yes	Yes	Yes
4) That is self regulating within limits set by external agencies	Yes	Yes	Yes	Yes	Yes
5) Which contributes to production of public purpose	Yes	Yes	Yes	Yes	Yes

Table 33: Comparison of cases against Sorensen and Torfing's definition of a governance network

Where next for network governance?

Three potential avenues for further study into the potential of governance networks to deliver policy goals are recommended. First, on the importance of non-negotiation 'space' for development of actor preferences and strategies. Is this a common feature of governance networks, or is it particular to capital-intensive infrastructure? Are separate dialogues needed within all governance networks? How exactly do non-negotiation spaces support or influence actor conceptions of policy goals and therefore willingness to negotiate?

Second, the research's findings on the link between the quality of governance network patterns and the policy outcomes would benefit from further study. Future research should both challenge the findings on the importance of density and explore relational characteristics further with other analysis methodologies such as Social Network Analysis. Questions include: is density of interaction important for all policy goals? Can more quantitative methods be applied to comparative research in messy policy problems? Are there implications for policy and practice of the need for high levels of density in interactions?

Third, on the extent of the importance of local government leadership for DHC. Is this identified trend specific to DHC; could, for example, air quality goals be achieved without local elected officials? Does supportive political leadership need to be local; could it be regional or national? The cases studied imply that for a place-based infrastructure such as DHC the governance leadership does need to be local, but further research is needed on this aspect of governance networks.

12.3.2 Implications for Institutional Theory

The comparative analysis in Chapter 11 suggests the influence of the institutional setting on the role of planning and other actors is strong, but also that there is no aspect of the institutional setting which guarantees success or that is more influential than other aspects of ACI. This indicates that Scharpf was correct to place the institutional setting as an overarching influence

on actors, actor constellations, and interactions. Positioned this way as the 5th aspect in ACI, the research was able to understand how the institutional setting influenced actor capabilities and the mode of interaction separately from influencing actor behaviours; distinguishing structural and intentional effects.

Low carbon energy infrastructure and the role of government

Chapter 3 described work by Bulkeley and Betsill (2013) and Bulkeley, Marvin, Hodson, Castan (2010) and others on cities and climate change which suggests that understanding and influencing urban energy infrastructure is central to a low carbon future (Guy, Marvin, & Moss, 2000). Consequently, seeking a low carbon future challenges the current relationship of the government to the control of energy infrastructure in urban areas (Spath & Rohracher, 2010; Bulkeley, et al., 2009). The five cases studied in this thesis were selected for their identification of DHC as an environmental policy goal and on balance show that cities are struggling to use climate change and low carbon goals as a means and a rationale to take greater control over utilities and local material resource use.

For example, Burlington's Planning Department attempted to use the local plan for energy considerations, but lacked other market regulations or incentives to support plan objectives; local politicians and the municipal government were unwilling to grow control infrastructure on environmental grounds. Barcelona's and London's municipal authorities did grow their control over resource use through the spatial planning of energy and waste infrastructure but this was limited to defined areas of the city. Toronto's City Council, supported by a strong civic environmental ethos, had the most success in using environmental goals as a rationale for changing urban energy infrastructure. Lerwick, with its isolated location and strong financial resources, retained more local government concern and responsibility for local service provision than other cases. In this research, the role of planning with regards to control of infrastructure for environmental goal demonstrates small steps towards an increasing role of governments, but with the government as better regulator and better initiator, not as provider.

Exiting utilities infrastructure and the spectrum of control

Chapter 3 also discussed socio-economic literature on the implications of the privatisation of utilities infrastructure (e.g. Marvin, Graham, & Guy, 1999; Offner, 2000; Adams C. , 2007; Hodson & Marvin, 2010) which stresses that in a neo-liberal energy market, privatized utilities are often managed by supra-national companies, with no local interest or representation. They describe how this has negative consequences for the ability of local authorities or local communities to influence or control material resource flows managed by these utilities. In the cases studied, not all existing utilities were managed by supra-national private companies; but where they were the "low levels of statutory control and influence" (Marvin, Graham, & Guy, 1999, p. 154) by local authorities were apparent as a challenge for the governance network. For example, in Lerwick, the local government sought the engagement of the electricity provider, a multi-national energy company, but were unable to attract them to supply the network with waste heat from the local power station. This limited the size of the network and potentially increased the cost that consumers pay by requiring additional investment in backup and peak

heating plant. From an environmental perspective it is a waste of resource: the power station discharges hot water from electricity production into the harbour.

The cases also demonstrated that the challenge of creating new DHC systems with respect to existing utilities is not just one of seeking to engage large privatised utilities to build DHC or provide heat. There were also challenges of competition with existing local energy companies. In Toronto the existing city-controlled electricity distribution company sought to compete with DHC; the balance of power between city hall and the distribution company was contested and required negotiation by senior local politicians. While in Barcelona, the use of the waste utility as low cost fuel for Districlima brought new purpose to existing utility-government relationships. The local waste incineration plant was managed (through a series of ownership structures) by the metropolitan government, and political links were called upon to engage the plant in fuelling Districlima through a thermal exchange agreement.

Together these cases indicate that for governance networks for DHC, actors need to recognise the contested and uneven nature of utility influence and control; that the 'splintered' and 'hidden' nature of material resource control is a challenge for the creation of DHC systems. The barriers identified by Marvin and others are strong, and more complicated than they seem at first glance. The complex and uneven nature of utilities ownership affects not only actor powers and resources but also actor perceptions and orientations about what others should do and therefore strategies for delivery. There is also an argument that the complexity of influence and control over local utilities demands engagement from local elected officials in governance networks for DHC; that public leadership can bring some utilities into the network negotiations either by control (e.g. Toronto) or influence (e.g. Barcelona). This latter point deserves future study and exploration, as it does not feature strongly in current socio-economic or technical literature on urban utility infrastructure.

12.3.3 The capacity of planning for environmental goals

The research findings have upheld the proposition of Chapter 1 that the scale of new DHC systems calls for local government involvement and the use of planning powers and capabilities. The research has also shown that some local governments recognise that proposals for urban form, as coordinated through the planning process, have implicit energy associations which require consideration of alternative forms of energy infrastructure provision.

The research findings also support the argument that DHC as an environmental goal occupies an unusual position in the scale of cities. It is not a technology such as photovoltaic panels which individual property owners can undertake, nor is it an issue for national or regional government such as large scale electricity generation. DHC is often a technology which serves an area that is smaller than the city boundary, and it requires a fine-grain understanding of constraints and opportunities of a place. There are physical and occupational constraints for connection, such as bridges or rivers, and opportunities controlled by local authorities in roads and rights of way. There are opportunities of supply in local geological energy sources or local human-made infrastructure. There are local issues of heating or cooling demand linked to

specific land uses. As the Technical Director for the Barcelona Energy Agency commented, "In the end the problem is not an energy problem to be solved, it is an urbanism problem that has to be solved. How to develop the network, how to open the streets to install all the pipes and link the programme to urban development timelines" (InterviewG4, 2012).

The literature review describes how an understanding of the role of planning organisations and processes in shaping, creating, and regulating urban utility infrastructure for environmental goals is only beginning to emerge. This research contributes to understanding in this area, outlining in detail the roles that planning organisations and planning interventions can play in supporting government policy around urban utility infrastructure. It also highlights how planning activity cannot be seen in isolation and that the success of interventions and practices is linked to other organisations' perceptions of government intervention in urban development and to conceptions of the role of government in managing resource use. The international perspective of this research should broaden the applicability of the research findings for practice and for further research. While identifying the potential of planning interventions and organisations in creating and focusing governance networks, the research also portrays a relatively limited set of planning methodologies and practices for energy masterplanning.

The research findings therefore recommend further theoretical considerations of the potential of municipal land use planning to support urban environmental goals. Planning studies should investigate links between the spatial coordination potential of planning and wider considerations of sustainable development in cities. These links could be explored at both structural or functional levels; challenging the scope and purpose of spatial planning and the capacity of land use coordination and masterplanning for policy goals such as increasing renewable generation or flooding. What would a legal framework for planning that supported local government control over urban utilities look like? Are there particularly helpful typologies of plan-making (e.g. city economic plans, detailed local plans) which effectively support different environmental policy goals?

One area recommended for further exploration is whether the methods and goals in transport planning could be transferred into a role for planning energy flows, low carbon generation, and efficient energy use. The field of transport planning is well developed in rationale for both state control of movement and for methodologies for coordinating land use, movement of goods or people, and investment. There is perhaps much to be learned through cross-fertilisation; not only modelling tools but also contextual and conceptual approaches which might support city governments in addressing climate change and energy management.

The potential for planning systems to support community ownership and activity for energy infrastructure could be explored further, investigating how collaborative and communicative planning approaches might usefully support governance networks for DHC. It is unclear if the relative absence of a capacity building role for planning in the cases studied arises from the capital-heavy nature of DHC or if the design of this research potentially excluded the role through case study selection.

Finally, there are potential links between the role of planning, governance networks, and the public-private partnership literature on infrastructure delivery. This public-private partnership literature is well developed, with typologies of approaches, theoretical discussions of social health, inequality, and sustainability, and practical suggestions for government enabling and regulation of large infrastructures. It would be prudent to understand if methods and identified practices from that body of literature could be incorporated into understanding the potential of planning to support governance for environmental infrastructure goals.

12.3.4 Implications for splintered urbanism and planning as an intermediary or enabler of transitions

Chapter 3 outlined potential roles for planning and DHC in a context of privatised utilities. Offner argues in *Territorial Deregulation: Local Authorities at Risk from Technical Networks* that there are potentials for planning to control infrastructure: "Without public space there would be no network" and therefore "Real authority for regulating the activities of the network operators exists...linked to the quality of the proprietor of the public domain" (2000, p. 177). The former proved true for DHC, in that DHC required right of way approvals for pipes installation through streets and public realm. However the power of planning to regulate DHC pipe networks through rights of way "is more a question of forbidding than encouraging" (2000, p. 178); a negative power to say no. This is not a helpful power over DHC as an environmental policy goal; it does not encourage DHC systems to be created.

Offner's second point was that to "control the network hubs is to control the structure of the network, and, therefore, to give oneself 'bargaining power'" (2000, p. 178); for DHC this corresponds with the control of occupied space (e.g. major energy consumer, or require new dwellings to connect). Did the market interventions of planning give government bargaining power via network hubs over the creation of DHC? The research findings suggest that yes, the control of energy use in buildings through the control of new development does give local governments bargaining power in DHC. The case studies also suggest, as does Offner, that local governments do not always recognise, or seek to use even when they do recognise, this power over utilities.

Chapter 3 also discusses how Guy, Marvin, Medd, and Moss build a case for the importance of intermediaries "developing novel ways of dealing with perceived defects" (2011, p. 210) in enabling change to the governance of urban energy infrastructures. While they do not explicitly mention planning organisations, the cases analysed in this research suggest that planning organisations and processes can play that transformative role. For example, Barcelona's Planning Department changed the governance of urban resource use through the publication of the *Special Infrastructure Plan*. Chapter 11 elaborates how planning organisations and interventions support DHC systems; a significant role is through broadening the scope of land use considerations of planning to include energy use and to set infrastructure goals.

But the cases also illustrate other actors as intermediaries. In Toronto the local councillors undertook intermediary functions by hosting charrettes and cross-sector working groups; the

local pension fund who provided finance for DLWC sat between provider, regulator, and consumer although not with particularly transformative goals. The research findings also support their point that intermediaries can be vulnerable; London shows how contextual changes reduce the capacity of intermediaries and how focusing support for DHC in one individual created a fragile governance network.

The research findings suggest ways to make planning organisations as intermediaries more effective. One, recognise that planning's market setting and intervention powers can spatially coordinate infrastructure in specific places. Two, the strong influence of the institutional setting on planning systems suggests that planning intermediaries need to understand the boundaries and potentials of their formal powers and capacities over DHC. However this research also identified limits to intermediaries in transition goals; planning or other intermediaries might help establish goals and support DHC, but actors need resources to bargain, and intermediaries (as neither consumer nor provider nor regulator) will rarely have sufficient resources to control or drive the creation of DHC systems in negotiation-based governance networks.

In a similar vein, Quitzau, Hoffmann, and Elle (2012) discuss how planning processes can have similarities to niche support of transitions, creating 'protected spaces' for technological innovation in support of environmental goals. In their concept of 'niche planning', "planners make strategic efforts to create and nurture technological niches, but where the strategic work is performed – not as a strategic niche management process – but as an integrated part of the spatial planning approach" (p. 1052). This research selected for cases in which DHC was an established policy goal; nevertheless the findings support their conclusions that transitions management can be "practised as an integrated part of local planning processes" (p. 1057). And that, at least for DHC systems, planning processes are uniquely placed to function as a contextually specific supportive framework.

12.4 Implications for Policy and Practice

This thesis finds that there is a role for planning organisations and planning practices in shaping urban energy infrastructure; this role is driven by the scale of such infrastructure versus traditional government boundaries, the association of DHC to specific locations and land uses, and the ability of governments to use planning interventions to shape future development. Each of these factors has implications for policy and for the practice of planning. The locally specific and cross- or sub- boundary nature of DHC creates political and administrative challenges for DHC as a policy goal. Planning practice has experience in overcoming these conceptual boundaries for other issues (e.g. housing provision) through the activities of spatial planning and development control. The findings imply that urban policy should encourage the use of planning tools and practices to influence energy flows and infrastructure in cities. Existing practices and methods of planning for other topics should and could be applied to energy masterplanning.

Policy recommendations

Chapter 11 described roles for planning organisations and planners in delivering DHC. Including energy infrastructure and consumption patterns in spatial planning and land use processes is

recommended as the most important role because it can initiate governance networks for DHC. But the market regulation and incentive interventions of planning are also important, particularly for areas of new urban development. Informal or legal traditions about market intervention for environmental goals might constrain planning activity, but the successful case studies show that when coupled with supportive local elected officials, market regulations and incentives can be powerful drivers for creating DHC.

The findings raise questions about the appropriate scale for future planning policy which integrates energy concerns. Historically arrangements of scale in planning have often taken economic (region), historical (conservation), or ecological (watershed) dimensions. Many countries already have national polices for energy efficiency, feed in tariffs, and the location of large scale generation. This research suggests that some energy efficiency concerns - the sharing of waste or excess heat, localised generation or the use of DHC - should be addressed through fine grain district energy plans.

This case study analysis described how other actors perceive of planning organisations and their role in energy management. With the exception of Barcelona, the planning departments are not assumed by other actors to be a particularly useful organisation even when the process of public sector planning for DHC was perceived to be important. To some extent this stems from the emerging nature of energy as an important resource for cities to manage, and from a historical focus of planning organisations on land use and urban growth. However this perception should be tackled within both urban policy, theory, and practice because issues of sustainable development are now predominately urban and, as this research shows, there is an important role for planning in managing resource use in urban areas. Publications such as *Planning for Sustainable Cities* (UN-HABITAT, 2009) and the C40 Cities report *Climate Action in Megacities* (2011) have begun to illustrate the potential of planning organisations and interventions in addressing environmental concerns, but the message about the positive environmental potential of proactive visions for urban development still has far to spread.

Finally, the research reinforces the importance of understanding the existing landscape of energy ownership in supporting DHC. And while this is emphasised by Offner, Marvin, Graham, Guy and others, the case studies illustrated that the complexity of energy governance has not overtly cascaded into practical recommendations or urban policy. This could be remedied through practical guidance and by broadening social studies of urban infrastructure to include a more detailed understanding of the potential of spatially minded intermediaries. In both practice and theory, one route to understanding energy in cities is through mapping of 'chains' of influence and focusing on intermediaries who create new formats of practice and engagement, as recommended by Guy, Marvin et al.

The case studies also identified that knowledge and understanding of DHC is a challenge for planners, other local government employees, and local elected officials. Publications such as the TCPA's *Community Energy: Planning, Development and Delivery* (2008) and *Energy:*

Looking to the Future. A Tool for Strategic Planning (Sherriff & Turcu, 2012) seek to address this but more could be done by both academic and professional bodies.

Implications for the practice of delivering DHC in cities

The research reinforces how urban government and urban governance of energy infrastructure are both critical to achieving greater sustainability in cites. On reflection the cases illustrate a limited level of power and capability in local authorities over local utility infrastructure. Given the significant influence of formal institutional settings on actor capabilities, national and international advocacy should be calling to give local government actors more powers and capacity over utility infrastructure. The research suggests that if DHC is sought as an environmental policy goal, the governance network will have a greater chance of success if city governments understand and seek more influence over local fuel sources (e.g. waste), promote a better understanding by local elected politicians, and seek to gain a level of influence over non-local private energy utilities.

As a minimum, the following four actions would be helpful for supporting the implementation of DHC networks. One, adapt the scope of planning activities in the city to require the planning department to undertake energy mapping as part of standard spatial planning activity, prioritising areas of regeneration or development. In areas with large scale development or regeneration, the planning department should use all available market interventions to support DHC. This could range from encouraging and raising awareness through to mandating the construction of DHC pipework and a tax to pay for the generating plant. Two, undertake a programme of education for local councillors and relevant local government employees about DHC, emphasising the benefits to them and their constituents.

