Sharing Local Energy Infrastructure
Organizational Models for Implementing Microgrids and District Energy Systems in Urban Commercial Districts

By

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ABSTRACT

There is a growing trend in cities toward establishing localized, shared energy infrastructure. As existing energy infrastructure ages and demand increases, cities face rising energy costs and security risks combined with mandates to decrease carbon emissions. Local energy infrastructure provides cities and neighborhoods with greater control over their energy production and consumption, including the ability to lower the cost of energy, move to low-carbon energy technologies, and improve energy reliability and security.

This thesis seeks to understand how stakeholders in urban commercial districts are creating organizations to implement two types of shared local energy infrastructure: district energy and microgrids. Building district energy and microgrids is a complex undertaking, which is one reason that they proliferate in urban environments where that complexity is reduced, such as universities, hospitals, and military bases. These areas may have single property owners, single land-owners or preexisting energy infrastructure that simplifies regulatory, legal, and development complexities of building new energy systems. Commercial businesses districts are significantly more complicated; they have multiple properties that abut public right of ways and that are owned by multiple, unaffiliated customers of legacy energy utilities. Establishing such a system in a commercial district requires addressing local utility rights, public right-of-way and franchise issues, as well as creating a new organizational structure that allows for the involvement of multiple parties in developing the system.

This thesis assesses the feasibility of two organizational models for implementing local energy infrastructure in commercial districts: a joint cooperative model and an independent provider model. In a joint cooperative, all properties in a district become customers of a jointly owned, operated, and managed energy system. With an independent provider, all district properties become customers of an independently owned and operated system. These models are evaluated through two cases in which they are currently being tested: a proposed district energy system in Portland, Oregon and a proposed microgrid in Stamford, Connecticut. Therein, barriers to implementation such as perception of risk and lack of familiarity with shared energy systems are also examined.

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Sharing Energy Infrastructure

Organizational Models for Implementing Microgrids and District Energy in Commercial Districts

Introduction

There is a growing trend in cities toward establishing localized, shared energy infrastructure. As existing energy infrastructure ages and demand for energy increases, cities face rising energy costs, increasing energy security and reliability risks, and mandates to decrease carbon emissions. Energy production is typically a regional enterprise in the United States, with the majority of energy produced far from the main areas of demand – cities. Local energy infrastructure such as microgrids, district heating and district cooling systems, allow cities and neighborhoods to exercise greater control over the production of energy they consume, driving huge value to energy consumers, energy utilities, new businesses and society at large. While all of these stakeholder groups benefit in different ways from shared energy infrastructure, its main value proposition for cities is three-fold: economic, environmental, and security.

Through generating and distributing energy more efficiently than conventional alternatives, local energy infrastructure significantly reduces the cost of supplying energy, allowing consumers to either save money on energy consumption, or transfer to higher cost, environmentally friendly forms of energy with no increase in their rates. Utica College and St. Luke's Hospital & Nursing Home in Burrstone, New York cut their utility consumption costs by 15 – 20% through creating a microgrid, while customers of St. Paul's district energy system have seen their rates remain below inflation for nearly 30 years while they have almost fully transitioned to renewable energy resources.[1] Shared energy infrastructure accomplishes this by generating energy close to the point of its consumption, capturing and using waste heat, reducing energy losses, and achieving economies of scale over small distributed energy generators, like individual boilers. These efficiencies can double those of conventional energy systems, reducing the total fuel consumed to deliver the same amount of energy.[2] Shared energy infrastructure is also a major force for economic development in cities. Through lowering energy costs, removing the need to install expensive thermal energy plants in individual buildings, or reducing the number of power outages customers experience, local energy infrastructure attracts new businesses and new real estate development. The creation of a district cooling system in downtown Austin has led to the construction of 8 million square feet of new building space in the last decade.[3]

The improved electrical and thermal efficiency of local energy infrastructure also results in major environmental benefits, primarily in the form of lower SO_2, NO_x, and CO_2 emissions per unit energy produced. For example, two thirds of the primary energy consumed in conventional power plants to produce electricity is lost as heat. This waste heat represents 28% of all energy-related carbon emissions in the United States, which is roughly equal to the emissions from the entire transportation sector.[4] Local, shared energy systems capture waste heat and use it for heating and cooling buildings. Both NYU and Cornell University cut their CO_2 emissions by roughly 40% through implementing a local energy system for their campus buildings.[5] Emissions are also reduced in local energy systems due to their ability to scale up and aggregate small renewable energy sources, like rooftop solar installations. Finally, local energy systems can help defer the need to invest in new conventional energy infrastructure, thus preventing

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[1] Michael A. Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State* (Albany, NY: New York State Energy Research and Development Authority, September 2010). www.nyserda.org. A-52; District Energy St. Paul. "District Energy: Competitive Advantage." accessed May 19, 2012.http://www.districtenergy.com/services/competitive.html.
[2] Environmental and Energy Study Institute. "Fact Sheet: What Is District Energy?" accessed April 15, 2012. http://www.eesi.org/district_energy_092311.
[3] Will Wynn. "Urban Revitalization / Economy." accessed May 19, 2012. http://www.willwynn.com/urban-revitalization-economy/.
[4] C. Marnay et al., "Policymaking for Microgrids," *IEEE Power and Energy Magazine* 6 (May 2008): 68, http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=4505828.
[5] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*.

additional emissions from fossil fuel-based power plants and environmental land use impacts from new transmission and distribution infrastructure.[6]

The last major value proposition of local shared energy infrastructure is energy security and reliability. Local energy systems deploy many different technologies simultaneously and can use multiple fuel sources, providing security and resiliency to customers if certain fuel becomes unavailable or prohibitively expensive.[7] Some local energy systems can also operate independently from gas or electric utility networks, allowing their customers to avoid losing energy during a network disruption. In areas with aging distribution infrastructure, energy reliability is a major concern, particularly for businesses and institutions that require power at all times, such as hospitals or data centers.

These advantages of producing and distributing energy locally depend greatly on the extent to which they are *shared*. Energy production must match consumption in order to operate energy systems efficiently. However, energy consumption patterns differ among customers and they change throughout the course of a day, as well as seasonally. Meanwhile, different energy generation technologies have varying potential to meet demand at any given point in time; for example solar energy is only useful during the day in clear weather, while some fossil fuel plants take a long time ramp up and produce energy. Therefore, the more diverse the demand patterns are of multiple users in an energy system, the more efficiently energy generation equipment can be sized and configured to meet that demand. In the context of local energy systems, gathering multiple users into a shared system is also necessary to aggregate enough demand to size energy generation equipment in a way that is cost effective.

Therefore, shared energy systems are most economical in areas with multiple, diverse, and relatively intense energy users. Urban commercial districts are prime candidate for shared energy infrastructure; they contain multiple buildings in close proximity, with a diversity of uses that are often energy intensive. While local energy infrastructure may promise benefits to stakeholders in a commercial district, sharing that infrastructure is a challenge, since these stakeholders tend to act competitively or independently, not collaboratively.

Research Objectives & Methodology

This thesis seeks to understand the organizations urban commercial district stakeholders have developed for implementing shared local energy infrastructure. Two shared energy system typologies are discussed in this thesis – district energy and microgrids.

Building district energy and microgrids in existing urban environments is a complex undertaking, which is one reason that to date, they have proliferated in environments where that complexity is reduced, such as universities, hospitals, and military bases. These areas may have single property owners, single land-owners or preexisting energy infrastructure that simplifies the regulatory, legal, and development complexities of building new shared infrastructure. Businesses districts are significantly more complicated. Commercial districts have multiple properties that abut public right-of-ways and are owned by multiple, unaffiliated customers of legacy energy utilities. Establishing such a system in a commercial district may require addressing local utility rights, public right-of-way and franchise issues, as well as creating a new organizational structure that allows for the involvement of multiple parties in developing the system. Therefore, it is critical to develop an organizational model for implementing shared energy systems that can address local constraints, meet diverse needs, and drive value to a wide range of stakeholders.

While many models for implementing shared energy infrastructure have been tested on the ground and evaluated in literature, this thesis seeks to vet one model in particular – the joint cooperative model. In a

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[6] Sara Bronin, "Curbing Energy Sprawl with Microgrids," *Connecticut Law Review* 43,2 (December 2010): 547–584.
[7] Compass Resource Management, Ltd., *Neighborhood Infrastructure: Doing More With Less* (Portland, OR, November 2010). www.portlandonline.com/bps. 9

joint cooperative model, customers of a shared energy system also share in the roles and responsibilities required for building and operating the system. While this means that customers face all the upfront costs and risks of implementing a shared system, they also maintain full control over system design and operation, and they garner the full economic reward of lowering their energy costs through system efficiency. Joint cooperative models are not normally associated with energy systems in cities because the upfront costs and complexity of implementation are so high; the literature on their effectiveness in commercial districts is very limited.[8]

Nevertheless, joint cooperatives are created to serve multiple, unaffiliated energy users according to shared, long-term energy goals and customer requirements. If multiple stakeholders in a commercial district see a common benefit in implementing a shared energy system – to lower costs, to attract new development, to reduce their carbon footprint, or to improve their energy reliability – they may wish to form a cooperative. Since commercial districts are in fact now mobilizing to implement shared energy systems, this model merits further assessment. This thesis evaluates this model through an analysis of stakeholder efforts in two commercial districts – Portland, Oregon and Stamford, Connecticut – to develop organizations for implementing shared local energy infrastructure.