Three, host open discussions with energy companies, interested local residents, and local government employees about the potential for DHC in specific places, but without any commitment about who pays for what. Planning officials could potentially facilitate this engagement, building on public engagement methodologies for urban design and other planning activity. This research has shown that these non-negotiation spaces help create a shared goal for DHC and enable better understanding of actor preferences and capabilities. And finally, require local government officers to develop an action plan for the use of any waste heat or local energy sources in the city and for the creation of DHC networks wherever heat or cooling densities prove sufficient. This could outline, for example, whether the authority intends to build the network itself, operate a concession approach, or support local residents in creating locally owned energy companies. It should include an awareness of ownership of existing utilities.

Appendix A: Works Cited

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Appendix B: Interview Pro-Forma

UCL FACULTY OF THE BUILT ENVIRONMENT

THE BARTLETT SCHOOL OF PLANNING

Semi-Structured Interview Questions

1. What is the aim or purpose of you / your organisation, in your own words? (open-ended)
2. How would you characterise your organisation? (prompted from list below)
    a. Local (government) authority
    b. Planning authority
    c. National government authority
    d. Campaigning organisation
    e. Residents or civic organisation
    f. Business group
    g. Individual business
    h. Energy company
    i. Consultant / Advisor
3. What kind of policies, incentives or regulations are you aware of that support the XX DHC system? (open-ended, prompt with knowledge from desktop review if necessary)
4. What kind of knowledge exchange or direct funding are you aware of that support the XX DHC system? (open-ended, prompt with knowledge from desktop review if necessary)
5. What has you / your organisations role been in delivering the XXX DHC system? (open-ended)
6. What kind of resources could you or your organisation have contributed?
    a. Time?
    b. Capital (funds)? Land?
    c. Knowledge / Expertise?
    d. Political or policy capacity?
    e. Coordination ?
    f. Regulation?
7. Which did you contribute? (prompted from answers to previous question)
8. What kind of actions could you or your organisation have undertaken in relation to the delivery of the XX DHC system? (prompted from list below)
    a. Collaborate with other groups or individuals?
    b. Tax or regulate other groups or individuals?
    c. Provide incentives for other groups or individuals?
    d. Deliver the DHC scheme (fund, procure, build or operate)?
    e. Knowledge sharing?
    f. Agree or disagree to connect?
    g. Other?

9. What kind of actions did you or your organisation undertake in relation to the delivery of the XX DHC system? (prompted from list below)
    a. Collaborate with other groups or individuals? If so, who? And how?
    b. Tax or regulate other groups or individuals? If so, who? And how?
    c. Provide incentives for other groups or individuals? If so, who? And how?
    d. Deliver the DHC system (fund, procure, build or operate)? How?
    e. Knowledge sharing?
    f. Agree or disagree to connect?
    g. Other?
10. Given the situation today, what kind of result would you prefer? (open-ended)
11. Which other organisations or individuals have been involved in delivering, or creating the environment for delivery of the DHC system? (open-ended)
    a. Are there specific individuals within those organisations who have been involved? (if necessary)
12. How did you communicate ore engage with other organisations or individuals regarding the system? Conferences, workshops, emails, meetings? (prompted with suggestions)
13. Of the organisations you mention in Question 11, what kind of actions and activities did each of them do in relation to this district energy system? What was their role? What do you think they should have done? (prompted, interviewer to complete the following table, adding organisations if needed).

	Organisation A	**Organisation B**	**Organisation C**
What was their role?			
What kind of powers or resources did they have? Over other actors?			
What did they do?			
What should they have done?			
Did your organisation collaborate with any of these? Was this formal?			
Did your organisation's aims or activities conflict with any of these?			

14. Did urban planning policy or the planning department influence the discussions or outcome regarding XXX DHC system? (open-ended)
    a. If so, how; what powers or capabilities did they have and what did they do? (open-ended)
    b. If not, why? (open-ended)
15. Did other government organisations influence the discussions or outcome of the XX DHC system? (open-ended)
    c. If so, how; what powers or capabilities did they have and what did they do? (open-ended)
    d. If not, why? (open-ended)

Appendix C. Analysis Details

Chapter 5 explains the data analysis approach. This appendix contains the four stakeholder analysis matrices for each case study. The self-identified actor and collective actor identified actor matrices have been converted from a table format into text to facilitate inclusion in this appendix.

As an example, a sample of the Barcelona Self-Identified Actor Matrix is shown for illustration purposes, which corresponds to the text in Section 1.1 below.

Actor	*Capabilities (1)*	*Orientation (2)*	*Preferences (3)*
Districlima	Company which operates and extends DHC network in 22@ district.....	Created for the purpose of operating the network.	Set up district heating and cooling network for use in heating, air conditioning and.....
Cofeley / GDF Suez (also Agbar)	Main shareholder of Districlima network. Also own Aguas	It is good thing for cities to be using district systems, and	
Tersa	The waste incineration company, owned		
Barcelona Regional	An urban planning agency which is separate	Environmental issues should be	Took advantage of Forum to implement infrastructure ideas. Negotiated with .....

In all cases, the number system is as follows:

1: Capabilities

2: Orientation (towards DHC)

3: Preferences (for how they or others should be involved in delivering DHC)

1. Barcelona

1.1 Self-Identified Actor Matrix

Districlima

1: Company which operates and extends district heating and cooling network in 22@ district. 27 or 30 year concession. Able to charge building occupiers to connect. Prices regulated by city on annual basis. (Districlima, 2012)

2: Created for the purpose of operated the network. (Districlima, 2012)

3: Set up district heating and cooling network for use in heating, air conditioning and sanitary hot water. Using waste heat reduces greenhouse gas emissions. Other benefits: reduction in refrigerant losses, reduction in noise and vibration, null visual impact. It's a pioneering project for Spain, but it is not futuristic or risky. (Districlima, 2012)

CEO, Districlima

1: DC works because it has political support, customers and financing. Large amount of finance needed to make investment in network creation. Limited in what prices they can charge to

customers. Right to make a profit during concession, but do not own and cannot sell network. (InterviewS2, 2012)

2: 2004-2007 was a technical period; now DC is in more of an operational and long term expansion phase. Barcelona is a good city to do this in because it is growing and it is innovative. Sees district heating and cooling as a social responsibility issue – it is efficient and quit and healthy (water). (InterviewS2, 2012)

3: District heating and cooling is a good solution because it solves the problem in a local area with a local source of energy. DC is a good solution – public investment needed first, but then private to run it. Best way to develop the project is to keep talking and communicating with businesses and politicians. His role is to do that and to manage the company. (InterviewS2, 2012)

Cofeley / GDF Suez (also Agbar)

1: Main shareholder of Districlima network. Also own Aguas de Barcelona (Agbar). Has the money to finance, even in 'crisis' – though shared with banks. (Gargante, 2010) (Mestrallet, 2011)

2: It is good thing for cities to be using district systems, and they offer special district network services – they want to grow in this area in Spain. They expect to lose money in the first 10 years. (Gargante, 2010) (Mestrallet, 2011)

3: No data

Tersa

1: The waste incineration company, owned by the Area Metropolitana (bigger than BCC) (InterviewA3, 2012)

2: No data

3: No data

Gas Natural

No data

Barcelona Regional

1: An urban planning agency which is separate from BUP but which predominately works for BUP. Shareholders are public agencies and institutions like the City Council. Wrote Barcelona Energy Improvement Plan and 22@ Special Infrastructures Plan. (Barcelona Regional, 2012)

2: Increasing complexity of urban planning – energy and environmental issues should be integrated within urban planning. (Barcelona Regional, 2012)

3: No data

Head of Energy Infrasturcture, Barcelona Regional

1: Responsible for energy infrastructure planning in Barcelona Regional. Has a small team. Made the feasibility studies for district energy network. (InterviewA3, 2012)

2: Environmental issues should be addressed through strategy and plan, not the environmental impact assessment. Spent many years investigating co-generation and district systems for

Forum and then 22@. Makes sense to take advantage of existing infrastructure at Forum, managed with Tersa – more of a political agreement - but not with other plant. (InterviewA3, 2012)

3: Took advantage of Forum to implement infrastructure ideas. Negotiated with city council and Tersa to use waste heat as part of Forum infrastructure, always with vision to extend. (InterviewA3, 2012)

Barcelona City Council

1:Two separate organisational levels: political and executive. Deputy mayors (political) take on departmental 'leadership'. (Ajutament de Barcelona, 2011)

2: Energy efficiency measures and investment are good – particularly in context of other European cities. Through the Energy Improvement Plan, published objectives to reduce atmospheric emissions and consumption of non renewable energy. They have a leadership role in supporting initiatives and a change in attitudes in the city, and believe that the city should use its power to regulate new installations. (Ajutament de Barcelona, 2011) (Ajutament de Barcelona, 2002)

3: Instructed Barcelona Regional to write the Plan for Energy Improvement in Barcelona. Approved plan, which includes Districlima. Energy infrastructures like Districlima are smart and efficient in energy, economic and environmental terms. (Ajutament de Barcelona, 2011) (Ajutament de Barcelona, 2002)

Imma Mayol i Beltran

1: Former Deputy Mayor for Environment and Former Head of Energy Agency. (Ajutament de Barcelona, 2011)

2: Recognises that 22@ existing infrastructure (energy and telecommunications) not sufficient. Cities – public administration – must lead to reduce energy patterns in cities. "Barcelona must by driven by a type of energy that ensures our city's way forward to a new and more sustainable global energy model" . (Ajutament de Barcelona, 2011) (Barelona Energy Agency, 2012)

3: The utility infrastructures that are needed to rejuvenate the 22@ district are in the Special Infrastructure Plan. . (Ajutament de Barcelona, 2011)

Barcelona Energy Agency

1: Public agency responsible to Deputy Mayor, funding comes from Ajutament. Identify and plan for efficient local energy use. Promote sustainable energy demand and renewables. Works alongside Spanish and Catalan agencies. In charge of delivering Barcelona Energy Improvement Plan, general framework for work of BCC in matters of energy policy. (Barelona Energy Agency, 2012) (Ajutament de Barcelona, 2011)

2: Promote Districlima (and other networks). European policy & European green city initiatives in this area are a consideration. Believes cities have a crucial role to play in better energy future. Citizen understanding and awareness is important. (Barelona Energy Agency, 2012)

3: Energy goals should be integrated into urban planning and land distribution. Districlima is one of 55 projects included in 2002 Energy Improvement Plan. (Barelona Energy Agency, 2012)

Technical Director, Barcelona Energy Agency

1: Idea for Districlima came from within municipality various departments including BUP and AEB – technicians first. Only 5 technicians in the agency. No national or European funding. (He previously worked for ICAEN on the Districlima Board) (InterviewG4, 2012)

2: Positive – the AEB has a long term vision for the city with energy networks connected. Recognise that it is difficult to implement., particularly the 'first' because of lack of knowledge and understanding. See themselves as partners with the Urban Planning Department for district heating and cooling. (InterviewG4, 2012)

3:Agency and urban planning department conceive of idea, design the infrastructure, and then tender a public concession to take project forward. PPP works for this kind of concession. AEB role is to manage Energy Plan and then to work with BUP to discuss Districlima with developers during planning permission stage. (InterviewG4, 2012)

22@ BCN

1: Did the urban planning that the city council had legal rights to (took those over). And supported developers. And also did projects themselves. Created by BCC to promote and manage 22@ transformation. Covered 198,26 Ha, 115 blocks, 1159626 m2 of land, investment in infrastructure: 180 m Euros. (InterviewA3, 2012) (Barcelona City Council, 2012)

2: The aim is to influence the development through investment and regulation. Recognise the significance of the 22@ regeneration project and the importance of the infrastructure plant to making it happen. (InterviewA3, 2012) (Barcelona City Council, 2012)

3: Worth trying to implement where they could. (InterviewA3, 2012)

Former Director of Infrastructures, 22@ BCN

1: Ability to invest money in public projects, approve building and infrastructure design for private projects. Had to follow some procurement policies, but not competitive dialogue. Did not know the best way to make the central heating and cooling network work. A 100% municipal company but it is a trading corporation and acts in the private market. Money from three sources: infrastructure fees for new approvals, city council, and funding from utility companies. (InterviewA3, 2012)

2: Residential and regeneration demand for heating not happening fast enough initially. (InterviewA3, 2012)

3: First they did an ideas competition to understand more about options. Districlima works because: political will, rising energy costs, and the 22@ regeneration means there is demand from new buildings to support growth. Very supportive, and thinks more cities in Europe should have the district systems. Compares them to street lighting as a service the municipality should provide. They are good means to an end. Needed the Forum project to make Districlima work. He would have preferred an extension to the Forum concession, but in the end 22@ did a new concession for the extension of the network. (InterviewA3, 2012)

Institute for Energy Diversification and Saving

1: Part of Spanish ministry for the Economy. Participated in the creation of the Barcelona Energy Improvement plan. . (Generalitat de Catalunya, 2012)

2: Supported Barcelona Energy Improvement Plan. The Municipalities have a great responsibility to deliver energy efficient technologies. (Generalitat de Catalunya, 2012)

3: No Data

Catalan Energy Institute

1: Support initiatives and action programmes for knowledge and development of energy technologies including renewables that improve efficiency. Funded by Catalan state. (Ajutament de Barcelona, 2002)

2: No data

3: No data

Barcelona Urban Planning Functions

1: Department of Ajutament de Barcelona executive structure. Creates city and neighbourhood plans. Coordinated Special Infrastructure Plan for Poblenou and Modification of General Plan to create 22@ district. Sets regulations for new build and refurbishment construction and building use, also in 22@ set infrastructure creation regulations. (Barcelona City Council, 2000) (Barcelona City Council, 2000) (Ajutament de Barcelona, 2011)

2: Create plans and establish regulation in accordance with city General Plan and with national and state legislation. For 22@, the infrastructure needs renewal. This should be financed by profit from regeneration and densification. They should design and then instruct how to create a large number of infrastructures including energy. Include DC in their planning process, as part of creation of new district, to ensure that development does not have a negative impact on the environment. (Barcelona City Council, 2000) (Barcelona City Council, 2000)

3: Urban Plans should be drawn up with criteria of sustainability, and the Special Infrastructures Plan sets out how private developers and city projects should design for and economically support creation of centralised air conditioning and hot water network. “To achieve the development of this project it is essential to co-ordinate a broad Special Infrastructure Plan which will act upon public areas as well as private community ones, determining surface land and underground land aspects. The content of the Plan will include aspects related to the water cycle, use and production of energy, cold and heat processes.” (Barcelona City Council, 2000) (Barcelona City Council, 2000)

Spanish National Government (various)

No data

Organisation Forum des Cultures

1: Co-organised by BCC, the Catalan Government, and SS. UNESCO is main partner. (Forum Barcelona, 2012)

2: No data

3: Wanted infrastructure (sewage and incineration) to form part of site. Otherwise says nothing explicit on old websites which still exist. (Forum Barcelona, 2012)

Building Owners /DC Customers

No data

Elected Councillors & Mayors / Politicians generally

1: No data

2: Barcelona has low CO_2 emissions per capital, but more effort required – and will be challenging. (Ajutament de Barcelona, 2011) (Ajutament de Barcelona, 2002)

2: "A real example of our commitment to being a benchmark for sustainable and smart urban development." Change in energy model can be demonstrated through new urban districts like 22@. Approved 22@ plan and infrastructure plan. (Ajutament de Barcelona, 2011)

1.2 Collective Actor Maxtrix

Districlima

1: Owned by GDF, but also have Tersa and Acbar and institutional support. Able to invest for many years before making a profit. Had the experience of GDF in creating district heating and cooling networks. (A3) (H602)

2: Brings many environmental improvements, such as efficient use of waste energy, reduction of greenhouse gases, reduction of refrigerant losses, reduction in noise and vibration. Also provides economic advantages to building owners. More expensive to retrofit in regeneration than to install in new neighbourhood. Hardest element is how to start, how to raise awareness, and how to encourage people to connect. (H602) (InterviewA3, 2012)

3: They should run the concession, operating the existing OFC system and trying to extend it with the City's help as the 22@ district is developed. Should offer prices that are cheaper than other ways of heating and cooling (reference case). The concession is for 30 years and expectation that same approach will be continued after that. (InterviewG4, 2012) (Barcelona City Council, 2000) (InterviewA3, 2012)

Cofeley / GDF Suez (also Agbar)

1:Only a few companies like GDF have mindset and funding to invest in long term concessions. Payback time could be 20 years. Technologically less aggressive than other companies, but financially sound and respected in Barcelona. (InterviewA3, 2012)

2: Was in a privileged position to win 2nd concession after winning the first. They like partnering with the public sector because it gives them confidence that the project will go ahead and smoothes difficult areas. Their existing presence in Barcelona is relevant to success of DC. (InterviewA3, 2012)

3: They won the first contract, to operate the Forum Network. They were seen as a good choice to do this – had the good technical knowledge and the money. Now the main shareholder in Districlima. (InterviewA3, 2012) (InterviewG4, 2012)