This thesis employs a case study approach to understand the process of developing an organizational model in each city. The analysis of the cases is grounded first in a literature review of microgrid and district energy technology as well as organizational models employed for implementing these technologies. The technology literature review focuses on system components, configuration and functionality. The literature review on organizations focuses on models used for implementing energy infrastructure in various urban contexts as well as energy-agnostic models for implementing capital projects in commercial districts specifically, such as business improvement districts. The range of models reviewed is used to assess potential models that will suit the unique context of commercial districts, in particular the joint cooperative model. Each case study is analyzed through a combination of secondary material – such as project RFQs, feasibility studies, industry and scientific reports, news articles, and organization meeting minutes – and interviews. Roughly six to ten individuals involved in each case were interviewed, including City officials, commercial property owners and managers, commercial district organization leadership, shared energy system customers, and shared energy system designers. The analysis of these cases looks only at the suitability of organizational models for district energy and microgrid systems in the context of commercial districts; it does not comment on their use in other urban environments.

Thesis Chapters and Topics:

Chapter 1 explores the energy system configurations of district energy and microgrid systems. This includes brief description of basic system components, potential system functions, and the subsequent value of these functions to different stakeholders.

Chapter 2 explores how the configuration of energy systems and stakeholder interests differ depending on contextual parameters such as market conditions, the regulatory environment, and the composition of urban neighborhoods. This chapter then evaluates how organizational models for shared energy implementation can be structured to respond to the particular challenges of commercial districts. Potential organizational models are assessed through core roles and responsibilities: ownership, management, operations, rate setting and financing. In particular, the potential of using a joint cooperative model, in which multiple customers share these responsibilities, is emphasized. This is justified through a comparison to an existing

[8] Portand Sustainability Institute, *Development, Ownership & Governance Models*, (Portland, OR, March 2011). www.portlandonline.com/bps/index.cfm?a=349828&c=54886; Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*; Raphael Sauter and Jim Watson, "Strategies for the Deployment of Micro-generation: Implications for Social Acceptance," *Energy Policy* 35, 5 (May 2007): 2770–2779. http://www.sciencedirect.com/science/article/pii/S0301421506004903.

organizational model that is unrelated to energy infrastructure but designed to implement shared projects in commercial districts: business improvement districts (BIDs).

Chapter 3 and **Chapter 4** each explore a case study where stakeholders are developing shared energy systems: a district energy system in the Lloyd Business District of Portland and a microgrid in the downtown business district of Stamford. In both of these cases, a joint cooperative organizational structure was set up in order for multiple property owners/business to jointly develop energy infrastructure (among other projects). Additionally, in both these cases, there is a pilot project underway to develop the primary node of a shared energy system in (predominantly) public buildings, which may or may not eventually expand to service other properties in the district.

The contextual parameters and stakeholder interests behind developing the broad organizational structure in each case is first explored, followed by a description of the organization itself – its roles and responsibilities. Since stakeholders in both cases ended up using a different organizational structure from the joint cooperative model to implement their pilot project, the motivations for doing so are analyzed as well as the implications of those decisions for developing shared energy projects in the future.

Chapter 5 synthesizes the major issues illuminated in the two cases with regard to how relevant the organizational models evaluated in this thesis are for successfully implementing shared energy projects, *specifically* in the context of urban commercial districts. The chapter suggests that given the experience in the case studies, the independent provider model, rather than a joint cooperative model, may be preferred among commercial district stakeholders for implementing shared energy in commercial districts.

This chapter also distills lessons from the 'pilot project' approach taken in both case cities. Specifically, the chapter argues that stakeholders in commercial districts are generally still very unfamiliar with shared energy systems and require a greater level of understanding in order to address multiple and diverse concerns they have with system risk. This chapter advocates that stakeholders pursue a different approach before initiating a pilot in order to facilitate successful pilot project implementation and expansion. This chapter suggests that the joint cooperative organizational model remains a key foundation from which stakeholders can launch an engagement and educational process that will prepare commercial property owners to interconnect into a shared energy system. Future areas of research are also described.

1. Shared Energy Infrastructure – District Energy and Microgrid Systems

To assess the suitability of different organizational models for implementing district energy or microgrids, it is important to understand how these energy systems work, why they are desirable, and the factors shape their design. This chapter describes technological underpinnings of each energy system type to illuminate how it functions in relation to conventional energy generation and distribution formats and why it therefore may be of interest to various stakeholders. The chapter first summarizes the technology components of each system type. The chapter then describes how various configurations of these components produce system *functions*, such as reduced costs or green house gas emissions. The broad set of stakeholder interests these functions appeal to are then described. The combination of technology configuration, functionality and shared interests, creates the impetus for organizations to form and implement district energy or microgrid systems.

Meanwhile, larger contextual parameters, such as the local regulatory environment, market conditions, or the climate shape stakeholder interests as well as the feasible configuration for a particular place.[1] The most appropriate organizational model for implementation must therefore respond to all of these constraints. Chapter 2 addresses these contextual parameters further and how they shape appropriate organizational models for system implementation in specific contexts.

Technology Components and System Configuration

There are multiple forms or manifestations of energy. The energy discussed in this paper is electricity and thermal energy (e.g. heat). The components of a local energy system are broken down here into three categories: energy generation, energy distribution (from point of generation to end use customer), and system control/operations. The configuration of any district energy and microgrid system is unique, therefore it is difficult to describe them with any single definition. However this overview is meant to inform practitioners across a wide variety of fields, therefore the technical complexity of these systems is simplified here.

District Energy

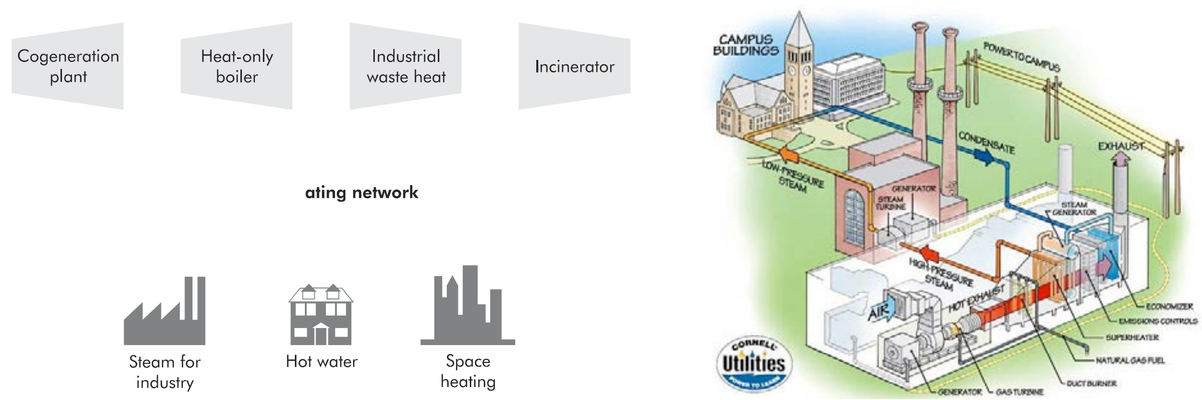
<u>Definitions</u>

District Energy (DE) is an energy distribution system that links energy generation sources to multiple buildings. These systems primarily provide thermal energy (e.g. heat and sometimes cooling) in the form of steam or water to designated customers through a network of underground pipes (Figure 1-1).[2] Several terms are used interchangeably to describe DE systems. At the most elemental level DE systems are district heating (DH) systems, which provide domestic hot water, steam, and/or space heating. District Cooling (DC) systems provide chilled water and/or space cooling, while DH/DC systems (district heating and cooling) provide both. Meanwhile, *DE* may refer to systems that produce *both* electricity and thermal energy simultaneously through cogeneration, also known as combined heat and power (CHP). These DE systems are still designed to meet the thermal energy requirements of their customers; any electricity produced concurrently is generally injected into the main electric grid, which distributes electricity to both DE and

[1] Greg Young Morris et al., "A Framework for the Evaluation of the Cost and Benefits of Microgrids," (paper presented at CIGRÉ International Symposium on The Electric Power System of the Future - Integrating Supergrids and Microgrids, Bologna, Italy, 2011). http://eetd.lbl.gov/EA/EMP/emp-pubs.html.
[2] International Energy Agency, *Coming in from the Cold: Improving District Heating Policy in Transition Economies* (Paris, France, 2004). www.iea.org/textbase/nppdf/free/archives/cold.pdf. 36-37.

non-DE customers. While DE systems can be small, serving only a few buildings, they are typically large, serving entire neighborhoods or entire cities like the DE systems in Denmark and former Soviet Union.

Figure 1-1: District Energy Generation and Distribution



(Source: Left: IEA, *Coming in from the Cold*, Right: EESI, *Role of District Energy*)

Generation and Distribution

DE systems can draw from many generation technologies and fuel sources to produce thermal or electrical energy. Typically, DE systems draw energy from one or a couple central plants that produce energy from combusting fossil (e.g. coal/natural gas) or renewable fuels (e.g. biomass/municipal solid waste) in boilers or cogeneration plants. Additionally, DE systems can utilize waste heat from industrial processes and waste water systems, solar thermal or geothermal energy (Figure 1-1).[3] While DE systems producing electricity require CHP, DH/DC systems can be powered by simple boilers or industrial waste heat.

The thermal distribution network for DE consists of insulated pipes buried underground that deliver steam, and/or hot and chilled water to buildings. Upon linking up with individual buildings, the distribution infrastructure consists of heat exchangers that use the steam or hot water for space heating and cooling, as well as hot and chilled water, obviating the need for large boilers in base building plants, or chillers and cooling towers.[4] The electricity network for a DE system may vary. Generally, electricity produced in a DE system is injected into the existing power grid, operated by an electric distribution utility, that is already serving electricity to the DE system's thermal customers. In this case, the energy joins the flows of electricity running through the entire distribution network. In other cases, a DE system may *physically* deliver electricity to its customers through a distinct, separate electric distribution network. This would constitute a microgrid.