Tersa

1: Have heat source – operate incineration plant and produce steam. Responsible to Area Municipality Have a 20% share in Districlima. Were planning to extend the plant at the time of the Forum. (InterviewS2, 2012) (InterviewA3, 2012)

2: They will lose money on the steam generation but make it back by the selling of the heat. They are influenced by the council but not fully – they are more influenced by Area Metropolitana. (InterviewA3, 2012)

3: Have a heat transfer agreement with the city and then Districlima and also own some shares. Their share is to demonstrate the public partnership angle, and oblige the city to be supportive. (InterviewA3, 2012)

Gas Natural

1: Supply natural gas to some (but not all) of Barcelona. (InterviewG4, 2012)

2: Not supportive – will see DC as a competitor. (InterviewG4, 2012)

3: No data

Barcelona Regional

1: They are contracted to write the Energy Improvement Plan. Had the experience of the people who managed the Olympic Games. Willing to be adventurous and take a bet. (InterviewA3, 2012) (Ajutament de Barcelona, 2002)

2: No data

3: Support through development of Special Infrastructure Plan. (InterviewA3, 2012)

Barcelona City Council

1: A first class city organisation. Powers include urban development ordinances, direct investment, campaigns to boost private actions, cooperation, etc. Invests directly in highways and public space improvements. Cannot mandate connection to DC. Able to approve urban plans. Able to finance initial elements of network and design basic idea with internal knowledge. (InterviewA3, 2012) (InterviewS2, 2012) (H602) (Ajutament de Barcelona, 2002)

2: Following external energy and carbon commitments, the council is supporting renewables and efficiency more and more. The energy plan demonstrates this. Supportive through the urban planning process, and in the street works it does – creating infrastructure and pipes on behalf of DC sometimes. As a beneficial network for all the citizens of Barcelona; the administration has the obligation to develop this and provide service. Through the OFC, funded the initial infrastructure for Districlima. They should (and did) provide the initiative. (InterviewA3, 2012) (InterviewG4, 2012) (Barcelona City Council, 2012) (InterviewS2, 2012)

3: They should/did incorporate energy criteria into urban planning and come up with the idea for the projects. (approved special infrastructure plan) They should/did run the district heating and cooling network as a concession. Through OFC, they should/did fund the initial network (crucial) and negotiate the connections to Tersa for the Forum. Then DC should/did run that network and the extension as a concession, with BCC on the board to help connections. They – with AEB – should establish prices for district energy on an annual basis and otherwise regulate. Financed the OFC network and the first three kilometres of the network. (InterviewA3, 2012) (InterviewG4, 2012) (InterviewS2, 2012)

Barcelona Energy Agency

1: Manage the Energy Improvement Plan and projects arising from that Plan. (H631)

2: No data

3: Help the district heating and cooling supplier develop the network, alongside BCC and BUP. (InterviewG4, 2012)

22@ BCN

1: No data

2: Important that district heating and cooling is part of their innovative vision for the area. It is necessary to redo the infrastructure in the area. (Ajutament de Barcelona, 2002) (InterviewS2, 2012)

3: The city council and 22@ should be instructing and educating developers about Districlima. The city council in the end has the concession, but TT should guide this and coordinate with urban redevelopment. (InterviewS2, 2012)

Former Director of Infrastructures, 22@ BCN

1: Had a very deep knowledge of the infrastructure and the process . (InterviewA3, 2012)

2: No data

3: No data

Institute for Energy Diversification and Saving

1: Have a 5% shareholding in Districlima. Public corporation which promotes alternative energy at state (national) level . (InterviewA3, 2012) (InterviewS2, 2012)

2: Supportive as part of their remit – but more from an image perspective than real help. (InterviewA3, 2012) (InterviewS2, 2012)

3: Has issued recommendations but has not developed clear policies to promote district heating and cooling systems. (InterviewA3, 2012) (InterviewS2, 2012)

Catalan Energy Institute

1: Have a 5% shareholding in Districlima. Public agency which promotes alternative and efficient energy at catalan level. (Ajutament de Barcelona, 2011) (InterviewG4, 2012)

2: Supportive as part of their remit – but more from an image perspective than real help. (InterviewA3, 2012)

3: No data

Barcelona Urban Planning Functions

1: Ability to draft district energy initial plan with support from BR and AEB. (InterviewG4, 2012)

2: Have a long term vision for district energy network in Barcelona. Understand the concept and are supportive. Leverage redevelopment permissions to pay for some of infrastructure investment, and establish vision in legal plans. (Barelona Energy Agency, 2012)(InterviewG4, 2012)

3: They establish levels of energy efficiency for new buildings in 22@ district, which can be met through district network. They need to be involved to plan out the network with the urban growth and to connect users with DC idea during development phase. “At the end it is not an energy

problem to be solved it is an urbanism problem that has to be solved" (Sagarra & Ruyet, 2006) (InterviewG4, 2012) (Barcelona City Council, 2000) (InterviewS2, 2012)

Spanish National Government (various)

1: Have jurisdiction over energy in Spain (not state/regional). (InterviewA3, 2012) (InterviewG4, 2012)

2: No data

3: Were not mentioned as 'lacking' in support.

Organisation forum des cultures

1: Organisation by which Barcelona promoted chance in the area. It had a number of public buildings which it could use to connect. (InterviewA3, 2012)

2: Controversial event, but enabled transformation of east of city. Served as an excuse to make the public sector investment. Existence of Forum and public investment in buildings is a big opportunity to make DC work. (H613) (InterviewA3, 2012) (InterviewS2, 2012)

3: Promotes and supports energy initiatives, including setting up district heating and cooling network. Use of the Forum buildings as big base load – through BCC investment - provided boost to DC process. (InterviewA3, 2012) (Ajutament de Barcelona, 2002)

Building Owners / Districlima Customers

1: Have money and also the heat or cooling usage. In charge of internal servicing to buildings. Most customers are businesses, institutions or large residential buildings. (Districlima, 2012) (InterviewS2, 2012) (InterviewG4, 2012)

2: Cannot be forced into connecting, but they do not know about the option and it is different from the tradition of individual generation and cooling. Efficiency is not important to them, but they should be interested if DC provides a cheaper solution in the long term because their occupiers will be. If a developer, they should contribute towards infrastructure. They should like the simplicity, space saving, and reliability- but it takes several years of demonstrating this. They should be interested in lower emissions because of energy ratings, but it will cost them more up front. Two developers resisted at first. It was hard to convince them that the initial costs would be worth it. (InterviewA3, 2012) (InterviewG4, 2012) (InterviewG4, 2012)

If a developer, they should design the service connections as established in the Infrastructure Plan, and also pay costs towards wider infrastructure as part of development permissions. They should sign 10 year contracts, but actually the contract is 'longer' because it hard to back out. DC think they should be obliged to connect. (InterviewA3, 2012) (InterviewG4, 2012) (InterviewS2, 2012) (Barcelona City Council, 2000)

Elected Councillors & Mayors / Politicians Generally

1: Deputy mayors are the presidents of TT and AE. They provide the will to make public capabilities work. The legacy of the Olympic planning is still there – knowledge and capability in the politicians to understand the process and strategy. (InterviewA3, 2012)

2: Very difficult to convince them (the first time) that they should support Districlima. Having their participation and support is critical to success. The energy plan which they committed to help

establish their support. Also saw DC as a way to avoid unsightly individual chillers in building windows. One interviewer saw them as interested because of their 'socialist' stance towards urban investment. (InterviewA3, 2012)

3: Their support is/was necessary to make public investment happen. Saw it as a great opportunity in the end, despite political risks and 'new' angle to technology. Did not want to force building owners, scheme should rest on its own merits and cheaper costs. (InterviewA3, 2012)

1.3 Self-Identified Strategy Matrix

	Market Shaping (4)	Market regulation (5)	Market Incentives (6)	Market capacity (7)
Districlima	+	0	+	++
Cofeley/GDF	U	U	U	U
Tersa	U	U	U	U
Gas Natural	U	U	U	U
Barcelona Regional	+++	0	U	+
Barcelona City Council	+++	++	++	+++
Imma Mayol i Beltran	U	U	U	+
Agència d'Energia de Barcelona	++	+	0	+++
22@ BCN	+++	++	0	++
Institute for Energy Diversification and Saving	+	0	0	+
Catalan Energy Institute	+	0	+	+
Barcelona Urban Planning Functions	+++	+++	U	+
Spanish National Government	U	U	U	U
Organisation forum des cultures	+	0	0	+
Building Owners DHC Customers	U	U	U	U
Elected Councillors & Mayors / Politicians generally	+	0	0	+

1.4 Collective Strategy Matrix

	Market Shaping (4)		Market regulation (5)		Market Incentives (6)		Market capacity (7)	
	Potent.	*Actual*	*Potent.*	*Actual*	*Potent.*	*Actual*	*Potent.*	*Actual*
Districlima	U	U	U	U	++	++	+	++
Coefeley/GDF	++	++	0	0	0	0	++	++
Tersa	++	++	0	0	0	0	0	0
Gas Natural	0	0	0	0	0	0	0	0
Barcelona Regional	+	++	0	0	0	0	+	+
Barcelona City Council	+++	+++	+++	++	++	+++	++	++
Imma Mayol i Beltran	U	U	U	U	U	U	U	U
Agència d'Energia de Barcelona	++	++	0	0	0	0	+++	++
22@ BCN	U	U	U	U	U	U	++	++
Institute for Energy Diversification and Saving	+	+			+	+		
Catalan Energy Institute	+	+			+	+		
Barcelona Urban Planning Functions	+++	+++	++	++			+	+
Spanish National Government	U	U	+	0	0	0	U	U
Organisation forum des cultures	+	+	+	+	++	+++	+	+
Building Owners DHC Customers	U	U	U	U	U	U	U	U
Elected Councillors & Mayors / Politicians generally	++	++	0	0	0	0	+	++

1.6 Actor Code References

Actor	*Reference*
Districlima	DC
CEO, Districlima	DS
Cofeley / GDF Suez (also Agbar)	GDF
Tersa	TR
Gas Natural	GN
Barcelona Regional	BR
Head of Energy Infrastructure, Barcelona Regional	GR
Barcelona City Council	BCC
Imma Mayol i Beltran	IMB
Agència d'Energia de Barcelona	AEB
Technical Director, Barcelona Energy Agency	MT
22@ BCN	TT
Former Director of Infrastructure, 22@ BCN	RS
Institute for Energy Diversification and Saving	IDAE
Catalan Energy Institute	ICAEN
Barcelona Urban Planning Functions	BUP
Spanish National Government (various)	SS
Organisation forum des cultures	OFC
Building Owners / Customers	BO
Elected Councillors & Mayors / Politicians generally	BC

1.7 Codes

20
21
22
23
AEB1AEB
AEB1BCC
AEB2AEB
AEB2BCC
AEB2BUP
AEB3AEB
AEB3OFC
AEB4AEB
AEB4BCC
AEB4BUP
AEB5AEB
AEB5BCC
AEB5OFC
AEB7AEB
AEB7OFC
BC1BCC
BC1BR
BC2BC
BC2BO
BC2TT
BC3BC
BC4BC
BC4BCC
BC7TT
BCC1AEB
BCC1BCC
BCC2BCC
BCC3BCC
BCC3DC
BCC3DS
BCC4BCC
BCC5BCC
BCC6BCC
BCC7BCC
BR1BR
BR2BR
BR3TT
BUP1BCC
BUP1BUP
BUP2BCC
BUP2BO
BUP2BUP
BUP3BCC
BUP3BO
BUP3BUP
BUP3DC
BUP4BCC
BUP4BUP
BUP5BUP
DC1BCC
DC1BO
DC1DC
DC2BO
DC2DC
DC2OFC
DC3DC
DC3BO
DS1BCC
DS1BO
DS1DC
DS1DS
DS1GDF
DS1ICAEN
DS1IDAE
DS1TR
DS2BC
DS2BCC
DS2BO
DS2DC
DS2DS
DS2GN
DS2OFC
DS2TT
DS3BCC
DS3BO
DS3BUP
DS3DC
DS4BC
DS4BCC
DS4ICAEN
DS4IDAE
DS4TR
DS5BC
DS5BCC
DS6BCC
DS6DC
DS6OFC
DS7DC
DS7DS
GDF1GDF
GDF2GDF
GR1BCC
GR1BR
GR1DC
GR1GDF
GR1GR
GR1IDAE
GR1OFC
GR1RS
GR1TR
GR2BCC
GR2BO
GR2BR
GR2DC
GR2DS
GR2GR
GR2ICAEN
GR2IDAE
GR2OFC
GR2TR
GR3BCC
GR3BR
GR3GDF
GR3TR
GR4BCC
GR4BR
GR4GR
GR4TT
GR5BCC
GR6DC
GR6OFC
GR7BR
ICAEN1ICAEN
ICAEN2ICAEN
IDAE1IDAE
IDAE2IDAE
IDAE3BCC
IDAE4IDAE
IDAE7IDAE
IMB1BCC
IMB1DC
IMB1GDF
IMB1ICAEN
IMB1IDAE
IMB1TR
IMB2BUP
IMB2CC
IMB2DC
IMB2IMB
IMB2TT
IMB3DC
IMB3IMB
IMB4BCC
IMB4BUP
IMB5BCC
IMB5SS
IMB6BCC
IMB6DC
IMB6SS
IMB7BCC
IMB7DC
IMB7IMB
MT1AEAB
MT1AEB
MT1BC
MT1BCC
MT1BO
MT1BUP
MT1DC
MT1GDF
MT1ICAEN
MT1MT
MT1SS
MT2AEB
MT2BC
MT2BCC
MT2BO
MT2BUP
MT2DC
MT2DCC
MT2GDF
MT2GN
MT2MT
MT3AEB
MT3BCC
MT3BO
MT3BUP
MT3DC
MT3MT
MT3SS
MT4AEB
MT4BCC
MT5AEB
MT5BCC
MT5BUP
MT5SS
MT6SS
MT7AEB
MT7BUP
MT7DC
MT7GDF
OFC1OFC
OFC3OFC
OFC7OFC
RS1BC
RS1BCC
RS1BR
RS1DC
RS1GDF
RS1OFC

RS1RS	RS2RS	RS4BR	RS7BCC
RS1SS	RS2TT	RS4BUP	RS7BR
RS1TT	RS3BC	RS4TT	RS7RS
RS2BC	RS3BCC	RS5BCC	RS7TT
RS2BCC	RS3BO	RS5BUP	TR1TR
RS2BO	RS3BR	RS5DC	TT1TT
RS2BR	RS3BUP	RS5TT	TT2BCC
RS2BUP	RS3RS	RS6BCC	TT2TT
RS2DC	RS3TT	RS6DC	TT4BUP
RS2GDF	RS4BC	RS6OFC	TT5BUP
RS2OFC	RS4BCC	RS7BC	

2. Burlington

2.1 Self-Identified Actor Matrix

Ever-Green Energy / MB

1: Substantial experience in organisation of renewable community–based large energy systems in St Paul, Minnesota. Ability to evaluate technical potential of options as well as legal, financial viability of options. (Ever-Green Energy, 2011) Appointed by BURDES committee with funding from a mix of sources. Mission driven company with the goal of creating efficient district energy systems to benefit communities. (InterviewA4, 2012)

2: Very supportive – see waste heat as untapped resource that is being wasted. As hired by BURDES, to use their experience to evaluate technical potential of options as well as legal, financial viability of options. Concluded that network could be built that provides cost-effective heat as well as a good return on cost investment. (Ever-Green Energy, 2011) Believe you have to take residents on 'journey' of understanding – but that you begin by explaining the benefits to politicians. (InterviewA4, 2012)

3: Advise local governments, politicians and residents and help organise the new network system. Not only feasibility studies and help from a consulting standpoint, but also have the potential to get involved with active management and opportunistically help to improve these systems. Prefer a community owned non profit network with politicians and customers representatives on a board of governors. (InterviewA4, 2012)

State

No data

Burlington city generally

1: Burlington has a city council-mayor form of government. (City of Burlington, 2012).

2: No data

3: No data

BE Burlington Electric

1: A municipal department of the City of Burlington. Directly governed by a five-person Board of Electric Commissioners, who are selected by the City Council and Mayor of Burlington.

Vermont's largest municipally owned electric utility, serving almost 20,000 customers. Partial owner of McNeil. (Grimes, 2011)

2: No data

3: No data

McNeil

1: Jointly owned by BED (50 percent), Central Vermont Public Service (20 percent), Vermont Public Power Supply Authority (19 percent) and Green Mountain Power (11 percent). Can burn wood or natural gas. At full load, the plant can generate 50 megawatts (MW) of electricity. (Grimes, 2011)

2: No data

3: No data

Burlington Community and Economic Development Office

1: Administering Community Development Block Grants and Urban Development Action Grants (City of Burlington, 2012)

2: No data

3: No data

BP Burlington Planning and Chief Planner

1: Prepares municipal plan every 4 years according to state statute – plan presents vision for development over next 10-20 years. (White, 2011) (Eldridge, 1985) Powers given by VSA title 24, chapter 117. "Purpose of planning: focusing public attention and raising public involvement on fundamental development aspects of the city. . Not appointed by the mayor. Ability to develop land use policy as well as land use regulations. Ability to develop strategic ideas and convene discussions about future of city. (InterviewP4, Director of Planning and Zoning, City of Burlington, 2012)

2: Support district heating and cooling if feasible – see it beneficial as alternative energy source, diversification of cities energy mix, and part of being a competitive location for business. Considered important in climate change mitigating and abatement options. (Eldridge, 1985) Planners originally instrumental in getting the city interested in climate change and talking about what the city should do. See their role as management of process that comes up with ideas and encouraging them, but not responsible for making ideas like district heating happen. (InterviewP4, Director of Planning and Zoning, City of Burlington, 2012)

3: Include district heating in city visions and planning, but Burlington Electric is the primary organisation to deliver network (White, 2011) (Eldridge, 1985). Try to keep the BURDES network going and keep an eye out for opportunities that present themselves (InterviewP4, Director of Planning and Zoning, City of Burlington, 2012).