Microgrids

Definitions

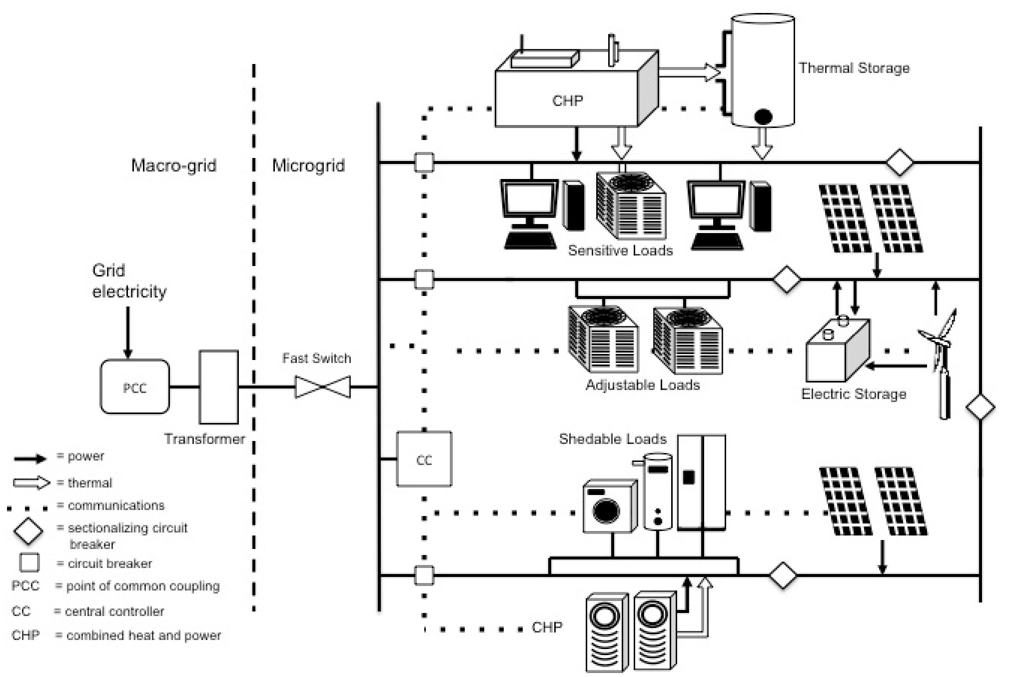
Microgrids are small, self-contained electricity, heat, and sometimes cooling distribution systems that coordinate and distribute energy supplied from multiple generation sources to a network of users in a

[3] Environmental and Energy Study Institute. "Fact Sheet: What Is District Energy?" accessed April 15, 2012. http://www.eesi.org/district_energy_092311.
[4] Compass Resource Management, Ltd., *Neighborhood Infrastructure: Doing More With Less* (Portland, OR, November 2010). www.portlandonline.com/bps. 2-3.

spatially defined area. These generation sources, called distributed energy resources (DERs) or distributed generation (DG), refer to energy generators that supply electricity to an electricity network and/or thermal energy to a pipe system. DERs include solar panels, wind turbines, cogeneration units, fuel cells, energy storage technologies, and controllable loads. Loads are mechanical systems or devices on the customer side that require electricity, which can be turned off or "shed" in order to reduce total customer demand for electricity. Referred to as demand-side management (DSM), controllable loads can be considered an energy resource in the form of energy conservation.

Unlike DE systems, which are primarily conduits for thermal energy distribution, the main focus of microgrids is electricity production, distribution, and quality. Furthermore, the defining characteristic of microgrids is *control*. In a microgrid, multiple DERs are centrally controlled and managed using smart grid technologies, including advanced metering infrastructure (AMI), automated control systems, and information and communications software.[5] These information and control technologies allow a central operator to aggregate and optimize the use of each DER technology in a microgrid according to a variety of factors and constraints, such as the weather, the time of the day, customer demand, and fuel and electricity prices.

Figure 1-2: Schematic Illustration of a Microgrid



(Source: Hammer & Hyams, "Smart energy for cities" in *Metropolitan Sustainability Understanding*)

As the subsequent sections will illustrate, there are multiple definitions of microgrids according to their various configurations and functions. However, the main components that form part or all of microgrids are summarized below and shown in Figure 1-2

- Microgrids draw power from multiple DERs, including distributed generating units, storage devices, and loads.

[5] Michael A. Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State* (Albany, NY: New York State Energy Research and Development Authority, September 2010). www.nyserda.org. S-1.

- DERs and customers are equipped with intelligent information, communications, and automated control equipment that allow a central operator or individual DER operator to forecast both customer loads and optimal DER output and then dispatch generators, storage units and controllable loads.
- Microgrids aggregate DER generated electricity over a distinct, independent electric distribution network that connects at a single point, called the "point of common coupling" (PCC) to the wider utility distribution grid (henceforth called the "macrogrid"). In this respect, microgrids appear to the macrogrid distribution utility as a single, controlled DER unit.
- The microgrid can disconnect from the macrogrid and operate autonomously, called "islanding."
    - These last two characteristics are true of "physical microgrids" but not "virtual microgrids," which are described below.[6]

Generation and Distribution

The DER technology mix employed in each microgrid is unique, designed to respond to spatial constraints, climate conditions, utility regulations, tariffs, and financial incentives, as well as the loads patterns and interests of customers they serve, which range from power reliability to environmental impact. As one microgrid engineer stated, "Microgrids are like Baskin Robbins, but there are a lot more than 31 flavors."[7]

A high level survey of multiple existing microgrids however, suggests that most fall under three broad categories. In one category, the microgrid relies primarily on a fossil fuel-based cogeneration plant sized to meet 100% of customer thermal requirements and the majority of customer electricity requirements, while supplemental electricity is purchased from the macro distribution utility. If there is a need, these systems can operate autonomously from the macrogrid, shedding non-critical load and/or operating additional back-up generators. In a second category, microgrids aggregate and dispatch only electricity generating DERs and DSM via smart grid infrastructure in order to reduce peak electricity demand from the macrogrid. These systems can shave or "flatten" daily demand for macrogrid-based power through deploying DERs like solar or batteries during peak hours. These systems can also respond to annual peak demand events, such as the hottest afternoon in the summer, through using DERs and dramatically shedding loads through DSM resources. The final microgrid configuration is a hybrid that utilizes renewable DERs, smart grid capabilities, and cogenerating units that draw from innovative, local fuel sources, such as locally generated biogas from wastewater and sewage facilities.[8]

Similarly, the distribution networks of microgrids may take many forms but generally mirror the primary configurations described above. "Physical microgrids" produce both electric and thermal energy, and distribute them through *separate and self-contained* networks of pipes and wires. Physical microgrids connect to the macrogrid at a single point and can disconnect at this point to operate in island mode. Physical microgrids are also generally small, interconnecting only a few proximate buildings. "Virtual microgrids" generally produce only electricity and distribute it using the *existing distribution network* of the macrogrid, or distribution utility. In this respect, customers of a virtual microgrid receive electricity produced both by the local DERs as well as conventional grid-supplied electricity.[9] Virtual microgrids can be large, representing an entire distribution network. Virtual microgrids however, cannot island.

[6] E. Perea, J. M. Oyarzabal, and R. Rodríguez, "Definition, Evolution, Applications and Barriers for Deployment of Microgrids in the Energy Sector," *e & i Elektrotechnik Und Informationstechnik* 125 (December 2008): 433, http://www.springerlink.com.
[7] Peter Asmus, "No Rules, Only Exceptions with Microgrids," *Pike Research*, November 23, 2010, http://www.pikeresearch.com/blog/articles/no-rules-only-exceptions-with-microgrids.
[8] Steve Bossart. "Renewable and Distributed Systems Integration Demonstration Projects" (presented at the EPRI Smart Grid Demonstration Advisory Meeting, Albuquerque, NM, October 12, 2009), www.smartgrid.epri.com; Nikos Hatziargyriou, et al., *Microgrids: An Overview of Ongoing Research, Development, and Demonstration Projects* (Berkeley, CA: Lawrence Berkeley Laboratory, July 2007), http://eetd.lbl.gov/EA/EMP/emp-pubs.html; Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*.; Marnay, Chris. "U.S. Activities" (presented at Microgrids: Novel Architectures for Future Power Systems, Paris, France, January 29, 2010), http://www.microgrids.eu.
[9] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. S-1.

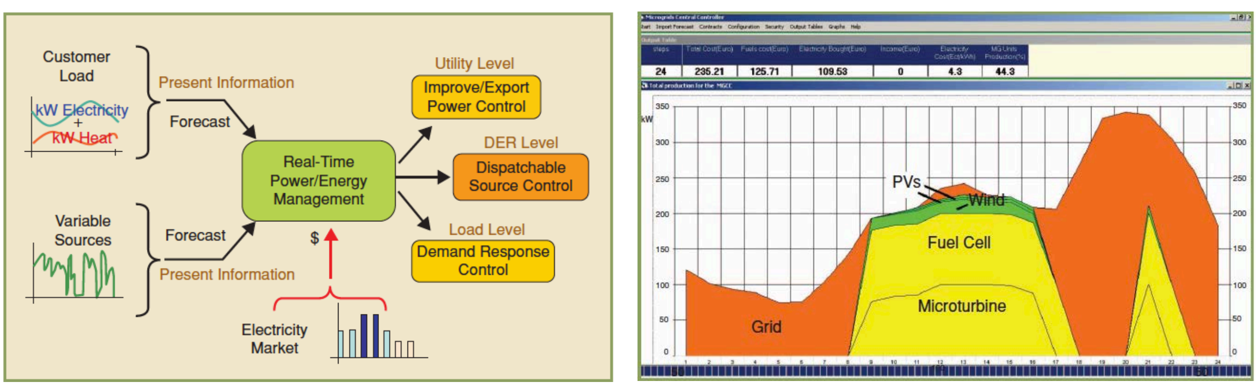
Controls

The complexity of managing multiple DERs with different characteristics and balancing their output with various end-use requirements (e.g. electricity, heat) while simultaneously interfacing with the macrogrid, requires microgrids to have specialized control systems. These essentially work to a) control the interface between DERs and the microgrid distribution network, b) control the interface between the microgrid and the macrogrid, and c) provide an information and communications platform through which DERs and loads can be coordinated. The latter two control mechanisms are more pertinent to the cases presented in this thesis and are therefore summarized here.