BURDES Committee

1: A group of citizen-volunteers who are committed to taking advantage of the underutilized heat from the McNeil Electric Generating Station. Raised grant money from foundations and funds to

do feasibility study work (BURDES, 2012) (Burlington District Energy Service, 2012). After several years of activity, understand major issues and technical details. (InterviewC2, 2012)

2: Very supportive - exist to promote a district heating network which uses waste heat from McNeil to serve downtown and/or the university and hospital. “Our citizen's committee believes that district heating service for the Burlington community using heat from the McNeil Station is an important step to reduce our carbon footprint and provide energy security in the coming years.” (BURDES, 2012) (Burlington District Energy Service, 2012). Understand it will take time and political will, and will not happen overnight. (InterviewC2, 2012)

3: Organise studies to identify a practical solution. Promote both technical options based on energy demand inventory as well as consider options for structure of organisation to run the network. Engage with potential large customers (BURDES, 2012) (Burlington District Energy Service, 2012). Open regarding future ownership of heating network – can see several options working both private and non-profit approach. Do not see themselves as future owners. (InterviewC2, 2012)

Local Journalists

1: Local journalists. (Baird, 2011) (Picard, 2011)

2: Positive, imagining how it could work in Burlington and identifies benefits for fuel diversity. (Baird, 2011) (Picard, 2011)

University of Vermont

1: Academic and residential campus. Student and staff population approx 13,000. (University of Vermont, 2012)

2: Strongly committed to conserving electricity, fuel, and water as part of its goals to become the "leading environmental university of the nation." Significant heat usage. (University of Vermont, 2012)

3: : Campus buildings are tied into a centralised heating system, with over 8.8 miles of high temperature hot water systems. (University of Vermont, 2012)

Fletcher Allen Hospital

1: Non-profit hospital serving local residents and providing advanced care to wider state population. Partnership with University of Vermont. Significant heat usage. (Fletcher Allen Hospital, 2012)

2: No data

3: No data

Residents

No data

2.2 Collective Actor Matrix

Ever Green Energy

1: Technical knowledge and experience of designing and operating wood and waste fuelled co-generation plants. (InterviewC2, 2012)

2: No data

3: Advise city, committee and residents on how to establish district heating network. (InterviewC2, 2012)

State

1: State level planning provides technical system and advice, not much authority. Ability to convey certificate of public good – benchmark of utility status. Stimulus funds. Own buildings in downtown and have 2020 target to be on renewable fuel for those buildings. (InterviewC3, 2012; InterviewP4, Director of Planning and Zoning, City of Burlington, 2012)

2: Perceived as interested and supportive, but not actively. For local buildings, aware and mildly interested in being a customer. (InterviewC3, 2012) (InterviewC2, 2012)

3: Approval of certificate of public good would be approval of project. Potentially as source of long-term loans for public projects. Also as a customer for federal buildings downtown. (InterviewC3, 2012) (InterviewC2, 2012)

Burlington city generally

1: Political leadership on issue. Mayor is elected at large every 3 years and appoints number of city staff. City councillors serve 2 year terms and act on boards or commissions. Ability to raise money for investment in BE projects through bonds. Local finances constrained by bad credit rating. Does not own many buildings. (InterviewC3, 2012) (InterviewA4, 2012) (InterviewC2, 2012)

2:Currently neither obstructive nor supportive. Need to be very supportive to make customers and finance work and explain to residents what is happening. Current Mayor likes the idea but thought it needed a concrete financial future and would not finance it without customers. Concerned about financial impact on city credit and budgets. (InterviewC3, 2012) (InterviewC2, 2012)

3: Older plans suggest the city should develop and energy budget and manage both consumption and local generating capacity. City municipal support needed before further customer engagement. Public works department would coordinate pipework installation in streets. Would not be a major customer of heat. (InterviewC3, 2012) (InterviewC2, 2012)

Burlington Electric Department

1: Owns McNeil and have residential presence. Partially owned by city municipality – seen as positive and also a limiting factor as have to listen to other owners – 2/3 vote for major projects. Provided funds for feasibility reports. With political support, raise money for power investment through bonds. Well managed and liked. Funded previous studies with state money granted. (Gertler, 1978) (InterviewC2, 2012)

2: Perceived as support essential to make the network happen. Older plans suggest they should consider social and environmental costs of energy options. Supportive of feasibility studies on using thermal energy from McNeil. Varied owners likely to be supportive, but unknown in detail. “not huge advocates but if something makes sense let's do it” – require further information on feasibility. (InterviewA4, 2012) (InterviewC2, 2012) (Eldridge, Municipal development plan, 1985)

3: Older plans give them responsibility for developing feasibility of network and leading on implementation if appropriate. Not seen as full leader - perceived as partner in final organisation which would run this, or other options for management. They would invest in and own the thermal generation plant but not be solely in control of pipe network, billing and operations. (InterviewA4, 2012) (Eldridge, Municipal development plan, 1985) (Ever-Green Energy, 2011) (InterviewC2, 2012)

McNeil

1: Waste heat is a great opportunity. Sufficient to meet needs of downtown Burlington. (InterviewA4, 2012) (Ever-Green Energy, 2011)

2: No data

2: No data

Burlington Community And Economic Development Office

1: Operate under the wing of the Mayor. Provided funds for feasibility reports. Staff attend BURDES Meeting. (InterviewC2, 2012; InterviewP4, Director of Planning and Zoning, City of Burlington, 2012)

2: No data

3: More active role in implementation of these kind of initiatives. (InterviewA4, 2012)

BP Burlington Planning and Chief Planner

1: Manage rights of way access. (InterviewC2, 2012)

2: No data

3: No data

BURDES Committee

1: Group of people committed to making district heating work. Obtained $140,000 funds for and commissioned latest feasibility study. Because of size of town, small group can have influence. (InterviewC3, 2012)

2: Committed to identifying a practical solution that leads to the creating of a renewable-fuelled community energy system in Burlington using the underutilized thermal energy from the McNeil Station. (Ever-Green Energy, 2011)

3: Pull together the people and ideas and knowledge. (InterviewA4, 2012)

Local Journalists

No data

University of Vermont

1: University with approximately 13,000 staff and students. Large heating consumption – potential customer who would be important for network. (Ever-Green Energy, 2011)

2: Historically not supportive as wanted to retain their existing generation plant associated engineering jobs. Interest depends on natural gas prices. Potentially more interested now than in past (Ever-Green Energy, 2011) (InterviewC2, 2012) (InterviewA4, 2012)

3: Be an anchor tenant which created enough demand to make pipe investment feasible. Sign up for long term contract to purchase heat from network on terms more favourable than natural gas (Ever-Green Energy, 2011) (InterviewC2, 2012).

FA Fletcher Allen

1: Large heating consumption - potential customer who would be important for network (Ever-Green Energy, 2011).

2: Unclear intentions with regards to future connection and/or technical compatibility. But expressed interest in continuing the discussions (Ever-Green Energy, 2011) .

3: Be an anchor tenant which created enough demand to make pipe investment feasible. Sign up for long term contract to purchase heat from network on terms more favourable than natural gas. To date, they have preferred to operate a gas or oil fired small steam heating network. Now slightly interested in connection to McNeil potential network (InterviewC2, 2012) (Ever-Green Energy, 2011).

Residents

1: 2/3 use natural gas for heating; previous electric or coal use. High proportion of rental properties and students in town. Value conservation and effective resource utilization and local solutions. Vote on financial loans and bonds for major projects. Aware of McNeil station as wood fired. (Ever-Green Energy, 2011) .

2: Interested in environmental issues – therefore potentially interested in waste heat and climate change reasons for district heating. Self-reliance reason is there, but subsidiary to general environmental concerns. Also expectation that they will be sceptical of city ownership and costs because of Burlington Telecom. (InterviewC3, 2012) (InterviewP4, Director of Planning and Zoning, City of Burlington, 2012) (InterviewC2, 2012) (Ever-Green Energy, 2011).

3: They would vote on finance (bonds) or city investment. Marginal interest in scheme to date, although public meeting in 2011 was enthusiastic. (InterviewC3, 2012) (InterviewC2, 2012) (InterviewP4, Director of Planning and Zoning, City of Burlington, 2012)

2.3 Self-Identified Strategy Matrix

	Market Shaping (4)	Market regulation (5)	Market Incentives (6)	Market capacity (7)
Ever Green Energy	0	0	0	+++
State	U	U	U	U
Burlington city generally	U	U	U	U
Burlington Electric	U	0	0	0
McNeil	0	0	0	0
BC community dept	+	U	+	U
BP Burlington Planning and Chief Planner	+++	+	+	++
BURDES	++	0	0	+++
Local Journalists	0	0	0	0
University of Vermont	0	0	0	0
FA Fletcher Allen	0	0	0	0
Residents	U	U	U	U

2.4 Collective Strategy Matrix

	Market Shaping (4)		Market Regulation (5)		Market Incentives (6)		Market Capacity (7)	
	Potent.	***Actual***	***Potent.***	***Actual***	***Potent.***	***Actual***	***Potent.***	***Actual***
Ever Green Energy	0	0	0	0	0	0	+++	+++
State	0	0	++	++	++	+	+	+
City of Burlington Generally	++	0	0	0	++	0	+	0
Burlington Electric	++	+	0	0	0	0	++	++
McNeil	0	0	0	0	0	0	0	0
Burlington Community dept	+	+	0	0	+	+	0	0
Burlington Planning and Chief Planner	+	0	+	0	0	0	0	0
BURDES	++	+	0	0	0	0	+++	+++
Local Journalists	0	0	0	0	0	0	++	++
University of Vermont	0	0	0	0	0	0	0	0
FA Fletcher Allen	0	0	0	0	0	0	0	0
Residents	0	0	0	0	0	0	0	0

2.5 Actor Code References

Code	***Name***
	Market
EGE	Ever Green Energy
MB	Senior Vice President, Ever Green Energy
	Public / State
S	State generally (incl public board of approvals)
B	City Government of Burlington Generally
BS	Former Community Development Officer
MN	McNeil Generating Station
BE	Burlington Coop Electricity
JI	Manager of McNeil Generating Station
BC	Burlington Community Economic Development Office
EA	Community Development Officer
DW	Director of Planning and Zoning, Burlington
BP	Burlington Planning Dept
	Civic
BURDES	Burlington District Energy Service
JS	Local Resident on BURDES committee
KP	Kevin Pickard, Journalist
FP	FREE Press (editorial unnamed)
JB	Joel Banner Baird, Journalist
UV	University of Vermont
FA	Fletcher Allen Hospital
R	General Residents

2.6 Codes

20
21
21]
22
B1B
B2B
BC1BC
BC4BC
BC6BC
BE1BE
BE4BE
BE4R
BED4R
BM2B
BP1B
BP1BE
BP1BP
BP1R
BP2B
BP2BE
BP2BED
BP2BP
BP2BURDES
BP3B
BP3BE
BP3BP
BP4BP
BP5BP
BP6BP
BP7BP
BURDES1BURDES
BURDES1FA
BURDES1UV
BURDES2BE
BURDES2BURDES
BURDES2UV
BURDES3B
BURDES3BURDES
BURDES3EGE
BURDES7BURDES
BURDES7EGE
DW1B
DW1BP
DW1BURDES
DW1DW
DW1S
DW2B
DW2BC
DW2BE
DW2BP
DW2BURDES
DW2R
DW2S
DW2UV
DW3BP
DW3R
DW3UV
DW4BC
DW4BP
DW5B
DW5BP
DW5S
DW7BP
DW7BURDES
EGE1B
EGE1BC
EGE1BE
EGE1BURDES
EGE1EGE
EGE1FA
EGE2B
EGE2BE
EGE2BURDES
EGE2EGE
EGE2FA
EGE2R
EGE3BUDES
EGE3BURDES
EGE3EGE
EGE4BURDES
EGE7BE
EGE7BURDES
EGE7EGE
FA1FA
FP1BE
FP1R
FP2BE
FP2R
JB1B
JB1BE
JB1BP
JB1BURDES
JB1R
JB1S
JB2B
JB2BE
JB2EG
JB2JB
JB2JI
JB2R
JB2S
JB3JI
JB3R
JB5BP
JB5S
JI1BE
JI1BURDES
JI1R
JI2B
JI2BE
JI2BURDES
JI2FA
JI2JI
JI2R
JI2UV
JI4B
JI6S
JS1BC
JS1BE
JS1BURDES
JS1FA
JS1JS
JS1R
JS1S
JS1UV
JS2B
JS2BE
JS2BURDES
JS2FA
JS2JS
JS2S
JS2UV
JS3B
JS3BE
JS3BURDES
JS3EGE
JS4B
JS4BP
JS4BURDES
JS5S
JS6S
JS7BURDES
JS7EGE
JS7JS
JS7S
KP1BURDES
KP2BURDES
MB1BURDES
MB1EGE
MB1M
MB1MB
MB2B
MB2BE
MB2BURDES
MB2EGE
MB2ENE
MB2MB
MB2R
MB3BURDES
MB3EGE
MB4BP
MB4BURDES
MB6S
MB7B
MB7BURDES
MB7EGE
MB7JB
MN1MN
UV2UV

3. Lerwick

3. 1 Self-identified Actor Matrix

Scottish Hydro/SSE

1: Leading electricity and gas company (private) operating in the UK and Ireland. Generation, transmission, distribution and supply of electricity. Production & distribution of gas and other energy services. (SSE, 2013)

2: No data

3: No data

SHEAP (also NW)

1: Lease DH kit from SICT. Serving district heating to both domestic and non-domestic properties since 1998. Money from thermie, charitable trust and Europe. Trust are financial backers. SICT breaks even with lease of kit, profits, employee costs etc. Learned about DH-originally thought it silly., Went to Denmark. Was originally a council officer in charge of engineering and new works. 6 Staff, 4 technical. Could handle 100 connections a year. (InterviewS1, 2011; Martin & Spence, 2010; Shetland Heat Energy and Power Limited, 2011)

2: Operate system. Get customers (now have waiting list) to sign up. Bill customers, provide them with heat. Wanted a large town ring main, took a while to connect up. Currently searching for an additional (cheap) energy source. No mains gas to compete with, so cost generally cheapest heating source (flux over time). Finances and return on investment not so good, but good for Lerwick. (InterviewS1, 2011; Martin & Spence, 2010; Shetland Heat Energy and Power Limited, 2011)

3: Build network to customers. Currently considering how to expand (need cheap heat). Original plan to serve whole town, through a ring approach. This was reduced to main pipeline. Hoping to start up connections again in 2013. Built out as much as heat output allows – require further source of heat to expand further. District Heating is appropriate for Lerwick. Start with commercial customers (non-residential) as residential more difficult. Not involved inside the houses due to lack of resources. (InterviewS1, 2011; Martin & Spence, 2010)

SICT

1: Set up in 1974 , recreated in 1997. Original payment £2m, total payments over £81m. Charitable Status. Can invest in subsidiary companies, stock market, for benefit of Shetland residents (specified areas). EU money for incinerator. £1 million from community energy programme – 1/3 shared w social housing. (Robertson, 2008; Shetland Island Charitable Trust, 2012)

2: Invest in a district heating scheme as it would provide an economic and environmental benefit to the whole of Shetland. Get return on lease from SHEAP – would be 'profit' (tax free) – to charitable trust. (Robertson, 2008; Shetland Island Charitable Trust, 2012; InterviewS1, 2011)

3: Own DH infrastructure. Originally seen as neutral investment, but conceded in 2002 investment was grant. Should keep expanding. (InterviewS1, 2011; Martin & Spence, 2010)

Gilbert Bain Hospital

1: Hospital was connected when current engineer joined; he understands the basics but doesn't have to get involved in running it. (InterviewU1, 2011)

2: Happy. Rarely has problems, if he does he calls Neville. (InterviewU1, 2011)

3: No data

SIC

1: Did not know about DH – went to Danish for expertise. Also spoke to Univer. Dundee and others. Hosted open dialogue about waste incineration & DH plans. Skilled individuals to evaluate environmental externalities. Owns waste to energy plant & has to deal with waste policy. Cannot sell hot water to customers. (InterviewG3, 2011; Martin & Spence, 2010)

2: Shetland Energy Plan (1998) promotes energy efficiency and sustainability. Had to replace existing incinerators. Landfill was not a good solution because of long term EU policy. Managing waste of off-shore industry keeps jobs in Sheffield. Recovery of heat essential in thermal efficiency of waste incineration - part of managing environmental externalities. Incineration without recovery same as landfill in environmental terms. Discussed with SH about taking heat from power station. Considered SICT as partner, as linked to economic development. (InterviewG3, 2011; Martin & Spence, 2010; Shetland Islands Council, 2000)

3: Policy Action Plan supports DH scheme. Success indicators in structure plan include number of homes connected to DH scheme. Incineration good for relationship with north sea oil companies. Head and Power (from incineration plant) the preferred option from early on. Council tenants have option of district heating or electric storage heaters. (Shetlands Islands Council, Planning Service; InterviewG3, 2011)

SIC - Waste to Energy Plant

1: WS: Council's budget for incinerator got reduced. But ERDF funding helped incinerator be built. Level of knowledge influenced by Europe. JG: Council led incineration discussion & negotiations with neighbours. Council struggled to find funds to build incinerator. Got ERDF funds. (InterviewG3, 2011; Martin & Spence, 2010)

2: No incentive to do power only. Cost neutral to do heat also. European directives pushing them to do waste to energy. Right thing to do environmental terms. Shetland prefers to be self sufficient. DH likely to be more contentious than incineration (historic). JG: Liked incineration – could see EU policy, also didn't make sense to ship off-isle. Recovery of heat essential in thermal efficiency of waste incineration - part of managing environmental externalities. Incineration without recovery same as landfill. Incinerator with heat not more expensive. Discussed with SH about taking heat from power station. (InterviewG3, 2011; Martin & Spence, 2010)

3: Designed waste to energy incinerator so that has to be connected to DH to be able to operate. This for environmental reasons. (InterviewG3, 2011)

Scottish Government – generally

1: Set overarching waste and energy policies. (Scottish Environmental Protection Agency, 2003)

2: No data

3: No data

European Government – Generally

1: ERDF & Thermie Funding. (European Commission)

2: No data

3: No data

SIC Planning Generally (incl BB)

1: Create policies that support or inhibit DH. DH required permission as not a statutory utility. Planning powers in this area relate to fact DH is not statutory utility and require permission.

(InterviewP2, 2011). Try and facilitate projects through coordination. Input into strategic documents such as structure plan and waste strategy. (Murray, 2011; Shetland Islands Council, 2004) G406

2: Policy requires notification of pipes. (Shetland Islands Council, 2004). Sees Planning at coordinating role – dig up king Harold street one (combine with other infrastructure works). Sees development (DH included) as positive - "we're pro development". (InterviewP2, 2011)

3: Success indicators in structure plan include number of homes connected to DH scheme. Local Plan references extension of DH scheme as part of energy initiatives. (Shetland Islands Council, 2004). Development plan & implementation office – coordinating everything.. Guide and persuade. Possible as small place. (InterviewP2, 2011)

3.2 Collective Actor Maxtrix

Scottish Hydro/SSE

1: Own power station with heat wastage (20 – 30 MW). 60% of output is heat and is dumped into atmosphere. Expectation but uncertainly about replacement power station – location, size, etc. (InterviewG3, 2011; InterviewS1, 2011; Shetland Times, 2008)

2: Initially interested in either owning or participating in heat network (could see heat). Would make power station cleaner and greener than it might otherwise be. Stated in press that spare energy in new plant can be used in DH scheme. Hydro board part of project at start . Thinking about it in relation to new station (not yet built). (InterviewG3, 2011; InterviewS1, 2011; Shetland Times, 2008)

3: Discussed for 3 years but did not commit. Also did not build new station. Uncertainly about new station hampered their involvement. "They realised the DH isn't a commercial activity in terms of the cost of laying pipes n what they'd recovery from the heat." (InterviewG3, 2011; InterviewS1, 2011; Shetland Times, 2008)

SHEAP – General

1: Got some of ERDF money for incinerator (900k), also separate European thermie (£1M) funds and some of community energy programme (EST). £2m grant money from Trust. Take (pay for?) heat from incinerator, lease pipes from Council. Had to build up knowledge over time - still rely on Danish expertise now and then. (InterviewG3, 2011; InterviewS1, 2011)

2: Established as social Investment by Trust to build and operate network, but expected to get investment back. The only way it could have been established (capital investment) was through Trust (several people mention). Original plan was to serve the entire town off a ring main. (Robertson, 2008; InterviewG3, 2011)

3: Customers happy with service and scheme. Leases kit for £20k a year from SICT, pays profits over to SICT. SICT at least breaks even. Serving over 1,000 customers. NM Runs SHEAP. Responsible for negotiating pipe layouts with landlords and city. (Robertson, 2008; InterviewG3, 2011)

SICT – general

1: Have oil money. Can do charitable things or investments in Shetland with approx 20% of total trust investment fund. Can invest in and encourage projects which support the local economy. (InterviewS1, 2011)

2: Looking for return on investments (20% on local investments, on 30 year basis), but also gave £2m initial grant. See district heating as good investment in local economic development. Initially was annual funding, but eventually accepted on long term basis. Generally in alignment with council objectives due to shared contacts and members. (InterviewG3, 2011; InterviewS1, 2011; Robertson, 2008)

3: Established SHEAP as social investment and invested in it. Expecting to get all money back on establishment but not necessarily make a profit. In 2002 accepted some investment as grant. Currently breaking even on heating income / staff costs / leasing of pipes. Stacks up in "Shetland PLC terms". (InterviewG3, 2011; InterviewS1, 2011)

Gilbert Bain Hospital

1: Use heat. (InterviewS1, 2011)

2: More interested than council buildings. (InterviewS1, 2011)

3: Significant customer of heat. Start with commercial customers (non-residential) as residential more difficult. (InterviewG3, 2011; InterviewS1, 2011)

SIC – general

1: Responsible for waste policy. Own heat source (waste to energy incinerator) for DH network. Budget was very tight in '93, and looked to Europe for funding of incinerator. Sent people to Denmark to learn more about district heating and incinerators. Cannot sell hot water to customers. (InterviewG3, 2011; InterviewS1, 2011; Martin & Spence, 2010)

2: Pro-development. Required to remove existing incinerator, supportive of new incinerator. Pro-incineration for waste policy reasons and tradition. Considered environmental impacts of incineration. Heat connection not significantly more costly than a power only option. . Influenced by Europe for waste policy. Did not have the money to fund the heat network installation. Mixed opinions about connecting council buildings to the network originally. (InterviewS1, 2011; Robertson, 2008; Scottish Environmental Protection Agency, 2003)

3: Build incinerator with support of local residents. Incinerator should use heat recovery for district network on environmental, efficiency and cost grounds. Did not automatically give 'heat' as 'customer' to SHEAP. Eventually did. (InterviewS1, 2011; Martin & Spence, 2010)

Scottish Government – generally

1: Not a source of information or support. Inland revenue was regular in tax terms. (InterviewS1, 2011)

2: Existing financial support required renewables or low carbon technologies to be connected to the grid (unhelpful). Waste policies behind European requirements. (InterviewG3, 2011; InterviewS1, 2011)

3: Point out as exemplar project. (Martin & Spence, 2010)

European Government – Generally

1: Source of funds for infrastructure projects. Source of environmental policy. (InterviewS1, 2011)

2: EU Directive on Incineration drove replacement of old with new. (InterviewG3, 2011)

3: Incinerator received ERDF funding. (InterviewG3, 2011; Martin & Spence, 2010)

SIC Planning Generally

1: Coordinating of public works. Has to approve pipe routes. (InterviewG3, 2011; InterviewS1, 2011)

2: Pro-Development. SHEAP is not a statutory utility so policy must regulate pipe works and planning permission required for laying of pipes. (note lack of mention of incinerator as issue). (InterviewG3, 2011)

3: Part of coordination of king Harold street works – heating pipes and repaving installed at same time. (InterviewS1, 2011)

Residents

1: Had choice about connection (except in new build). Had to pay for connection and in-home infrastructure. (InterviewS1, 2011)

2: Practical folk, see a need for it. Seen as part of lanes street refurbishment. Costs less than higher oil costs and cheaper than electric. Plumbers initially weary but over time became very good promoters of scheme. (InterviewG3, 2011; InterviewS1, 2011; Robertson, 2008; InterviewP2, 2011; Shetland Heat Energy and Power Limited, 2011)

3: Accepted it. Now seen as added value to homes (listed in sales adverts). More given choice accepted it over time (70% of street). Initially neighbourhood may have accepted it because of Norwegian links. No objections to incinerator (had one previously). Waiting list for connection. (InterviewG3, 2011; InterviewS1, 2011; InterviewP2, 2011; Shetland Heat Energy and Power Limited, 2011)

3.3 Self-Identified Strategy Matrix

	Market Shaping (4)	Market Regulation (5)	Market Stimulation (6)	Market Capacity building (7)
Scottish Hydro/SSE	+	0	0	0
SHEAP – General	0	0	++	+++
SICT – general	+	0	+	0
Gilbert Bain Hospital	U	U	U	U
SIC – general	+++	0	++	+++
Scottish Government – generally	+	U	0	U
European Government – Generally	+	++	++	U
SIC Planning Generally	++	++	0	++
Residents	U	U	U	U

3.4 Collective Strategy Matrix

	Market Shaping (4)		Market regulation (5)		Market Stimulation (6)		Market capacity building (7)	
	Potent.	***Actual***	***Potent.***	***Actual***	***Potent.***	***Actual***	***Potent.***	***Actual***
Scottish Hydro/SSE	++	0	0	0	0	0	0	0
SHEAP – General	0	0	0	0	++	++	+++	+++
SICT – general	++	+	0	0	++	+++	0	0
Gilbert Bain Hospital	0	0	0	0	0	0	0	0
SIC – general	++	+	0	0	+++	++	+++	+++
Scottish and UK Government – generally	+	0	0	0	++	+	+	0
European Government – Generally	+	+	++	++	++	++	U	U
SIC Planning Generally	0	0	+	+	+	+	0	0
Residents	0	0	0	0	0	0	+	+

3.5 Actor References

- Treating JI, JS and WS as COUNCIL
- NW as own
- JG as SHEAP OR SICT

Actor	***Reference***
Scottish Hydro/SSE	SH
SHEAP General Manager	NM
SHEAP – General	Sheap
SIC – general	Council
SICT – general	Trust
SICT – financial Controller	JG
Gilbert Bain Hospital	HE
Hjatland Housing Association – Director	PL
SIC - Waste to Energy Plant – Director	WS
SIC – Energy manager	JS
SIC – Waste Services – Director	JI
Scottish Government – generally	SG
European Government – Generally	EG
Robert Henderson - Local Councillor (SICT, SIC)	RH
Richard Nickerson – Local Councillor	RN
SIC - Planning Officer	BB
SIC - Planning Generally	Planning
SIC - Previous Planning Officer	FM
Residents	R

3.6 Code List

20
21
22
BB1BB
BB1planning
BB2BB
BB2council
BB2planning
BB2R
BB3R
BB4BB
BB4council
BB4NM
BB4planning
BB5BB
BB5planning
BB7BB
BB7planning
Council1Council
COUNCIL1COUNIL
COUNCIL1PLANNING
COUNCIL2COUNCIL
COUNCIL2EU
COUNCIL2FOE
COUNCIL2R
COUNCIL2SG
COUNCIL3COUNCIL
COUNCIL4COUNCIL
COUNCIL4SH
Council4Trust
COUNCIL6SG
Council7Council
EG4EG
EG5EG
EG6EG
HE1HE
HE2HE
HE3Sheap
J17COUNCIL
J2SH
JG1Council
JG1Sheap
JG1Trust
JG2Council
JG2Sheap
JG2Trust
JG3R
JG3Trust
JG6Council
JG6ECC
JG6EG
JI1COUNCIL
JI1PLANNING
JI1SHEAP
JI1Trust
JI2COUNCIL
JI2R
JI2SG
JI2SH
JI2SHEAP
JI2Trust
JI3R
JI3SEHAP
JI3SH
JI3SHEAP
JI4COUNCIL
JI6SG
JI7COUNCIL
JS1Council
JS1JS
JS1SG
JS1trust
JS2Council
JS2JS
JS2R
JS3R
JS4COUCNIL
JS4COUNCIL
JS5ECC
JS5SG
NM1Council
NM1EG
NM1NM
NM1R
NM1SG
NM1Sheap
NM1Trust
NM20
NM2Council
NM2ECC
NM2HE
NM2NM
NM2R
NM2SG
NM2SH
NM2Sheap
NM2Trust
NM3Council
NM3NM
NM3R
NM3Sheap
NM3Trust
NM4Council
NM6Council
NM6ECC
NM6EG
NM6EU
NM6R
NM6SG
NM6Sheap
NM6Sheat
NM7Council
NM7NM
NM7R
NM7Sheap
PLANNING3PLANNING
PLANNING4PLANNING
PLANNING5PLANNING
PLANNING5SHEAP
R2COUNCIL
R2TRUST
SG2COUNCIL
SG2SH
SG2Trust
SG3SH
SG4SG
SH1SH
SHEAP1SHEAP
SHEAP2R
SHEAP2SHEAP
SHEAP3SHEAP
SHEAP4SHEAP
SHEAP6R
SHEAP6SHEAP
TRUST1TRUST
TRUST2R
TRUST2TRUST
TRUST3SHEAP
TRUST3TRUST
TRUST4TRUST
TURST1TRUST
WS1Council
WS1EG
WS1NM
WS1Planning
WS1SG
WS1sheap
WS1trust
WS1WS
WS2Council
WS2planning
WS2R
WS2SH
WS2trust
WS2WS
WS3council

WS3Council
WS3HE
WS3Planning
WS3R
WS3SH
WS3trust
WS3WS
WS4Council
WS4EG
WS4PLANNING
WS4SG
WS4SSG
WS4WS
WS5Planning
WS5R
WS6
WS6Council
WS6ECC
WS6EG
WS6HE
WS6SG
WS7council
WS7NM
WS7WS
WSHE

4. London

4.1 Self-Identified Actor Matrix

DBIS / BERR

1: Publish national policy. Influence amount of financial support provided to renewables or DHC schemes through national incentive schemes. Influence central government spending on energy towards carbon neutrality. (DTI, 2003; DTI, 2007)

2: Support energy market, business and promote a low carbon economy through national policy. Technical and structural challenges to decentralised energy. Distributed energy can potentially lower emissions, increase diversity of supply and lower costs. It would be a significant change from status quo. (DTI, 2003; DTI, 2007)

3: Introduce some economic reforms to promote decentralised energy, including CHP, through a private sector 'market' for delivery. Goal is remove barriers and create level playing field. (DTI, 2003; DTI, 2007)

Clinton Climate Change Initiative

1: Raise profile of scheme, share information about other schemes (InterviewC1, 2011)

2: Promote examples of leadership at an international level, knowledge sharing is key to helping cities address climate change. (InterviewC1, 2011)

3: Advise, sharing knowledge and provide external recognition. (InterviewC1, 2011)

Dalkia Bio-Energy

1: Technical knowledge of delivery, and corporate finance to fund some (not all) of scheme delivery. (Dalkia, 2008)

2: Make profit out of providing energy through a contractual relationship with the local authority. (Dalkia, 2008)

3: Changed their approach over time – from centred on Elephant and Castle to centred on Aylsebury. This was in response to likely build time and programme delay. (Cllr Fiona Colley, 2011)

DCLG

1: Set national planning and community strategy, generate new laws and regulations, administer incentive schemes; provide guidance. Plays a key role in supporting government environmental objectives. (CLG, 2007; Ellis, 2008)

2: CHP is an efficient form of decentralised energy. State a national community energy objective to be delivered at local level by public sector and provide some financial support. (CLG, 2007; Ellis, 2008)

3: Set national planning framework for local authorities to take forward in their areas and regulate new building energy emissions. Use the planning system to encourage the private sector and local authorities to deliver community energy. (CLG, 2007)

DEFRA

1: Set national climate change strategy and promote low carbon or efficient energy generation (until 2008). Recognised that CHP target / promotion not working. (DEFRA, 2007)

2: They should promote promote a low-carbon economy through national policies (prior to 2008). CHP potential is large, but there are a number of barriers to delivering more district energy in the UK. (DEFRA, 2007)

3: Support increasing use of CHP and its role in community energy schemes through quality assurance, fiscal incentives, and changes to licensing (prior to 2008) (DEFRA, 2007)

Greater London Authority (Mayor of London) / London Development Agency

1: Regional government with some powers over local councils. Set vision for district energy and provide information on energy, heat loads, and the potential for district energy. Ability to regulate major new development, SP planning policy, and GLA development for energy efficiency and use of DHC Some ability to direct funds to support schemes. (Greater London Authority, 2009; Greater London Authority, 2004; Greater London Authority, 2005)

2: Decentralised energy is not appropriate in all circumstances, but can deliver significant cost and energy savings. Evolved from activist to business enabling. Did consider delivering DHC through a partnership with EDF, but it did not live long. Through London plan, should direct borough planning departments to support DHC in major developments. (Greater London Authority, 2006; Greater London Authority, 2005; Greater London Authority, 2009; Greater London Authority, 2007)