Physical microgrids interface with the macrogrid at a single point of common coupling (see Figure 1-2). In grid-connected mode, energy flows from the macrogrid into the microgrid distribution network in order to supplement electricity produced by onsite DERs. Therefore, this physical interconnection requires hardware that ensures that the energy injected into the network by DERs is synchronous with the grid and that no disruption risk or safety hazard is posed to the macrogrid infrastructure or utility line personnel.[10] Interconnection hardware also requires mechanisms that allow the microgrid to disconnect from the macrogrid and operate in island mode in a manner that does not significantly impact the microgrid's operations. To date, this has generally been be accomplished by circuit breakers disconnecting from the macrogrid while black-start operability allows the microgrid to ramp back up and operate autonomously, all within a matter of seconds. If the microgrid wishes to reconnect to the macrogrid, it must similarly shut down and reboot in synchronicity with the macrogrid.[11]

On the information and communications side, the microgrid is enabled with smart-grid technologies that allow for an accurate flow of information about DER characteristics and customer load in real time. Intelligent controls operating DERs and customer loads can respond to this information instantaneously, allowing microgrid users or a central operator to respond to a variety of system goals, including cost minimization, carbon emission reductions, or reliability targets.[12] Within the constraints of system goals, multiple inputs are considered such as the cost, intermittency and environmental impact of each DER, availability and capacity of controllable loads, price of utility power, weather forecasts, etc.[13]

Figure 1-3: A) Microgrid Energy Management System B) Daily Schedule for Microgrid DER Dispatch



(Source: Farid Katiraei et al., "Microgrids Management" 63)

[10] K. Twaite, "Monopoly Money: Reaping the Economic and Environmental Benefits of Microgrids in Exclusive Utility Service Territories," *Vermont Law Review* 34 (2010). 992.
[11] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. A-73
[12] Galvin Electricity Initiative. "The Value of Smart Distribution and Microgrids." accessed October 3, 2011. www.galvinelectricity.org.
[13] Farid Katiraei et al., "Microgrids Management: Controls and Operation Aspects of Microgrids," *IEEE Power and Energy Magazine* 6 (May 2008): 62, http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=4505827.

Figure 1-3A illustrates an Energy Management System (EMS) for a microgrid. In a centrally controlled microgrid, the microgrid central controller (MCC) will make decisions about optimal DER dispatch; in a decentralized system, each DER or customer load controller can make decisions independently and submit bids to a MCC. Figure 1-3B illustrates an example of the daily economic scheduling of 400-kW microgrid that includes a 100-kW microturbine, one 100-kW fuel cell, one 40-kW wind-turbine, and two 10-kW PV panels.[14] In this case, although the technical generating capacity of the DERs in the microgrid can meet its customers' daily demand, various input factors such as those listed above create a situation in which macrogrid power is utilized as well as onsite generation.

Functions and Potential Value Proposition of District Energy and Microgrid Systems

Depending on the technological configuration of a DE or microgrid, the system will provide various functions that may be of varying interest to stakeholders. While DE and microgrids are fundamentally different systems that are designed to provide different services, they share certain functions and potential value to customers. It is important to note that in the event that each system type produces both electricity and thermal energy, some of these shared functions pertain to the common use of cogeneration or waste heat recovery. Here, the shared functions and value proposition of DE and microgrids are first described, followed by functions and benefits that are specific to microgrids.

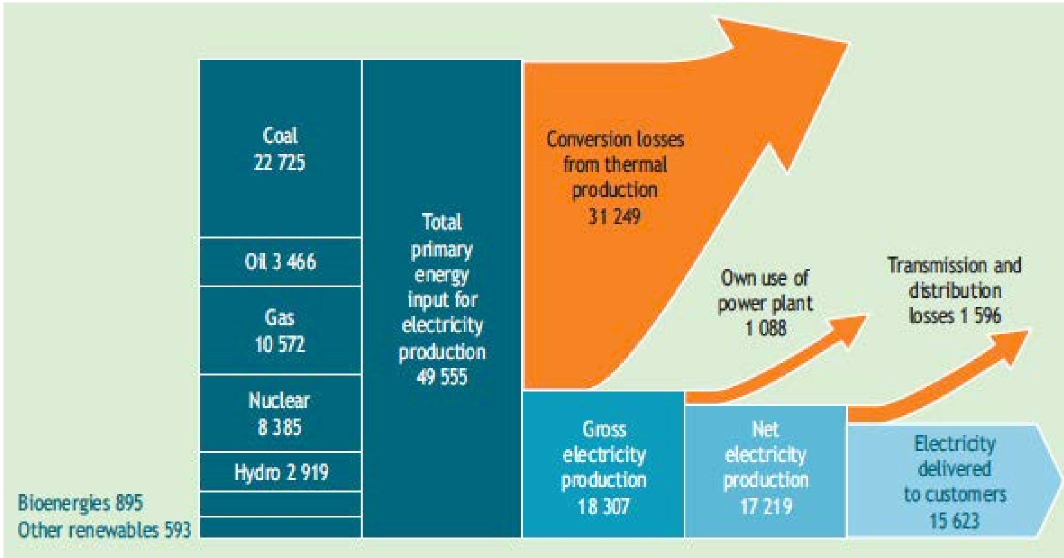
<u>Economic benefits</u>

There is a strong economic argument for DE and microgrid systems, primarily because they distribute energy significantly more efficiently than conventional alternatives, reducing the cost of supplying energy. This efficiency improvement is accomplished in several ways. District energy systems have lower marginal costs than multiple stand-alone thermal plants (e.g. individual base-building boilers and chillers) due to the economies of scale realized by centralized thermal plants. Secondly, stand-alone building thermal plants are frequently overbuilt in order to meet a building's infrequent peak heating and cooling demand and to provide redundancy in case a single boiler fails. This means that for the majority of the year, plants do not operate at their efficient load levels and cycle on and off more frequently, which reduces equipment life expectancy. Centralized plants that serve multiple buildings require less redundancy and can take advantage of the diversity of customer load profiles to provide a steadier stream of thermal energy. These systems can be 15 – 25% more efficient.[15]

Another major reason DE and microgrids distribute energy efficiently is because they generate energy close to the point of its consumption. On one hand, this allows for the use of heat, which is a useful by-product of electricity generation or industrial processes that usually is not captured. When waste heat recovery or cogeneration is employed in a DE or microgrid system, less fuel is needed to per unit of energy produced, bringing total primary energy conversion efficiencies to double or more than that of conventional large-scale power plants. CHP plants and fuel cells with waste heat recovery can achieve energy efficiencies of 80 – 90%.[16] For microgrids or DE systems producing electricity, a large portion of this efficiency derives from the consumption of electric energy in close proximity to the point of generation, avoiding transmission and distribution losses, which generally represent 8-10% of the electricity produced at conventional power plants (Figure 1-4).[17]

[14] Ibid. 63
[15] Compass Resource Managment, Ltd., *Neighborhood Infrastructure: Doing More With Less.* 6-7
[16] U.S. Department of Energy. "Fuel Cells." http://www1.eere.energy.gov/hydrogenandfuelcells/pubs_educational.html.
[17] Environmental and Energy Study Institute. "Fact Sheet: What Is District Energy?".

Figure 1-4. Energy Flows of Global Electricity Production



(IEA, *Cogeneration and Renewables*, 7)

Finally, through lowering primary energy demand and potentially sourcing local fuels such as biomass, municipal solid waste, or industrial waste heat to power cogeneration plants, fuel transportation costs may be reduced.

A second economic benefit of DE and microgrids is that they reduce the upfront capital costs associated with developing cogeneration and DERs through providing a platform upon which multiple users can share costs and risk. Low carbon-emission DERs used in DE and microgrid systems typically have high upfront costs and medium to long-term payback periods, depending on how they are financed. For real estate developers who do not manage their buildings over the long term, there is little incentive to integrate them with expensive DER technology. Meanwhile, individual property owners often cannot handle or are sensitive to these high upfront costs. DE and microgrid systems, on the other hand, allow a group of users to pool resources to share development costs as well as the benefits of paying less for energy and potentially generating revenues through sale of excess power.[18] There are also economies of scale and reduced costs realized through joint staffing for operations and maintenance, capital planning and strategic energy management services.[19] Alternatively, DE and microgrids often provide the scale attractive for a third-party utility that has longer-term investment horizons and can finance a system with lower-cost debt.[20]

The risk of installing a single DER on an individual building is also mitigated by spreading that risk over more users and by allowing technology diversification and flexibility. DE systems and microgrids deploy different technologies, some of which can use multiple fuel sources, providing an opportunity for arbitrage if certain fuel prices are high. This fuel flexibility provides energy resiliency to customers, and may potentially catalyze the development of local fuel sources, which keeps money circulating in the local economy, and provides communities with new economic opportunities and greater energy security.