3: CHP is a good solution for cutting carbon emissions and should be main priority approach. Strongly planning policy which requires new major development to consider DHC and achieve energy efficiency standards. Encourage boroughs to consider, and encourage private sector with information and seed funding; grant fund where possible. Set up two different agencies to promote and deliver DHC. Delivery based off GLA direct/controlled development. (Greater London Authority, 2006; Greater London Authority, 2007; Greater London Authority, 2005; Greater London Authority, 2009)

London Energy Partnership

1: Independent consortium of boroughs and energy companies to provide knowledge and connections. Established by GLA. Produced reports. Existed until mid 2009. (London Energy Partnership, 2007; London Energy Partnership)

2: Own study concluded large scale DCH led by CHP is the best option for London carbon reductions in cost terms. Aimed to serve as best practice sharing forum. (London Energy Partnership, 2007; London Energy Partnership; London Energy Partnership, 2006)

3: Promoted large scale DHC projects. A better understanding of finance, skills, and heat mapping will support community energy. (London Energy Partnership, 2007; London Energy Partnership, 2006)

Brian Dunlop Associates

1: Consultant advisor to LB Southwark – technical knowledge and analysis. Advised on energy and water approach and technical specification from 2003 to 2010; contributed to resource flow

assessment and concept of MUSCO. Has knowledge of other UK DHC schemes such as Woking. (InterviewA1, 2011)

2: DHC is best approach for E&C regeneration to address environmental issues. If the project takes too long to deliver, momentum will be lost and the politics will have changed. (InterviewA1, 2011)

3: Supportive of multi-utility infrastructure concept. Local Authority should take control and drive the scheme through planning and perhaps even control operation. The energy centre / district approach was the most cost effective reductions in £/kgCO_2. DHC schemes need a champion who understands both financial and engineering sides (based on understanding of other DHC schemes). (InterviewA1, 2011)

Inventa Partners

1: Able to develop commercial models for emerging technology implementation. Able to (and appointed to) help Southwark find alternative financing for MUSCO (and generally new infrastructure) for Elephant and Castle. (InterviewA2, Director, Inventa Partners, 2011)

2: Appointed to (being paid to) find a way to finance and commercially deliver the MUSCO and energy centre. (InterviewA2, 2011)

3: Supportive of MUSCO concept. They should be establishing commercial structure and advising Southwark on strategic approach to reducing up- front cost. (InterviewA2, 2011)

Lend Lease

1:Finance, development knowledge and experience with other similar schemes. Provided a view on the procurement process; did not make decisions on which energy company or decision to withdraw. (InterviewD1, 2011)

2; Global construction and development company; generate profit from development to local standards. Will connect if financially viable (that was agreed in the development agreement). Publicly supportive of MUSCO after appointment but before financial agreement signed. (InterviewD1, 2011)

3: Neutral; agreed to connect if financially viable. Accepted the obligation on development to connect to the MUSCO only if financial viable. (InterviewD1, 2011)

Local Landowners/developers

No data

Southwark Council Generally (combination of Councillors and Officers)

1: Owns almost 50% of housing stock in the borough and a significant proportion of land near Elephant and Castle. Constrained by local authority finance controls over the way capital expenditure is constructed. (InterviewE1, 2011)

2: A climate change strategy identified that CHP led district heating is the best way to achieve carbon reduction goals. The MUSCO approach demonstrate the Council's commitment to sustainable redevelopment of Elephant and Castle. (London Borough of Southwark, 2006)

3: No data

Southwark Council Regeneration

1: Control land assets, housing (heat loads) and regeneration programme (remit to redevelop) in the area. 500,000m2 mixed use development envisaged, 75% owned by council. Ability to secure land and pipe routes needed for energy centre. A level of control over planning processes in the area . Leadership for regeneration and support of politicians (at first). Lacked a lot of information about MUSCO / DE systems, particularly at the beginning. (InterviewG1, 2011; InterviewP1, 2011)

2: DHC schemes should be non-political. Saw DHC as a way to reduce infrastructure costs and achieve environmental goals simultaneously. That a scheme could be developed which would be economically advantageous for both the council and for developers. Got very excited about it. “One of those objectives was to achieve zero carbon. A second objective was to bring forward regeneration of the area. A third objective was to be ensure that in doing all that the councils financial and legal obligations were met.” “Minded to take responsibility for it”. (InterviewG1, 2011; InterviewP1, 2011)

3: Create special purpose vehicle to deliver CHP-led MUSCO energy and environmental services and deliver net zero carbon growth. (London Borough of Southwark, 2004; London Borough of Southwark, 2010; InterviewG1, 2011). Set vision and terms for procurement, offering it as a concession over 30 years to the private sector to run and install. The MUSCO would have been an umbrella organisation - with LBS representation on the board, bought through offering the land to the organisation - for series of contracts for the different service aspects. As the private sector development became less certain, minded to link the MUSCO with public sector housing redevelopment to make the project less risky. (London Borough of Southwark, 2011)

Southwark Council Planning Department

1: Create and enforce planning policy which requires major and minor developments to achieve energy efficiency standards. Establish environmental goals such as avoiding pollution and reducing energy use in masterplan for E&C (London Borough of Southwark, 2009; London Borough of Southwark, 2004). Can obligate developers to specific payments or actions associated with development (London Borough of Southwark, 2008).

2: Explicit support of CHP fuelled DHC at the site (in the regeneration masterplan) as part of a commitment to zero carbon growth. The planning approvals process should be sued to regulate energy performance in new buildings, following reductions, efficiency, and clean energy. (London Borough of Southwark, 2007; London Borough of Southwark, 2009). “The regeneration of the Elephant & Castle and the scale of development envisaged provides a perfect opportunity to introduce and adopt a range of innovative measures to minimise energy consumption” (London Borough of Southwark, 2004)

3: Supports MUSCO approach. Use the development framework and approvals process to require new development to be compatible with the MUSCO. “The priority is for developments to contribute to the success of the energy strategy for the opportunity area as a whole, and, in particular, to supply energy efficiently through the use of district wide Combined Heat and Power or Combined Cooling Heat and Power systems" (London Borough of Southwark, 2008). (London Borough of Southwark, 2004)

Southwark Council Finance Department

No data

Southwark Councillors

1: Council has significant number of council-owned residential properties. Because re-supplying council housing does not get national grant, do not have money to regenerate or re-home tenants living in old/bad properties. Needed private sector to fund regeneration of E&C area. Unclear about the details of a MUSCO , the financial organisation, or what it might look like; lack of knowledge about DHC systems. (InterviewE1, 2011)

2: Carbon – good thing to address, cutting edge – good for Elephant and Castle. The Elephant and Castle regeneration is a unique opportunity to delivery cheaper locally generated heat and power (London SE1 website team, 2006) (Pugh, 2010). But unclear about details and more concerned about social housing rebuilding and overall regeneration. Some political pressure to be 'green' and distinctive. Assumed it would be 'unseen' technology – a box underground somewhere. (InterviewE1, 2011)

3: "Liked the sound" of MUSCO and accepted officer advice about target and MUSCO approach. Part of 'here's our masterplan, who wants to build it' thinking; that council's role was to establish the project and stand back, making some kind of return. (InterviewE1, 2011) When the (now labour) councillors rejected the Dalkia proposals and the MUSCO concept, they committed to continuing the 'net zero carbon' goal (London SE1 website team, 2006). Liberal Democrat councillors contested the cessation of the MUSCO work (London SE1 website team, 2011).

4.2 Collective Actor Matrix

This matrix summarise the perception of each actor by all other actors. It groups responses from all actors and from the desktop research, so that each specific actor is described in a collective way by all the other actors.

1: Capabilities and Resources

2: Orientation towards DHC

3: Preferences for how they should be involved in DHC

DBIS / BERR

No data - not mentioned by others

Clinton Climate Change Initiative

1: No data

2: Should promote the zero carbon growth goal and support initiative with knowledge about other schemes (Lend Lease, 2011)

3: They should not be involved in delivering the scheme, but should be kept in the loop. (InterviewD1, 2011)

Dalkia Bio-Energy

1: Given scale of project and long-term concession, can build, design, finance and operate MUSCO. A figure given for up-front investment was £30 million. As the scheme grew (connection with Aylesbury Estate) they needed further conversations with their banks. In2010, council decided they were not capable of delivering or financing MUSCo. (London Borough of Southwark, 2011; InterviewA1, 2011; InterviewA2, 2011)

2: They (and others) were interested in tendering for and going through procurement for MUSCO. They were willing to take a significant amount of risk to deliver the MUSCO, but needed some certainty customers would be built (new development) or linked up to existing social housing. Became more interested in doing bio-fuel energy. Also more interested in electricity-led rather than heat-led scheme. (InterviewE1, 2011)(London SE1 website team, 2011). (London Borough of Southwark, 2011)

3:Dalkia (or any non-government energy company) should deliver (preferred provider) and operate scheme under a concession approach from London Borough of Southwark. As commercial house building changed in the recession, that Dalkia and MUSCo needed to connect with more social housing for guaranteed customers and potentially a bigger biomass fuelled scheme – 1 large energy centre instead of 2 linked ones. In 2010, council decided they should not be involved. (InterviewA2, 2011; InterviewG1, 2011) (InterviewP1, 2011)

DCLG

1: Set policy. Did not engage directly in scheme. (InterviewP1, 2011) (Greater London Authority, 2007)

2: Do not mandate CCHP (Greater London Authority, 2007). Support MUSCo style arrangements on environmental and cost grounds (London Borough of Southwark, 2004). Policy changes (Code for Sustainable Homes standards) confused thinking about MUSCO. (InterviewG1, 2011)

3: Did not mandate MUSCo approach from national level, but should have. (InterviewP1, 2011)

DEFRA/ECC

No data

Greater London Authority (Mayor of London)/ London Development Agency

1: Did not provide funding or direct engagement, but was seen as supportive and influential at a strategy, political 'influence' level. Saw their power as "All assistance short of help". (InterviewP1, 2011) Several actors commented they lacked the technical capability and personal resources to help with the detail. However London Plan set renewables requirement for major developments and was supportive of DHC schemes; therefore major developments negotiated with LBS and/or GLA about connection to MUSCO. (InterviewA1, 2011)

2: Supportive at civic strategy, political and technical planning level, although political support clouded by different political parties in control. Appointed E&C as 1 of 4 energy action areas. No direct role for them to play in delivering scheme, role was through planning permission for major applications (InterviewA1, 2011) and influence on major stakeholders such as Lend Lease. Did support a 'London ESCO' approach in 2004-2007 which tendered for E&C but did not proceed with procurement process. (InterviewP1, 2011)

3: Through negotiation with LBS, GLA allowed future connection to MUSCO to count towards London Plan requirements for major developments. Communication between technical teams and planners on major applications in E&C area supported MUSCO; they used London Plan policies to support the scheme (InterviewG1, 2011). Originally there was potential for a LDA backed ESCo to be the main provider, but that did not go very far (InterviewA2, 2011). Over time, they were seen to back off direct support as they focused energies on other potential DE schemes in London. Some sense that they could have been more supportive and engaged than they were, even if only at a political level (InterviewP1, 2011).

Brian Dunlop Associates

1: Technical side, advising Southwark Regeneration. Developed engineering side of scheme to procurement and enabled discussions with developers at planning stage. (InterviewP1, 2011)

2: Supportive, and very good at advising Southwark Regeneration. (InterviewP1, 2011)

3: Technical advisor to Southwark and neutral party communicating between various people within LB Southwark to drive forward deal with Dalkia. (InterviewP1, 2011)

Inventa Partners

1:Advise on how to make new technology commercially feasible. Understood commercial model. (InterviewP1, 2011)

2: Advise Southwark Regeneration. (InterviewP1, 2011)

3: Financial advisor to Southwark. (InterviewP1, 2011)

Lend Lease

1: Money and knowledge to be regeneration partner – build houses. Create significant housing in a regeneration area – create private sector market from scratch. Abilities and resources decreased with recession. Unsuccessful experience with DHC system in other part of London. One particular director understood the potential of the MUSCO. (InterviewA1, 2011) (Leader of the Council, 2010) (InterviewC1, 2011)

2: Struggled to tender for energy element when originally included in masterplan (Different risk and profit structures mean that property developers not interested or capable) and initially quite sceptical, because it was added complexity to their work. But then became supportive of non-LL MUSCO concept as way to reduce infrastructure cost (particularly specific individual in LL was supportive). This support decreased over time after change in leadership in LL and Southwark; two risks: ability to deliver MUSCO on time and impact of energy centre (visually) on regeneration area. Also concerned about potential change to regulatory framework. (London Borough of Southwark, 2011) (InterviewE1, 2011)

3: They did not want to be the delivery agent, but would supportive if made financial sense for them. Initially supported MUSCO through regeneration agreement. In recession, they changed number of homes likely to be built - this increased risk for procurement of MUSCO; they unwittingly damaged success of MUSCO. With larger energy centre they were unsupportive, due to land take and visual impact. (InterviewA1, 2011) (InterviewE1, 2011) (InterviewG1, 2011) Eventually MUSCO included in regeneration agreement between LL and SR only ‘if financially and legally viable’. (London Borough of Southwark, 2010)

Local Landowners/developers

2: Would be supportive if economically advantageous to connect. Would be concerned about large energy centre (industrial use/visual impact) on major road (impact on value / neighbourhood). (InterviewG1, 2011; InterviewA1, 2011; London Borough of Southwark, 2007)

3: London policies expected developers to get involved in establishing local energy networks. Southwark Planning and CLG policies expected developers to work with the council to realise zero growth strategy. Southwark regeneration wanted them to sign up to the MUSCO through S106. (CLG, 2007) (Greater London Authority, 2007) (London First, 2008).

London Energy Partnership

No data

Southwark Council Generally

No data

Southwark Council Regeneration Department

1: Lead role for MUSCO and Regeneration delivery; owned 70% of land and large amount of social housing (InterviewA1, 2011). Ability to make decisions about content of Development Plan, MUSCO approach, preferred energy company, and involvement of consultants (InterviewD1, 2011). Significant control over planning department in Elephant and Castle area (InterviewE1, 2011). Able to 'drive things forward despite Southwark rather than with them'. Individual skills varied, but Chris Horn specifically strong capabilities: "When he left and the department was dismantled it became less able to push the project forward" (InterviewA2, 2011). Lack of funding for MUSCo because concept was new. Had legal powers to develop district heating network. (London Energy Partnership, 2007)

2: Very supportive and pushed idea to local councillors, particularly Chris Horn because it was a way to deliver funding for infrastructure from private sector and also achieve environmental goals (InterviewA2, 2011). Thought it should be delivered by the private sector, but Southwark needed to retain some control to financially support MUSCO (guarantee housing) and to ensure concession delivered appropriately (InterviewA1, 2011). Searched for other funding besides land investment to have a greater stake in the final MUSCO organisation (InterviewA2, 2011). Considered several procurement routes (joint venture, etc). (London Energy Partnership, 2007)

3: Following several years of considering options, Southwark Regeneration would manage Southwark's offer of a concession through a formal procurement process. After legal advice, they followed 'negotiated EU procedure'. (InterviewA1, 2011). Then Southwark Council would invest the land to have a stake in the MUSCO. Southwark would have only a minor non-controlling stake in MUSCo, driven by value of land they could bring to concession (InterviewA2, 2011). The council should also have a say in price regulation. (InterviewE1, 2011)

Southwark Council Planning Department

1:The planning system can be a useful tool for encouraging renewables and connecting to CHP networks (London Energy Partnership, 2007). While technically responsible for planning policy and application determination, Regeneration department led masterplanning process in the area (InterviewA2, 2011). National and London government expected plans to include local

decentralised energy (Ellis, 2008) (Greater London Authority, 2004). Participated in discussions about conditions for specific applications with GLA (InterviewA1, 2011). Not involved in procurement process. (InterviewP1, 2011) (InterviewG1, 2011)

2: Neither supportive nor unsupportive; worried about risk to project but more concerned with detailed planning policy (InterviewP1, 2011). Department saw their role as regulating development, which included energy issues as directed by GLA policy (InterviewA1, 2011).

3: Department wanted a standard set of rules they can apply to each planning application they have to determine (InterviewP1, 2011). National and London government expected them to regulate new development for connection or renewables (DTI, 2007) (Greater London Authority, 2004). Supportive in that they published 2004 SPG which includes resource flow analysis and net zero carbon growth – this established goal. Technical documents for interfacing requirements with private sector developers (InterviewA1, 2011).

Southwark Council Finance Department

1: Ability to approve or decline contractual agreements the council enters into. (InterviewP1, 2011)

2: Did not understand MUSCO. Risky commitment for Council to make (InterviewE1, 2011). Do not understand why Council need to maintain involvement in MUSCO. Not supportive and actively obstructive. All they really wanted was for us to spend as little money as possible to sell sites, to provide capital, to bolster the council's financial positions." (InterviewP1, 2011)

3: Probably recommended to councillors to pull out of MUSCO. (InterviewP1, 2011)

Southwark Councillors

1: Aware of DHC (existing on older council estates) (InterviewA2, 2011) but did not have knowledge of how to deliver it new on large scale or understand what 'zero carbon' meant. Liberal Democrats seen to be unused to political power (usually in opposition). (InterviewP1, 2011)

2: Like the idea (particularly liberal democrats), but never confident about defending it or supporting it when issues came up (size of energy scheme, concern about shared infrastructure). This changed when the energy centre plans were published (very large) and the finance department became worried about long term investment and risk and impact on development values (InterviewP1, 2011). They could no longer see political benefit of supporting scheme (InterviewG1, 2011).