DE systems and microgrids can also lower costs for electric utilities as well as their rate-payers. DE reduces electricity demand for air-conditioning and thus can reduce peak electric demand, allowing utilities to

[18] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. S-4
[19] C. Marnay et al., "Policymaking for Microgrids," *IEEE Power and Energy Magazine* 6 (May 2008): 67, http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=4505828.
[20] Compass Resource Managment, Ltd., *Neighborhood Infrastructure: Doing More With Less*. 8

avoid the costs of dispatching inefficient plants and overtaxing transmission and distribution infrastructure. This benefits ratepayers who are passed a large portion of these costs.[21] During a peak demand event, microgrids can similarly relieve stress on utility infrastructure through islanding, load shedding, or providing the utility with an additional source of power or ancillary services. In the long term, these actions may allow utilities to defer investing in additional generation, transmission, and distribution infrastructure, which both reduces their costs and benefits society through lower rates.[22] Finally, procuring power or services from DE systems and microgrids may be the most cost-effective way for a utility to meet reliability targets or mandates to purchase power from low-carbon generation sources.[23] Microgrids can also reduce the risk utilities face from integrating multiple DERs. Through aggregating and coordinating multiple DERs on a separate distribution network and employing special controls to interface with the macrogrid at a single point, microgrid interconnection shield utilities from DG interconnection risks.[24]

Environmental benefits

The improved electrical and thermal efficiency achieved by DE systems and microgrids through cogeneration, waste-heat capture, and lower losses also result in environmental benefits, primarily in the form of lower CO_2 emissions per unit energy produced.[25] Currently, two thirds of the global electricity production mix is lost as uncaptured heat, thus these emissions have no direct benefit to energy consumers.[26] This waste heat represents 28% of all energy related carbon emissions in the United States, which is roughly equal to the emissions from the entire transportation sector.[27] To the extent that DE or microgrids utilize zero-carbon emission technologies such as solar or wind, these systems further decarbonize the energy supply to their costumers. Finally, certain DERs utilized in DE and microgrid systems, such as CHP, may displace or reduce the combustion of fossil fuels that release other emissions such as NO_x, and SO_2.[28]

DE and microgrid systems also allow for the use of innovative low-carbon emission technologies that otherwise may be uneconomical for individual buildings or conventional power plants. For example, DE systems can provide adequate thermal energy demand to make geothermal energy or waste heat recovery from sewer systems or industrial processes economical.[29] The necessary proximity of DE plants to their customers also allows these systems to take advantage of thermal storage facilities. Microgrids, meanwhile, allow for the economical use of various electric storage devices that are designed to be coupled with smaller DERs, significantly increasing the ability of customers to rely on intermittent renewable energy resources.[30] Finally, the ability of DE systems and microgrids to defer investment in new transmission and distribution infrastructure has major environmental benefits from reduced land use impacts, wildlife disruption, and natural resource pollution.[31]

Security Benefits: Power Reliability and Quality

Microgrid systems offer a few more unique benefits to their customers through improving power reliability and quality. Power reliability refers to the secure, short-term availability of power. A black out or shock to the main utility grid results in a loss of power that is extremely costly to customers who rely on electricity as an essential good. To the extent that microgrids are able to disconnect and operate autonomously from the

[21] Environmental and Energy Study Institute, "Fact Sheet: What Is District Energy?".
[22] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. S-4
[23] Compass Resource Managment, Ltd., *Neighborhood Infrastructure: Doing More With Less*. 23
[24] Perea, Oyarzabal, and Rodríguez, "Definition, Evolution, Applications and Barriers for Deployment of Microgrids in the Energy Sector." 433
[25] Carolyn Gochenour. *District energy trends, issues, and opportunities: the role of the World Bank* (World Bank, 2001).
[26] International Energy Agency, *Co-Generation and Renewables: Solutions for a Low-Carbon Energy Future* (Paris, France, May 2011). 7
[27] Marnay et al., "Policymaking for Microgrids." 68
[28] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. S-7
[29] Compass Resource Managment, Ltd., *Neighborhood Infrastructure: Doing More With Less*. 23
[30] Marnay et al., "Policymaking for Microgrids." 68
[31] Sara Bronin, "Curbing Energy Sprawl with Microgrids," *Connecticut Law Review* 43,2 (December 2010): 554.

grid, they can provide reliable power to their customers. This is highly desirable for customers that operate what are called "sensitive loads" which may be either energy intensive equipment such as data servers, which are of high economic value to business, or critical care facilities, such as hospitals and emergency response systems.

Power quality, on the other hand, refers to the consistency and level of quality of electricity provided. Reduced power quality is caused by imbalances and deviations in power supply (e.g. specified voltage, frequency, etc) and can result either in loss of power or can wear down the devices receiving power. Despite the fact that not all electronic devices require the same level of power quality, power quality levels are standardized across power systems, and therefore reflect the highest level of quality required by devices currently in use. Maintaining the highest standard for power quality across the entire distribution network will be extremely costly as higher levels of quality are required for increasingly ubiquitous digital devices and sensitive loads such as data centers. Microgrids allow for the customization of power quality to different users according to their requirements at a price premium. As providing high quality power is increasingly expensive, allowing for "heterogeneous" power quality is more economical system-wide.[32]

Conclusion

Generally, district energy and microgrids can be described as systems combining discrete generation and distribution infrastructure to produce and distribute thermal energy, electricity, or both to designated buildings within a set geographic area. These systems draw energy from a diverse set of fuel sources and generation technologies, including waste heat, renewable energy, demand side resources, and energy storage. In the case of microgrids, these technologies can be aggregated and centrally controlled to match energy demand from a set of customers. District energy and microgrids confer multiple benefits over conventional alternatives, specifically that they generate and distribute energy more efficiently, leading to potential savings and reduced environmental impacts. Microgrids also provide a measure of power reliability to their customers through their ability to operate autonomously from the grid and can further tailor electricity to individual customers according to their power quality requirements.

As the previous sections illustrate however, the potential technology configurations for DE systems and microgrids are highly variable, as are the potential value propositions of these systems. While the technology configuration and subsequent value proposition are interdependent, they are also shaped by other factors, such as the climate, market conditions (e.g. electricity and fuel prices), and the regulatory environment (e.g. presence of renewable energy incentives or mandates). For example, if increased temperatures in a locality lead to a drought and subsequent increases in electricity demand for air conditioning or a loss of hydropower availability, microgrid development may become more desirable to electric utilities. Or, if policy makers enact a carbon tax, DE and microgrids may become profitable for private system developers. Thus, the local contextual parameters may also determine which set of stakeholders find DE systems and microgrids to be of the greatest value.

The next chapter considers how such parameters shape the local context and stakeholder interests within urban commercial districts. The chapter illustrates how district energy and microgrids may be highly desirable technologies for urban commercial districts but why they may be equally difficult to implement. Finally, the chapter will consider which organizational models are best suited to successfully implement DE and microgrid systems in the urban commercial district context.

[32] C. Marnay, *Microgrids and Heterogeneous Power Quality and Reliability*, (Berkeley, CA: Lawrence Berkeley Laboratory, July 2008), http://eetd.lbl.gov/EA/EMP/emp-pubs.html. 1-6

2. Organizational Models for Shared Energy Systems in Commercial Districts

Building district energy systems and microgrids is a complex undertaking, which is why they tend to proliferate in urban environments where that complexity is reduced. This chapter first considers the parameters that predominantly shape the complexity of developing shared energy systems in cities – urban development and energy regulation and market conditions. Their description is by no means exhaustive; it is meant to introduce key issues impacting DE/microgrid development that are most present in the case studies examined in chapters 3 and 4. Specifically, these sections illustrate how local regulation, energy markets, and diverse customer demand requirements for energy impact DE/microgrid project feasibility and economics. Potential organizational models for implementing shared energy infrastructure are then investigated to determine the potential options for responding to the conditions set by these parameters in urban commercial districts.

Local Energy and Urban Development Regulation

The local regulatory framework for energy generation and distribution is the most critical parameter influencing the technical configuration of a DE/microgrid system and the organizational model for its implementation. Energy regulation first and foremost determines whether ownership and operation of the supply and distribution of thermal and electric energy are the responsibility of single or multiple public and/or private actors, thus affecting the potential legality of a shared energy system. Where systems are allowed, regulation may shape the relationship between a DE/microgrid owner and existing energy utilities, potentially enabling or constraining system operability. Finally, energy regulation also may control the relationship between a DE/microgrid owner and its customers, impacting economic feasibility.

In an area where DE is not prevalent, building heating is generally the responsibility of individual building owners, who provide this service by purchasing fuel from a regulated gas or oil company and burning it in base-building boilers. Therefore a DE system essentially creates a new entity that continues to purchase fuel but replaces building owner responsibility for equipment, and creates a new thermal distribution network. DE systems are generally allowed by regulators, however the extent of regulatory control depends on how a DE entity is defined, in some cases according to its size and the number of customers it serves. DE systems must be sized to match customer demand for thermal energy and their economic viability depends on guaranteed levels of demand over time. Therefore, in some areas regulators require buildings to interconnect to the DE network.[1] In a location where customers have a choice of heat supply (e.g. individual base-building thermal plants versus hooking into a DE system), the ultimate success of the regulatory structure will be whether DE is cheaper for consumers than an alternative local heat supply. Additionally, other regulatory mechanisms may impact the viability of DE through rate setting, incentives for low-carbon fuels and clean energy production, or subsidies for customer interconnection.

Microgrids face a different situation. Since a microgrid generates and distributes electricity, it may be seen as a direct replacement for an existing electric distribution utility, which may have been statutorily granted an exclusive right to physically distribute and/or sell electricity in a specified area. This right is coupled with extensive regulatory control over utilities, therefore the primary regulatory issue surrounding microgrids is whether or not they should be considered utilities at all. This distinction substantially impacts political and economic feasibility of microgrid development as legal definitions may determine allowable size, number and type of customers, and technological configurations.[2] For example, some electricity regulators have suggested that for microgrids to operate legally, their

[1] International Energy Agency. "Energy Efficiency Policies and Measures: Heat Supply Act." accessed October 12, 2011. http://www.iea.org/textbase/pm/?mode=pm&action=detail&id=1212.
[2] Michael A. Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State* (Albany, NY: New York State Energy Research and Development Authority, September 2010), www.nyserda.org. 66.

owners must be the primary consumer of the onsite energy generation, not third party companies whose primary objective is energy sales. Or, multiple customers located in one building may share power generated onsite, but electricity may not be distributed to additional customers if it requires crossing a public right-of-way that has already been granted to a distribution utility.[3]

Like DE, other regulatory mechanisms may facilitate or disincentive microgrids through shaping their economic feasibility. Currently, regulations governing DG interconnection can make microgrids prohibitively expensive due to physical interconnection fees, exit fees, or standby charges, which require microgrid owners to reimburse the default distribution utility for making electricity available in case all microgrid DERs fail. On the other hand, these regulations may be crafted in a way that encourages the integration of DG and microgrids into existing distribution networks.[4]

In addition to energy and utility regulation, DE and microgrid systems must be integrated into the physical environments in which their customers are located, and thus are shaped by various other local regulatory bodies. While these are location specific, a scan of agencies in Portland that a DE entity must interface with is exemplary of general issues for both DE and microgrids in cities:

> *Permitting:* DE plants and other above ground structures must obtain a Commercial Building Permit and pay a Building Permit fee and Development Services fee to the Bureau of Development Services.
>
> *Zoning:* DE systems must fall under the zoning code of the area they intend to locate in. For Portland, this required a zoning amendment, but a DE system still may need to obtain a Conditional Use permit to expedite the zoning approvals process from the Bureau of Planning and Sustainability.
>
> *Franchising.* A franchise agreement that grants a DE system the authority to operate within designated boundaries must be obtained from, and a fee paid to, the Office of Cable and Franchise Management.
>
> *Right of way:* Gaining access to the public right of way (ROW) requires a DE system to obtain a Street Opening Permit from two separate offices of the Portland Bureau of Transportation and pay high permitting costs. The DE must also coordinate its distribution infrastructure schedule with the Portland Water Bureau (water supply infrastructure) and the Bureau of Environmental Services (sewer infrastructure).
>
> *Siting and Environmental Impact:* A DE developer must obtain various permits from the state Department of Environmental Quality.[5]

Thus, the physical form and overlaying regulatory definitions of urban neighborhoods also have significant impacts on the implementation of local energy systems.

Market Conditions

Market conditions on both the supply (energy market) and demand (customers/buildings) side also shape the technological configuration and organizational models for implementing DE and microgrids. On the

[3] D.E. King, *Electric Power Micro-grids: Opportunities and Challenges for an Emerging Distributed Energy Architecture* (Pittsburgh, PA: Carnegie Mellon University, 2006). 64.
[4] United States Environmental Protection Agency, Office of Atmospheric Programs. "Standby Rates for Customer Cited Resources." Accessed December 10, 2011. http://www.epa.gov/chp/state-policy/utility.html.
[5] Portland Sustainability Institute, *Streamlining Portland's District Energy Regulations* (Portland, OR, March 31, 2011), www.portlandonline.com/bps/index.cfm?a=349827&c=54886. 7-17.

supply side, energy prices or fuel costs may be affected by a multitude of variables, such as the energy supply mix in a region, or the condition of the transmission and distribution networks. For example, in Oregon, electric power is supplied in large part by hydro and is significantly cheaper than the national average, which may make a microgrid less economically attractive. In Connecticut, transmission infrastructure is severely constrained and electricity is very expensive, making locally generated electricity desirable.

On the demand side, the energy consumption patterns of buildings and the power reliability and quality requirements of tenants also determine the appropriate application of a DE or microgrid system. Where there is a large, steady and/or diversified requirement for thermal energy services or steam, DE systems become viable. Where there is a conglomeration of high-quality power users (e.g. financial firms) or critical facilities (e.g. hospitals), neighborhoods may be wiling to pay a premium to receive power from a microgrid. The physical composition of buildings and building systems also will determine the ability of buildings to economically hook into a DE or microgrid network as well as to take advantage of certain DER technologies. For example, two buildings may be far enough away from one another that the expense of building a thermal distribution pipe may increase their energy costs over what they would pay before hooking into a DE system. Alternatively, the density of a neighborhood may preclude the use of larger energy plants and instead favor the use of multiple, smaller DER technologies.

The Challenge of Implementing DE & Microgrids in Urban Commercial Districts

Considering the large range of contextual and technological parameters at play, building DE systems and microgrids is a complex undertaking. This is the main reason that they tend to proliferate in urban environments where that complexity is reduced, such as universities, hospitals, and military bases. These "campus environments" are generally characterized by having a single property owner, a single land-owner and often preexisting centralized thermal energy generation and distribution infrastructure. These characteristics can simplify the aforementioned regulatory and physical development complexities of building new, shared infrastructure in many ways. For a microgrid for example, all buildings on a campus may be considered one customer from the viewpoint of an electricity regulator and the streets on a campus may in fact be private, allowing for limited distribution networks to be built. Similarly for a DE system, a campus may not require the same level of local permitting to construct underground pipes. These types of institutions are also energy intensive users, which make them an excellent candidate economically for local energy infrastructure. While there are actually several DE systems in commercial districts, many of which are being modernized, fewer existing commercial districts in the United States are building or expanding new DE infrastructure today.[6] Meanwhile, microgrids in urban commercial districts are basically non-existent in the United States with a few small exceptions.[7] Industry experts expect that single-owner educational and medical campuses will provide the lion's share of growth in the global microgrid market over the next decade.[8]

Meanwhile, downtown commercial districts are also prime candidates for DE and microgrid systems. They have dense conglomerations of buildings, with a mix of uses, and large concentrations of businesses or facilities requiring high quality and reliable power such as financial services, data processing, telecommunications and bio-tech firms, hospitals and science research facilities. Thus, commercial districts have the thermal and electric load diversity, as well as desirable electric end uses, to successfully deploy DE and microgrids.[9] Nevertheless, the parameters circumscribing commercial districts are much more complex and the number of stakeholders infinitely more numerous. They have multiple, separately owned

[6] Compass Resource Managment, Ltd., *Neighborhood Infrastructure: Doing More With Less* (Portland, OR, November 2010), www.portlandonline.com/bps. 3
[7] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. A-4 & A-6.
[8] Peter Asmus, "U.S. Campus Microgrids Lead Despite Utilities," *Matter Network*, January 9, 2011, http://www.matternetwork.com/2011/9/us-campus-microgrids-lead-despite.cfm.
[9] Tanya Paglia, "Energy Improvement Districts and Local Energy Production" (research paper, Cornell University, January 2011), https://catalog.library.cornell.edu. 59

properties that abut public rights-of-way and host an even greater number of unaffiliated customers of legacy distribution utilities. Establishing a DE or microgrid system in a commercial district requires addressing local energy regulation, public right-of-way and franchise issues, as well as creating an organizational structure that allows for the involvement of multiple stakeholders in developing the system. The following section summarizes the range of potential organizational models for DE and microgrid development in order to point to appropriate models for commercial districts.

Organizational Models for District Energy and Microgrids

The literature on organizational structures for DE/microgrid implementation essentially describes four different models with respect to five different aspects of organizational roles and responsibilities: ownership, management, operations, rate-setting and financing. Given the characteristics of a commercial district, I emphasize the potential of a joint cooperative model, in which multiple customers share system ownership as well as other responsibilities. This includes a brief consideration of business improvement districts (BID) as a relevant precedent for joint cooperative organizations in commercial districts.

<u>Municipal or Private Utility</u>

A city government may choose to directly, or through a subsidiary, own, operate and finance a district energy system. The municipality may choose to take on one or many roles, for example the City may own and finance the system, while the system design and operation are contracted out to third-party firms. The municipality may finance the construction of the system through its own funds or partner with a private developer that is given access to low-cost debt.[10]

If the municipality also owns and operates an electric utility, it may also choose to design, own, and operate microgrids within its service territory as well. If the local utility is a private, regulated electric distribution utility, this utility may also elect to build and manage microgrids as a way of lowering system costs or providing customized power to specific customers in their network.[11] It may also allow individual customers to own DERs, which could be aggregated and controlled by the utility on its existing distribution network as a virtual microgrid.[12] Finally, a private utility may choose to build and operate a DE system that is powered either through utility-owned or private, third-party owned cogeneration equipment.