3: Consultants and Regeneration department wanted them to approve idea and Dalkia proposal (InterviewA2, 2011). Before 2008, no political obstruction. After 2008, impossible to get political support for MUSCO (InterviewP1, 2011). Priority was to deliver regeneration of area and bolster councils financial position. Eventually labour-led council takes the decision to back out of MUSCO procurement because they were concerned about risk (InterviewA2, 2011).

4.3 Self-Identified Strategy Matrix

Ranked on scale of 0 (none), + (minor), ++(medium), +++ (significant). U indicates unknown.

	Market Shaping (4)	Market regulation (5)	Market Incentives (6)	Market capacity (7)
D BIS / BERR	++	+	+	++
Clinton Climate Change Initiative	+	0	0	+++
Dalkia Bio-Energy (or the final MUSCO provider)	0	0	0	0
DCLG	++	++	0	0
DEFRA	+	+	++	+
Greater London Authority / London Development Agency	+++	+++	0	+++
London Energy Partnership	+	0	0	+++
Brian Dunlop Associates	0	0	0	++
Inventa Partners	0	0	0	++
Lend Lease	+	0	0	0
Local Landowners/developers	U	U	U	U
London Borough of Southwark Generally	+	U	U	+
Southwark Council Regeneration Department	+++	+++	+	++
Southwark Council Planning Department	+++	+++	0	++
Southwark Council Financial Department				
Southwark Councillors	+++	0	0	0

4.4 Strategy Matrix (Collective)

	Market Shaping (4)		Market regulation (5)		Market Incentives (6)		Market capacity (7)	
	Potent.	*Actual*	*Potent.*	*Actual*	*Potent.*	*Actual*	*Potent.*	*Actual*
D BIS / BERR	0	0	+	0	0	0	0	0
Clinton Climate Change Initiative	0	0	0	0	0	0	++	0
Dalkia Bio-Energy (or the final MUSCO provider)	0	0	0	0	0	0	0	0
DCLG	0	0	++	+	0	0	+	0
DEFRA	0	0	0	0	++	0	+	0
Greater London Authority / London Development Agency	+++	+	++	+	++	+	+	0
Brian Dunlop Associates	0	0	0	0	0	0	++	++
Inventa Partners	0	0	0	0	0	0	0	0
Lend Lease	+++	+	0	0	0	0	+	0
Local Landowners/developers	0	0	0	0	0	0	0	0
London Energy Partnership	0	0	0	0	0	0	0	0
Southwark Council Regeneration Department	+++	++	++	++	+	+	+	+
Southwark Council Planning Department	++	++	+++	+++	+	+	0	0
Southwark Council Financial Department	+++	0	0	0	++	0	0	0
Southwark Councillors	++	0	0	0	0	0	0	0

4.5 Actor Code References

Actor	Reference
D BIS / BERR	BIS
Clinton Climate Change Initiative	CCI
Dalkia Bio-Energy	D
DECC	ECC
DCLG	CLG
DEFRA	FRA
Greater London Authority / Mayor of London	L
Brian Dunlop Associates	B
Inventa Partners	I
Lend Lease	LL
Local Landowners/developers/residents	P
London Energy Partnership	LEP
Southwark Council Regeneration	SR
Southwark Council Planning Department	SP
Southwark Council Finance Department	SF
Southwark Councillors	SC

4.6 Codes

B1B
B1D
B1I
B1L
B1LL
B1SC
B1SP
B1SR
B21
B2B
B2CLG
B2D
B2I
B2L
B2LL
B2P
B2SP
B2SR
B3
B3B
B3D
B3L
B3LL
B3SR
B4L
B4LL
B4SP
B4SR
B5CLG
B5L
B5SP
B5SR
B6SP
B6SR
B7B
B7L
B7SP
BIS1BIS
BIS1D
BIS1L
BIS1LBS
BIS1SP
BIS2BIS
BIS2LBS
BIS2LC
BIS3BIS
BIS3CLG
BIS3LBS
BIS3SP
BIS4BIS
BIS5BIS
BIS6BIS
BIS7BIS
CC1L
CC1LL
CC1SR
CCI1L
CCI1LL
CCI1SR
CCI2CCi
CCI3CCI
CCI7CCI
CLG1CLG
CLG1LBS
CLG1SP
CLG1SR
CLG2CLG
CLG2SP
CLG3CLG
CLG3LBS
CLG3P
CLG3SP
CLG3SR
CLG4CLG
CLG5CLG
CLG5LBS
CLG5SP
D2D
D2SR
D3D
ECC1ECC
ECC1L
ECC1LBS
ECC2LC
ECC3CLG
ECC3L
ECC3LBS
ECC4ECC
EFRA1EFRA
EFRA2EFRA
EFRA6EFRA
EFRA7EFRA
I1B
I1D
I1I
I1L
I1SC
I1SP
I1SR
I2D
I2I
I2L
I2LL
I2SC
I2SF
I2SR
I3D
I3L
I3SC
I3SR
I7B
I7CLG
I7I
I7SR
L1CLG
L1L
L1P
L2D
L2L
L2P
L2SP
L3L
L3P
L4L
L5CLG
L5L
L5SP
L6ECC
L6L
L7L
LBS1LBS
LBS2LBS
LBS2SP
LBS3SF
LBS3SP
LBS4LBS
LBS5L
LBS6EFRA
LBS6FRA
LBS7EU
LBS7LBS
LEP1D
LEP1LEP
LEP1SP
LEP1SR
LEP2D
LEP2L
LEP2LEP
LEP2SR
LEP3LEP
LEP4L
LEP4LEP
LEP5BIS
LEP5L
LEP5SP
LEP6L
LEP6SP
LEP7LEP
LL1D
LL1LL
LL1SR
LL22
LL2CCI
LL2LL
LL2SR
LL3CCI
LL4SR
LL5SR
LL7CCI
P1L
P1P
P2L
P2P
P3D
P3L
P3LBS
P3P
P3SP
P4L
P4LBS
P4SP
P5ECC
P5L
P5P
P5SP
P6ECC
P6L
P7L
P7P
R1SC
SC1D
SC1SC
SC1SR
SC2D
SC2L
SC2LL
SC2SC
SC2SF
SC2SR
SC3LL
SC3SC
SC3SF
SC3SR
SC4SC
SF3SF
SP1LBS
SP1SP
SP2CLG
SP2L
SP2LBS
SP2P
SP2SP
SP3P
SP3SP
SP4SP
SP5L
SP5SP
SP6SP
SP7SP
SR1
SR1B
SR1CLG
SR1D
SR1I
SR1L
SR1LL
SR1SC
SR1SP
SR1SR
SR2
SR20
SR21
SR22
SR22SR
SR2B
SR2CLG
SR2D
SR2L
SR2LL
SR2P
SR2SC
SR2SF
SR2SP
SR2SR
SR3B
SR3CLG
SR3D
SR3LL
SR3P
SR3SC
SR3SF
SR3SP
SR3SR
SR4BIS
SR4CLG
SR4D
SR4L
SR4LL
SR4SP
SR4SR
SR4SR
SR4SP
SR5CLG
SR5SC
SR5SP
SR5SR
SR6L
SR6SP
SR6SR
SR7
SR7B
SR7L
SR7LL
SR7SC
SR7S

5. Toronto

5.1 Self-Identified Actor Matrix

1: Capabilities (Resources)

2: Orientation (towards DLWC, and the role they should play)

3: Preferences

Enwave

1:Market interested because chillers at end of life. Also more commercial offices built new than residential. Lot of demand for cooling equipment.. Non regulated monopoly. Previously known as Toronto District Heating Company; owned jointly by City of Toronto and Omers. Served heating customers, operating 3 steam plants and 140 buildings, but not all happy. (City of Toronto, 2001) (Enwave Energy Corporation, 2011) (Enwave, 2005) (City of Toronto, 2000)

2: Would like to provide DLWC. Start incrementally building the network. Contracts are for 20-30 years, so stable income but at 9-10% return on investment.. DLWC will enable city to cut amount of coal –fired electricity it consumes. Don't need regulation because the customers are very sophisticated. Privatization brought the capital and resources to develop Deep Lake Water Cooling (Enwave Energy Corporation, 2011)

3: They should help fund drinking water pipe, then build the equipment to take cooling from drinking water, then operate network & sell cooling for customers. Do not operate internal building systems. Value proposition in the marketplace is - environmentally friendly heating and cooling. Totally renewable cooling, environmentally friendly heating. (InterviewS3, 2012)

Chief Executive, Enwave

1: Became chairman of TDHC then Enwave. MBA. Former councillor. Had heard of deep lake water cooling from c:ouncillor experience. Convinced OMERs. Convinced OS to enable privatisation. (InterviewS3, 2012)

2: Preferred public private partnership approach (compared to public only or private only); a fully private entity would not have risked it, and a fully public entity would not have had sufficient upfront investment. (InterviewS3, 2012)

3: Drove privatisation - originally motivation was to get city investment in TDHC back. Wanted to become sole provider of steam heat and deep lake water cooling to downtown Toronto. (InterviewS3, 2012)

OMERS (merged with Senior Vice President for summary table)

No data

Toronto District Heating Corporation

1: A very shoestring operation; we had a board that met monthly. And everything was properly reported to the board, Kevin the then president did everything. 80% everything and 20% me (InterviewE3, 2012). Non-profit cooperative established to provide efficient and environmentally

friendly heating to institutional government buildings in downtown Toronto. Had exclusive right to sell steam thermal energy in downtown Toronto. (City of Toronto, 1999)

2: Supportive – regularly investigated cost options. Seen as part of reducing Toronto's impact on the environment and climate change. (Enwave Energy Corporation, 2011)

3: Investigated options, but eventually converted into a private company called Enwave to gain access to investment funds. (City of Toronto Executive Committee, 1988)

Ontario Clean Air Alliance

1: DLWC not terribly new – helped history of TDHC. Good thing – helped with smog public health care crisis. Private ownership can work very well if it is properly regulated. (InterviewC4, 2012)

2: Only involved in ETF, which supported DLWC. (InterviewC4, 2012)

Environmental Task Force & Environment Roundtable

1: Responsible for preparing a comprehensive environmental plan for the city in the late 1990's. Made up of City Councillors, City staff, representatives from environmental agencies and citizens representing business, labour and environmental groups, school boards, universities and schools across Toronto. Created by City councillors. (Toronto Environmental Task Force, 2000)

2: District heating and cooling is a cost-effective and efficient way to heat and cool buildings. (Toronto Environmental Task Force, 2000)

3: No data

Deep Lake Water Cooling Investigation Group

1: Active for 2 years (1991-1993) to investigate deep lake water cooling possibilities. Funded by the Canadian Urban Institute. Engaged BO, NGO's, TDHC, Various city organisations and provincial organisations. (Canadian Urban Land Institute, 1993)

2: Positive. Existed to explore options for making DLWC happen. (Canadian Urban Land Institute, 1993)

3: The Group recommends that a district cooling system be established to serve buildings in and near downtown Toronto, preferably based on deep lake water cooling (DLWC). This should be led or coordinated by the city government. (Canadian Urban Land Institute, 1993)

Toronto Star

No data

Better Buildings Partnership

1: City of Toronto programme; works with owners and managers to promote high energy performance. (Better Buildings Partnership)

City of Toronto

1: Owned THDC; did not have enough money / limited in ability to raise money / to invest in full DLWC. Invested in engineering and legal expertise to conduct studies and enable investment. (City of Toronto, 1999) (City of Toronto, 2010) (City of Toronto, 2001)

2: Different elements of the city different levels of support; but no significant opposition. Maintaining the security, quality and purity of the City's water supply remained paramount. Environmental issues and carbon reduction is important. (City of Toronto, 2010) (City of Toronto, 2001) (City of Toronto, 2007)

3: Sold half of TDHC to enable investment to create DLWC, but agreed to maintain some interest. Provided some land Enwave for plant. Became customer of Enwave for city downtown buildings some time after it started. (City of Toronto, 2010)

City of Toronto Planning

1: Planning governed by provincial legislation. Plans must be approved by council. Operates the green development standard. Governs development in varied ways, including environmental performance. (InterviewP5, 2012) (City of Toronto, 2010) (City of Toronto, 2006)

2: Try to be forward thinking and help the city, using tools at their disposal. Green Development standard encourages DLWC. (InterviewP5, 2012)

3: Aware, and supportive due to city's environmental goals, but they were not a driver. (InterviewP5, 2012)

Director of Planning and Zoning

1: Project manager with land use policy that pertains to environmental issues ; city wide policy. (InterviewP5, 2012)

City of Toronto Energy Efficiency Office

1: Responsible for developing and co-ordinating the implementation of an energy efficiency and conservation strategy for Toronto. Review technical submissions by Building owner with respect to Energy Efficiency. (InterviewP5, 2012)

2: Founded after DLWC built. Helps developers and the city identify options in new developments for DH/DH. (InterviewP5, 2012)

3: No data

City of Toronto Councillors

1: Govern city investment and strategic decisions. Adopt or reject reports from city officers an city committees. (City of Toronto , 2006) (City of Toronto, 2001)

2: Adopted City's environmental plan which includes promoting district heating and cooling including DLWC. Different councillors had varied levels of support, but as a group they agreed to invest in DLWC through city owned TDHC. Supportive of DLWC as a renewable resource. Environmental issues and carbon reduction is important. (City of Toronto Executive Committee, 1988)

3: Approved plan. Approved financial investment in studies and in the restructuring of Enwave into private and the joint venture with OMERS. Decided Enwave should be preferred DC provider. (City of Toronto, 2000) (City of Toronto Executive Committee, 1988) (City of Toronto, 1999) (Moloney, 2003)

Richard Gilbert

1: Visited European systems. Councillor of metro and city Toronto. CEO of TDHC. After politics became Head of Canadians Urban Institute. (InterviewE3, 2012)

2: Very supportive of amalgamating heating networks to use waste to steam energy. Then actively kept idea alive through Canadian Urban Institute. (InterviewE3, 2012)

3: No data

Joe Pantalone

1: 1980 City of Toronto councillor. Last 7 years assistant Mayor. Chair of a number of committees. (InterviewE2, 2012)

2: Council needed to make Toronto Water and Enwave share the pipe. Required major political support. (InterviewE2, 2012)

3: No data

City of Toronto Environment Office

1: 21 staff. Mandate to support environmental priorities of city and community. Also has reporting requirements to Province. (InterviewG2, 2012)

2: Had to explain benefits and lack of negative impact to Island community carefully. (InterviewG2, 2012)

3: Supportive – promoted scheme with residents. (InterviewG2, 2012)

Director, Environment Office

1: Managed the environmental assessment of the new pipe intakes. (prior to TEO) (InterviewG2, 2012)

2: Ongoing debate with Toronto Water for the provision of potable water for expansion of the plant and providing more cooling power. And that debate sort of rages on. (InterviewG2, 2012)

3: No data

Building Owners Generally

1: Own buildings which consume energy. Manage that energy or at least some part of it on behalf of tenants.

2: No data.