<u>Private Independent Provider or Landlord</u>

In this case, an independent, third party company develops, finances, owns and operates a DE system or microgrid.[*] This company produces and sells thermal and/or electric energy to multiple, unaffiliated customers who voluntarily join the network on a long-term contract basis (unless mandatory connection is set up). Generally, these contracts commit the building owner to purchasing energy from the independent provider, at competitive or reduced rates compared to their current costs for procuring energy from an alternative source. Independent providers generally finance projects through external debt financing, however they or their customers may have an equity stake in the projects, or projects may receive public subsidies.[13]

In a microgrid application, an independent provider model that served non-contiguous, unaffiliated customers would require a regulatory environment in which they could build a separate electric distribution

[10] Portland Sustainability Institute, *Development, Ownership & Governance Models*, (Portland, OR, March 2011). www.portlandonline.com/bps/index.cfm?a=349828&c=54886. 13
[11] King, "Electric Power Micro-grids." 60
[12] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. S-8
[*] Many of these companies are investor-owned utilities, however since they are not the 'incumbent utility' and may or may not be regulated in the various locations in which they build or acquire systems, they are considered here as private energy services companies, (ESCOs).
[13] Portand Sustainability Institute, *Development, Ownership & Governance Models*. 18

network that crosses public right-of-way/utility franchise areas. Alternatively, a landlord could own and operate a microgrid that served buildings or tenants only on his/her own, contiguous property. This "Landlord" model may be viewed separately from an independent provider for three critical reasons: first, the distribution network may not need to cross a right-of-way; second, the microgrid does not serve multiple, unaffiliated customers; third, the landlord may themselves be the primary consumer of energy produced onsite and the purpose of the DE system/microgrid may not be viewed as commercial profit.[14] University or medical campuses generating and distributing energy are examples of a landlord model.

Joint Cooperative

In a joint cooperative model, ownership and management of the DE system and/or microgrid is shared among the system's customers. In this case, buildings or businesses join together to build a system that serves their distinct thermal and/or electricity needs. Cooperatives are collectively owned and managed by representative stakeholders, such as a board comprised of anchor customers or public agency representatives. Customers also sign long-term service contracts with the cooperative. Cooperatives may employ multiple financing options, however profits are generally reinvested in system maintenance and expansion or returned to shareholders as dividends. Cooperatives may directly operate or contract out operations of a DE or microgrid system.[15]

Hybrid

As suggested above, any of these models may delegate the various responsibilities – ownership, operations, financing, rate setting, and management – to other entities, forming a hybrid model. In a hybrid model, public-private partnerships including municipal agencies, private companies, utilities, and/or community organizations may share these tasks. For example, parties may pool funding and form a joint venture that combines all system assets into a single entity with joint ownership and shared decision-making. Or, energy generation assets may be financed and owned by one party, while another owns the distribution infrastructure. Regardless of the ownership or financing arrangement, any owner may choose to contract out operations, maintenance, and capital planning for a system.[16]

Potential Organizational Models for Commercial Districts

When assessing the potential of these models for DE/microgrid implementation, it is necessary to consider the feasibility of each organizational entity to take on the roles of ownership, operations, finance, and management within the unique context of commercial districts. Therein, the independent provider, joint cooperative and hybrid models all seem plausible, while the municipal, utility, and landlord models appear less likely. Since the landlord model refers to a campus environment, only office parks with single owners would fall under this category. Municipalities or utilities may choose to develop a system in an existing commercial district, and there are examples of such DE and microgrids, particularly in cities with a municipal utility. However the literature on the United States suggests these are the exception rather than the rule, especially for physical microgrids.[17] For municipalities this is generally due to a lack of resources and expertise while for utilities it stems from a disinterest or discomfort with duplicative energy systems.[18]

Meanwhile, the independent provider model is geared toward serving environments like commercial

[14] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. S-8
[15] Portand Sustainability Institute, *Development, Ownership & Governance Models*. 28.
[16] Ibid. 22.
[17] Chad Comeault, *QUEST ICES Business Case: Southeast False Creek Neighbourhood Energy Utility* (Vancouver, Canada: Sauder School of Business, October 2011), http://isis.sauder.ubc.ca/research/carbon-management/quest-ices-business-case-southeast-false-creek-neighbourhood-energy-utility; Steve Bossart. "Renewable and Distributed Systems Integration Demonstration Projects" (presented at the EPRI Smart Grid Demonstration Advisory Meeting, Albuquerque, NM, October 12, 2009), www.smartgrid.epri.com
[18] Kevin Brake, Vihn Mason, and Development Manager of Portland Development Commission, interviewed by Genevieve Sherman, City of Portland, February 3, 2012;
Laure Aubuchon, telephone interview, March 9, 2012; King, "Electric Power Micro-grids."

districts. Independent providers see the economic profitability of inserting a more efficient energy generation and distribution system in a commercial district and convince building owners and businesses to sign long-term contracts that offer competitive or lower rates than their alternative. Independent providers have the resources to finance, own and operate systems. Therefore they assume all the upfront costs and financial risk associated with the system, while customers receive an economic, environmental, and/or reliability benefit.

This model may face resistance in commercial districts from incumbent utilities or energy regulators where they perceive independent providers as illegal. For example, if a regulator designates an independent microgrid owner as a utility, it could impose costs on that owner that it could not handle. Or if an owner is operating in the service territory of an incumbent utility, that utility may opt to legally defend its franchise rights, leading to insurmountable costs for the microgrid developer.[19] While an independent provider could avoid these issues through creating a virtual microgrid – aggregating DERs using the utility's distribution infrastructure – this would remove the power quality and reliability benefit of physical microgrids that may be desirable to commercial buildings and tenants.[20] Another characteristic of the independent provider model that may affect its feasibility for commercial districts is that it places management within one private organization that may not respond well to the interests of diverse stakeholders within a commercial district.

The joint cooperative model is also configured to manage DE/microgrid implementation in commercial districts. Commercial property owners and businesses may independently recognize the opportunities of having a DE/microgrid system in their district and wish to form a cooperative in order share decision-making over system design, operation, and the distribution of profits. Furthermore, the shared interests among commercial district stakeholders in having DE/microgrid capability, as well as the communication networks among neighbors, may provide a strong base for managing system implementation. The work of authors Sauter and Watson examining various studies on customer valuation of renewable energy, which like microgrids and DE represent a shift in energy supply, is instructive. They concluded that independent provider models are well suited to "play an essential role to overcome the absence of personal commitment…and a lack of knowledge amongst more 'mainstream' consumers'," due to its ability to both muster the resources to pay for upfront installation costs but also to market microgeneration to potential customers. Meanwhile, they found that cooperative models would provide similar benefits but with a higher potential for success since marketing provided by local organizations are considered more trustworthy by consumers.[21] Nevertheless, cooperative models may not have the necessary resources or technical expertise required to finance and operate systems.

Still, the arguments that local stakeholders desire control over projects with shared benefits, and that stakeholder organizations are successful marketers – are borne out in the experience of business improvement districts (BID). BIDs are a globally ubiquitous model for collective financing and management of programs and capital improvements in commercial districts. At their core, BIDs are privately run management organizations, which are led by a board of downtown stakeholders and self-funded. BIDs typically employ a special purpose vehicle, wherein properties and businesses in a district elect to voluntarily tax themselves to cover the cost of providing agreed-upon services within that district. Critically, BIDs are empowered by local legislation that both defines their legal status – setting geographical boundaries and determining mandatory participation – and articulates the mechanism through which stakeholders of different sizes and means define and carry out an equitable assessment proportional to their expected benefits. This special assessment is collected by local government and funneled to the BID organization, which is governed by those same businesses and property owners and run by their appointed representatives. This professional staff works with the BID leadership to carry out the activities BID stakeholders feel will improve the district and in turn benefit their own businesses and properties.[22]

[19] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. 23
[20] Shalom Flank, telephone interview, February 27, 2012.
[21] Raphael Sauter and Jim Watson. "Strategies for the deployment of micro-generation: Implications for social acceptance." *Energy Policy* 35, 5 (May 2007): 2777.
[22] Lawrence O Houstoun, *BIDs: Business Improvement Districts, 2nd ed.* (Washington, D.C: Urban Land Institute and International Downtown Association, 2003). 9

The first BIDs in the United States were responding to an alarming cycle of public and private disinvestment and subsequent degradation of urban downtowns. In an attempt to revitalize them, these BIDs formed on a platform of "clean and safe," employing private street cleaning and security personnel as well as implementing streetscape improvement programs to improve the quality of the district.[23] These new roles and practices taken on by downtown BIDs spread rapidly; the number of BIDs in the US in 1980 tripled by the end of the 20st century.[24] As the requirements for maintaining vibrant downtowns changed, BIDs have taken on far more expansive roles, from economic development, to streetscape design, to transforming commercial districts into 24-hour mixed use hubs. Throughout the evolution of BIDs however, the core proposition has remained the same. First, that providing services and capital improvements beyond what the public sector can accomplish is necessary to attract new businesses, tenants, shoppers and development, thus benefitting property owners, businesses, and employees through higher rents, tenant retention, higher sales, and safer, more enjoyable work environments. Secondly, that a privately led organization, governed by downtown stakeholders in partnership with the public sector, is the best mechanism for carrying out the vision of downtown stakeholders.[25]

While BIDs have not traditionally been used as vehicles for developing major infrastructure projects, they provide a precedent for a joint cooperative organization to develop DE or microgrid systems. First, BIDs are a successful collaborative organizational model among unaffiliated, in fact competitive actors in commercial districts. As one expert stated, "... [BIDs] required acceptance of something rarely considered in the competitive world of leasing space and selling goods and services – cooperation. The BID concept required those accustomed to market place rivalry to join hands and agree to universal and involuntary cost sharing and, for many, leadership sharing as well."[26] Second, BIDs are an example of multiple stakeholders acknowledging they share impacts of external factors, such as the degradation of the public realm, and taking responsibility for changing those circumstances in the place of agencies that otherwise would be responsible, such as city government. Finally, the proliferation of BIDs suggest that they are widely acknowledged by downtown business and real estate communities as an acceptable cost of doing business.