3: The renewable fuel element of it is important to them and their customers. That plus price hedging is a positive driver and can influence property values. Also they have the benefit of getting rid of chiller space so more rentable floor area. (InterviewU2, 2012) (Canadian Press, 2003)

3: Once it was demonstrated that it would work practically and the contracts / pricing were fixed against inflation, others signed up. (InterviewU2, 2012)

Senior Vice President, OMERS

1: Responsible for office property investments in Toronto. Had experience with change in fuel (coal – gas) and district heating (approx 17 years). Managed Oxfords' properties whose chillers were coming to end of life and up for replacement. (InterviewU2, 2012)

2: Saves capital cost of replacing air conditioning equipment. Contract enables him to hedge future electricity costs – which he expects to rise. But tough call to make – entrusting third party to basic service to 'customers'. Makes no difference that Omers is investment owner. (InterviewU2, 2012)

3: Was first adopter with One University Building. Good business case to invest – and environmental reasons as well. (InterviewU2, 2012)

Tridel

1: Linking up to Enwave is part of building green residential buildings. There are noise benefits as well use of renewable energy and increase in energy efficiency. Generate residential sales from Enwave connection alone. (Cordileone, 2003)

2: No data

3: Want to connect their condominiums. (Cordileone, 2003)

Toronto Water

1: City department responsible for drinking water and sewerage. Own water intakes now (although Enwave built) . Can shut down intake plant and therefore Enwave's system. Have state licence to operate drinking water system; this limits Enwave. (InterviewG5, 2012)

2: No data

3: Needed some formal agreement between Enwave and Toronto Water to govern engineering interface and ensure they meet their state licence requirements. (InterviewG5, 2012)

Director, Toronto Water

1: Joined city in 2003; became manager in 2005. Have technical agreement which governs Enwave's relationship with drinking water facilities. (InterviewG5, 2012)

2: Neutral; Formal, technical relationship with Enwave to ensure drinking water purity. Sees benefit s- a new intake pipe so cleaner water and expanded capacity. (InterviewG5, 2012)

3: No preference on how owned as long as technical agreement in place. (InterviewG5, 2012)

Ontario Province (various authorities)

1: Sets policy and legislation for Ontario energy and planning sectors among others. Through the Ontario Energy Board, regulates prices of gas and after 1998 electricity. (Blakes, 2008)

2: No data

3: No data

Ontario Hydro

1: Province owned electricity generation, transmission and some distribution functions. Dismantled in 1988. (Blakes, 2008)

2: No data

3: No data

Toronto Hydro

1: Owned by City. (sole shareholder). Electricity distribution for the City. (Toronto Hydro, 2012)

2: No data

3: Entered into a joint venture (the Northwinds Project) with a private company, Unicom Thermal Technologies, and the Ontario Hydro Services Corporation to develop ice plants to produce cooling energy to be used in a district cooling system. (City of Toronto, 1999)

5.2 Collective Actor Influence Matrix

1: Capabilities

2: Orientation

3: Preferences

Enwave

1: Previously TDHC, distributed steam energy. (InterviewE3, 2012)

2: Not a new idea – and there are good benefits: capital costs, reliability, hedged against future greater than inflation increasing in energy costs, and you have environmental benefits. Lake water cooling is renewable, helps reduce electricity generation and smog from coal. TW thought E were focused on getting it done quickly cheaply and showing shareholder returns. Initial city support and then partial privatization is appropriate for a big but new investment. Good benefit for the city with the new drinking water intake. (InterviewU2, 2012) (Moloney, 2003) (InterviewS3, 2012) (Enwave Energy Corporation, 2011) (InterviewC4, 2012)

3: They should operate renewable cooling for environmental reasons (reduces energy consumption by 90% for cooling compared to traditional chillers) and because of their history of running district heating. Good that they agreed to fix cooling costs over contract to index – eased concerns about price changing. The pricing model where prices are fixed and subject to CPI was a very important element. TW is concerned need to keep drinking water in mind; have agreement about this but city should own intakes at end of day. Several post 2004 documents suggest the system should expand further. (InterviewC4, 2012) (InterviewS3, 2012) (InterviewE3, 2012) (City of Toronto , 2006) (City of Toronto, 2003) (City of Toronto, 2006)

OMERS (merged with Senior Vice President for summary tables).

1: Have a very long term horizon and resources to invest. (InterviewS3, 2012) (City of Toronto, 1999)

2: They like infrastructure as a long term investment, like DLWC. expect a 9 per cent to 10 per cent rate of return over a 20-year amortization period. Great investment for them. Seen by city as very supportive of Enwave, including potential expansion beyond initial DLWC. (InterviewS3, 2012) (InterviewU2, 2012)

3: They were the idea investors because they waited 6 years to make a profit before we started turning the corner. City councillors approved of their shareholding and investment in Enwave. (InterviewS3, 2012) (Canadian Urban Land Institute, 1993)

Toronto District Heating Corporation

1: Function governed by Ontario legislation. Reliable in service, but prices not hedged and subject to last minute adjustments. Lots of good ideas, but never made any money. Bleeding red ink- owed the city 30 million dollars. Legally and structurally difficult to raise money for

capital growth. (Sustainable Energy Workgroup of the City of Toronto, 1999) (InterviewE3, 2012)

2: Not sure they should expand from steam into cooling without some change. Privatization seen in good light. Idea of city combining all district heating systems into one came from Ray Bremner- focus on energy from waste. Able to get a lot of support from the community to privatize TDHC because we need to find money to build deep lake water cooling (InterviewS3, 2012) (InterviewE3, 2012)

3: Lack of trust between customers – perhaps not the best to lead DE. Should deliver or support delivery – be the preferred provider for city cooling. The city's ownership of TDHC should lead to cost effective heating and also to a gain in the value of the city's investment. Should restructure into privatized Enwave in order to delivery DLWC. "Since the City has already invested $33 million over the years in TDHC, it makes sense to protect its investment and maximize it to the fullest extent possible." (InterviewS3, 2012) (Toronto Environmental Task Force, 2000) (Sustainable Energy Workgroup of the City of Toronto, 1999) (City of Toronto, 1999) (City of Toronto, 2006)

Ontario Clean Air Alliance (Jack Gibbons)

No data

Environmental Task Force & Environment Roundtable

1: Advised city of Toronto; created by city council. Looked at greenhouse gas emissions. Great deal of citizen participation in environmental objectives ; Incubating ideas. Members: Chaired by a councillor the members were appointed citizens who had an interest in the environment and then there was a staff group formed to support it. (InterviewC4, 2012) (InterviewE3, 2012) (InterviewS3, 2012) (InterviewP5, 2012)

2: They were supportive – alongside many other things. "So when it came time for government approvals, leading environmentalists of the day were supportive, and that was helpful." (InterviewS3, 2012)

3: Raise awareness, set it in the city environmental plan. (InterviewP5, 2012)

Deep Lake Water Cooling Investigation Group

No data

Toronto Star

No data

Better Buildings Partnership

No data

City of Toronto

1: Funds BBP. Various departments had to give lots of time and effort to get the legal and engineering agreements signed. Needs to engage with all stakeholders around energy future for Toronto. Limited in goals by ability to raise money – province controls taxes and funding. (Toronto Hydro, 2012) (Moloney, 2003) (InterviewU2, 2012) (Better Buildings Partnership)

2: Interested in environmental matters, a big advocate for reducing climate change emissions, and saw property and buildings as a big area. Should be in charge of 'carrying' DLWC idea and process. This builds on THDC ownership, but also from environmental perspective city should make it happen any way possible. Various departments should be involved – not just Environment. Public health, planning, economic development. (Canadian Urban Land Institute, 1993) (InterviewS3, 2012) (Sustainable Energy Workgroup of the City of Toronto, 1999)

3: Did not actively promote with building owners. Should be leading creation of network and cooling system. Wanted the city to share investment with private company . Built the beginning of the network at Air Canada Centre. All agencies should be promoting district heating and cooling. City should 'lead by example' to support company. Councillors eventually instructed city (various departments) to enter into agreement with TDHC/Enwave and for the privatization. (InterviewU2, 2012) (Sustainable Energy Workgroup of the City of Toronto, 1999) (Toronto Environmental Task Force, 2000) (City of Toronto , 2006)

City of Toronto Planning

1: Central to the city's long term environmental health and should be involved with the planning for hits. Building guidelines require developers to comply. (Sustainable Energy Workgroup of the City of Toronto, 1999)

2: No data

3: Should be defining and establishing areas appropriate for DHC. Should use planning process to improve energy efficiency above provincial standard. (InterviewG2, 2012) (Sustainable Energy Workgroup of the City of Toronto, 1999)

Director, Planning and Zoning

No data

City of Toronto Energy Efficiency Office

1: No data

2: No data

3: Their mandate should be expanded to all forms of energy generation and distribution in the city. (Toronto Environmental Task Force, 2000)

City of Toronto Councillors

1: Should know about energy issues and be engaged in discussions. Their instruction needed to proceed with Enwave agreement and project. Their support needed to make Toronto Water and Enwave share a pipe. (Enwave, 2005) (Moloney, 2003)

2: They were looking it a from an engineering problem and how can we get our drinking water solved not a wonderful district cooling project. One of the big challenges was convincing the city councillors to privatise the company. Initially some were hesitant but most eventually came around. (InterviewP5, 2012) (City of Toronto, 1999) (InterviewE3, 2012)

3: Did not actively promote with building owners. Agreed that railway lands was a good place to start cooling network. Less concerned about privatization with OMERS, city pension fund, involved. Should push city to work only with TDHC (& not hydro) – did that Voted to use water

infrastructure money to support DLWC and Enwave because it bought them a new pipe. (Moloney, 2003) (InterviewE2, 2012) (Sustainable Energy Workgroup of the City of Toronto, 1999)

Richard Gilbert

1: Attended charrettes as a councillor. Very smart man, great guy. Big long term goals – see the big picture. Not your traditional politician. (InterviewS3, 2012) (InterviewC4, 2012)

2: Very supportive & long term advocate. A champion of district energy in many forms – believed in energy conservation and efficiency as a good thing for the city and the world. (InterviewS3, 2012) (InterviewC4, 2012)

3: Glad to have a champion for the idea like him. (InterviewS3, 2012)

Joe Pantalone

No data

City of Toronto Environment Office

No data

Director, Environment Office

No data

Building Owners Generally

1: Only interested with new buildings or refits for end of life plant. And Quite a few buildings' chillers were at end of life and needed replacing – due to property life cycle. Do care about environment. (InterviewU2, 2012) (InterviewS3, 2012)

2: Particularly compelling for condominium owners because saves capital costs on construction – which means greater profit for builders. Must trust Enwave to be reliable and cost effective over 20 years; can be difficult given TDHC history. Reason to be cautious – not a common thing to do, a huge contract by value, and needs careful thought. Initially, massive resentment due to TDHC history. Would be interested in fixing prices. Not resistant. (InterviewS3, 2012) (InterviewU2, 2012) (InterviewG2, 2012) (City of Toronto Executive Committee, 1988)

3: Did not want to get involved themselves: "utilities are not our business". Expected to be sceptical of ability of TDHC to handle given previous price issues, and many technical and insurance concerns. But also many positives around prices and running costs – also environmental. "the vast majority of my counterparts who have had the opportunity to sign up to this have signed up to it." (InterviewU2, 2012) (Canadian Urban Land Institute, 1993)

Senior Vice President, OMERS

1: No data

2: The 20 year contact is a hedge against future energy price increases. Even if it isn't cheaper now, if energy prices spike in the future, his buildings will save significantly on energy costs. (Cordileone, 2003)

3: "Andrew is the reason that oxford buildings connected to Enwave." A huge proponent of Enwave and DLWC. Agreed to be the first one to connect. With One University Avenue, an 18-storey building. (InterviewS3, 2012)

Toronto Water

1: No data

2: They were supportive to get new intake pipe because the old intake pipe they had was becoming in need of replacement. Concerned about drinking water. (InterviewG2, 2012)

3: Eventually supportive after long negotiations about water safety and engineering. (InterviewG2, 2012)

Director, Toronto Water

No data

Ontario S Province (various authorities)

1: Offer energy savings funds to building owners. Should fund research and business case establishment for district cooling. Regulate water drinking quality and energy prices (to varied extent) and hence Toronto Water. Control amount of money that city and TDHC can raise via borrowing. (City of Toronto Executive Committee, 1988) (Better Buildings Partnership)

2: They probably would have tried to totally privatize it (conservative government). They were supportive. They had to pass the Toronto District Heating Corporation Act which was the legislation that created Toronto District Heating Corporation. (InterviewE3, 2012) (InterviewS3, 2012)

3: They should not be involved. They have a energy regulation function and had to approve extended remit of THDC to cooling and then privatization. (InterviewE3, 2012)

Ontario Hydro

1: Provincial owned generation and distribution company. Dysfunctional. (InterviewE3, 2012)

2: Not conservation minded. (InterviewE3, 2012)

3: No data

Toronto Hydro

1: City-owned energy distribution utility. Great capability for transition to more sustainable energy. (Community Planning Office, 2006) (InterviewC4, 2012)

2: Not seen an positive light generally. Tried to form their own district cooling company while TDHC was being privatized. They were upset about Enwave building network without open market competition. (InterviewE2, 2012) (InterviewG2, 2012) (InterviewE3, 2012)

3: Did not want them involved in running DLWC – distrust of them but also it would compete with their electrical load and they could have just shut Enwave down. Initially thought they could partner with TDHC to help deliver cooling network. But then after conflict the city decided it could back only one company – Enwave. City directed Toronto Hydro to align its marketing activity to support Deep Lake Water cooling as the cooling base load source. (InterviewC4, 2012) (InterviewS3, 2012) (Sustainable Energy Workgroup of the City of Toronto, 1999)

5.3 Self-Identified Strategy Matrix

This matrix defines how each actor perceives their potential options around Deep Lake Water Cooling, given institutional constraints and powers. Their self-identified potential options are ranked on scale of 0 (none), + (minor), ++(medium), +++ (significant). U indicates unknown.

	Market Shaping (4)	Market regulation (5)	Market Incentives (6)	Market capacity (7)
Enwave (DF)	++	0	+++	+++
OMERS	U	U	U	U
Toronto District Heating Corporation	++	0	++	++
Ontario Clean Air Alliance	+	0	0	+
Environmental Task Force & Environment Roundtable	+	0	0	++
Deep Lake Water Cooling Investigation Group	+	0	0	++
Toronto Star	0	0	0	0
Better Buildings Partnership	0	0	++	++
City of Toronto	+++	+	+	++
City of Toronto Planning	++	+	+	+
City of Toronto Energy Efficiency Office	n/a	n/a	+	++
City of Toronto Councillors	+++	+	+	
City of Toronto Environment Office	0	+	+	+
Building Owners Generally	0	0	0	0
Director, OMERS	0	0	0	++
Toronto Water	++	++	0	0
Ontario Province (various authorities)	+	+	+ (for BO)	U
Ontario Hydro	U	U	U	U
Toronto Hydro	U	U	U	U

5.4 Collective Strategy Matrix

The collective matrix summarises what all actors perceive of other actors potential and actual interventions with respect to the Deep Lake Water Cooling project. Their collectively identified potential options are ranked on scale of 0 (none), + (minor), ++(medium), +++ (significant).

	Market Shaping		**Market regulation**		**Market Incentives**		**Market capacity**	
	Potent.	***Actual***	***Potent.***	***Actual***	***Potent.***	***Actual***	***Potent.***	***Actual***
Enwave (DF)	++	++	0	0	+++	+++	++	++
OMERS	+++	+++	0	0	0	0	0	0
Toronto District Heating Corporation	++	++	0	0	++	++	+++	++
Ontario Clean Air Alliance	0	0	0	0	0	0	0	0
Environmental Task Force & Environment Roundtable	+++	+++	0	0	0	0	++	++
Deep Lake Water Cooling Investigation Group	0	0	0	0	0	0	0	0
Toronto Star	0	0	0	0	0	0	0	0
Better Buildings Partnership	0	0	0	0	0	0	0	0
City of Toronto	+++	+++	+	+	++	+++	+++	++
City of Toronto Planning	+	+	++	+	+	+	+	?
City of Toronto Energy Efficiency Office	+	0	0	0	+	?	+++	+
City of Toronto Councillors	++	++	+	+	++	++	++	+
City of Toronto Environment Office	0	0	0	0	0	0	+	+
Building Owners Generally	0	0	0	0	0	0	0	0
Director, OMERS	0	0	0	0	0	0	0	0
Toronto Water	0	0	0	0	0	0	0	0
Ontario Province (various authorities)	++	0	++	++	++	++	0	0
Ontario Hydro	0	0	+	+	0	0	0	0
Toronto Hydro	++	0	0	0	0	0	0	0

5.5 Actor code references

Actor	Code
Enwave	E
Chief Executive, Enwave	DF
OMERS	O
Toronto District Heating Corporation	TDHC
Ontario Clean Air Alliance (Jack Gibbons)	CAA / JG
Environmental Task Force & Environment Roundtable	ETF
Deep Lake Water Cooling Investigation Group	DCIG
Toronto Star	TS
Better Buildings Partnership	BBP
City of Toronto	T
City of Toronto Planning	TP
City of Toronto Planning Officer	JW
City of Toronto Energy Efficiency Office (FC)	TEE / FC
City of Toronto Councillors	TC
Richard Gilbert Former Local Councillor	RG
Joe Pantalone Former Local Councillor	JP
City of Toronto Environment Office	TE
Chief Executive, Clean Air Alliance	LO
Building Owners Generally	BO
Director, OMERS	AM
Tridel	Tri
Toronto Water	TW
Director, Toronto Water	LD
Ontario Province (various authorities)	OS
Ontario Hydro	OH
Toronto Hydro	TH

5.6 Codes

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21
22
23
AM1AM
AM1BO
AM1E
AM1O
AM1T
AM1TDHC
AM2AM
AM2BO
AM2E
AM2O
AM2T
AM2TC
AM2TDHC
AM2TH
AM2THDC
AM3AM
AM3BO
AM3E
AM3O
AM5T
AM7AM
AM7O
AM7T
AM7TDHC
AM7THDC
BBP1BBP
BBP1OS
BBP1T
BBP6BBP
BBP7BBP
BO2BO
BO2E
BO3E
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DCIG4OS
DCIG4T
DCIG5OS
DCIG6OS
DCIG7DCIG
DCIG7T
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DF6T
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DF7E
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E1TC
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E2E
E2O
E2TDHC
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E4O
E5E
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ETF1T
ETF1TDHC
ETF1TP
ETF21
ETF22
ETF2ETF
ETF2T
ETF2TDHC
ETF3T
ETF3TC
ETF3TDHC
ETF3TEE
ETF3TH
ETF3TP
ETF4ETF
ETF4TP
ETF5T
ETF5TP
ETF6BBP
ETF6TP

ETF7ETF
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ETF7TEE
ETF7TP
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