With respect to energy, this suggests that there is a precedent for real estate and downtown business owners moving away from the being passive customers of energy utilities and taking responsibility for the mode and manner of their energy consumption. As the reliability, price, and environmental impact of energy become more important issues for downtowns to attract and retain businesses, developing local energy infrastructure may increasingly be seen as an acceptable cost of businesses as well. As BIDs represent a shift in the roles and responsibilities of commercial building property owners and managers from passive recipients of services provided by an external agency to active participants in service provision, they may be willing to adopt certain roles normally played by utilities. Furthermore, as commercial stakeholders are already familiar with the BID model, it may be a useful platform to build upon to create a cooperative energy development entity.[27]

Conclusion

Energy and urban development regulation as well as market conditions for energy both impact the legal and economical feasibility of implementing DE and microgrids in commercial districts. Energy regulation dictates the legal relationships between DE/microgrid owners and their customers as well as with incumbent utilities. Energy regulation also impacts project economics through incentives for clean energy generation or

[23] Rick Williams and Sarah Heinicke, interviewed by Genevieve Sherman, January 31, 2012.
[24] Kevin Ward. "Entrepreneurial Urbanism and Business Improvement Districts in the State of Wisconsin: A Cosmopolitan Critique," *Annals of the Association of American Geographers* 100 (October 29, 2010): 1181. http://www.tandfonline.com/doi/abs/10.1080/00045608.2010.520211.
[25] Williams and Heinicke, interview.
[26] Houstoun, *BIDs: Business Improvement Districts*. 16
[27] Paglia, "Energy Improvement Districts and Local Energy Production." *57*

costly fees for interconnection and permitting. Urban development regulation impacts system design and phasing, which also changes project costs. Energy market conditions meanwhile, determine the current condition of energy generation and distribution in a locality as well as customer demand, creating potential incentives to build local shared energy infrastructure that is cheaper, more environmentally friendly, or more reliable.

Urban commercial districts are attractive candidates for DE/microgrid systems, however they present a complex environment for system implementation including multiple unaffiliated customers, local regulatory requirements, and potential resistance from incumbent energy utilities. Of the basic organizational models presented here, both the independent provider and joint cooperative are geared to respond to the unique opportunities and challenges of commercial districts. Independent providers see commercial districts as an economic opportunity and have the financial resources and technical expertise to develop systems. Meanwhile, cooperatives may have a management advantage in their ability to include diverse stakeholder interests in system design and operation as well as market new technologies like DE/microgrids to their membership. While a hybrid model could take many forms, it can draw from the strengths of these two organizational frameworks as well as public agencies and utilities.

These issues are explored through an analysis of shared energy systems in two commercial districts: a proposed district energy system in Portland, Oregon and a proposed microgrid in Stamford, Connecticut. Both these cases illustrate the extent to which a joint cooperative model verses an independent provider model were utilized by downtown stakeholders, and the benefits and constraints of each model when employed on the ground.

3. Shared Thermal Energy System in Portland, OR

In 2009 the City of Portland, Oregon launched an initiative to create EcoDistricts: geographically delimited areas in which district stakeholders organize to implement sustainability projects, including shared energy infrastructure. In 2010 the property owner and businesses leadership of the Lloyd District, one of the main commercial districts in Portland, joined with public stakeholders to pilot one of the first EcoDistrict organizations. Using the Lloyd Business Improvement District as its implementation arm, this EcoDistrict organization is planning multiple district-delimited energy and sustainability efforts. Concurrently, three of the EcoDistrict stakeholders who are clustered in a portion of the neighborhood called the Rose Quarter signed an agreement to build a pilot district energy system that will serve their properties. This chapter explores why and how the City of Portland and the Lloyd District are pursuing a district approach for developing shared energy projects. This chapter then describes the planned Rose Quarter district energy system and evaluates why those stakeholders ultimately chose not to pursue a joint cooperative model. Finally, this chapter considers how commercial stakeholders in the broader Lloyd district view interconnecting into a district energy system, and what implications these views hold for the future role of the EcoDistrict as a joint cooperative entity for developing shared energy infrastructure.

Portland EcoDistricts

The EcoDistrict initiative was launched by the Portland Sustainability Institute (PoSI) – a leading think tank and advocacy group – with the City of Portland and the governor in response to goals in the City's 2050 Climate Action Plan. An EcoDistrict is an organization that provides an institutional framework for enabling the successful implementation of district level sustainability projects, such as shared community energy infrastructure, and water, waste and green infrastructure projects. The initiative acknowledges that these projects tend to be implemented slowly because comprehensive municipal policy frameworks don't exist to enable them, nor do the institutional networks within communities. The 'EcoDistrict' concept hypothesizes that the neighborhood is the most effective level for scaling up sustainability initiatives and for developing organizations that can negotiate the complexity of implementing them; at this scale, Ecodistricts organizations can successfully aggregate users to the point where sustainability projects become cost effective. The City and PoSI advocated that this approach would benefit residents and property owners in the district through lower energy, waste and water costs while spurring economic development through providing sustainable product and services companies with a platform to launch district scale projects.[1]

The Lloyd District, located just opposite the river from Portland's downtown central business district, was designated as one of five pilot EcoDistricts (Figure 3-1). Even before its designation however, the Lloyd District served as a model for the EcoDistrict concept. The leadership of the major property owners and anchor businesses in the district are highly organized and have a history of collaborating around sustainability initiatives through creating cooperative organizations that design programs, build public-private partnerships, and develop innovative district-associated revenue streams. These initiatives have in turn improved the sustainability of the district and driven value back to its businesses, employees and the city at large.

Their organizing efforts to transform Lloyd from a car-oriented business district to one with robust multi-modal transportation options are exemplary. Initially, parking in the district was free and unrestricted leading to over three times as much parking as other commercial areas of Portland. While the City wanted to develop the district, the cost of providing additional parking to accommodate their employment forecasts was too high. As one stakeholder stated, "Without a change in development patterns, the district was destined to continue as a suburban enclave with low densities and inefficient use of available lands,

[1] Portland Sustainability Institute, *The EcoDistricts™ Framework: Building Blocks of Sustainable Cities*, (Portland, OR, June 2011), http://www.pdxinstitute.org/. 1-5.

which were being dedicated to parking."[2] Leaders in the district took action to reverse this trend, founding the Lloyd Transportation Management Association (LTMA) in 1994 and the Lloyd Business Improvement District (LBID) in 2000 to provide matching private funds. As a non-profit organization, the TMA created innovative strategies that drastically reduced car use in the district, reduced transit costs for employees, and garnered the TMA unique revenue streams, such as a commission on sales of transit passes and revenue from parking meters in the district that could be channeled toward future projects.[3]

Figure 3-1: Portland's EcoDistricts

(Source: Portland Sustainability Institute, "EcoDistricits")

While these efforts benefitted existing businesses and property owners through higher employee retention and decreased building vacancy, new development in the Lloyd District remained at a complete standstill. Meanwhile, the district contains several developable sites and could legally absorb three times the amount of floor area that currently exists.[4] As new commercial development ramped up in other neighborhoods of Portland and Lloyd remained stagnant, attracting major new development became the number one priority for the executive leadership in the district. From their experience, they knew that the tenant office market in Portland is very interested in sustainability and they believed this would drive the real estate market in the near future. Based on their successes with the TMA, they felt that fostering a sustainable environment would produce a brand for the Lloyd District that would attract new development and provide them with a competitive niche.[5]

In partnership with the city, the executive leadership of the Lloyd District produced an influential study called *Lloyd Crossing*, which looked at how energy, water, waste, habitat, and place-making strategies could lower operating costs and increase the value of properties within the district, while reducing

[2] Rick Williams, *Lloyd District White Paper*, (December 12, 2006), www.wsdot.wa.gov. 3
[3] Ibid. 1-3.
[4] Compass Resource Managment, Ltd., *Neighborhood Infrastructure: Doing More With Less* (Portland, OR, November 2010), www.portlandonline.com/bps. 41
[5] Rick Williams and Sarah Heinicke, interviewed by Genevieve Sherman, January 31, 2012.

environmental impact and improving desirability for residents and employees.[6] Despite great interest in the findings, financing for project recommendations floundered and the plan was largely shelved. When EcoDistricts launched however, PoSI and the City immediately approached the Lloyd District leadership as a natural fit for the initiative. The leadership felt more than ever that creating and branding a green district was a sound economic development proposal necessary to gain a competitive edge in the local and regional real estate market. Along with the City of Portland, the Portland Development Commission, the governor's office and PoSI – the EcoDistrict partners signed a 'Declaration of Cooperation' in 2010 for a three-year pilot to develop permanent governance structures and long-term financing options to implement an agreed-upon list of priority projects and activities of the district.[7]

The Lloyd EcoDistrict: Roles and Responsibilities

Despite the fact that the EcoDistrict Initiative is a publically driven process, the Lloyd EcoDistrict governing organization currently resembles a business improvement district in that the goals and priorities of the EcoDistrict stakeholders will largely be implemented through the Lloyd BID/TMA. This kind of locally controlled, cooperative organization is desirable among Lloyd stakeholders. The Lloyd District has a highly concentrated real estate market with roughly eight major property owners controlling over 70% of the value of the property in the district. Furthermore, these businesses have been a consistent presence in the district for over two decades.[8] Therefore the leadership behind the Lloyd BID has the largest stake in the value of the district and has remained relatively stable, allowing them to more easily establish joint priorities and goals. These stakeholders also prefer the BID model because they feel their priorities have not received adequate public support over the years. For example, though the district had been a tax increment financing (TIF) district since 1989, it was not lost on the Lloyd BID that significant portions of TIF revenues were funneled to new, burgeoning commercial districts while real estate development in the Lloyd District stagnated.[9]

When the concept for a Lloyd EcoDistrict was introduced, the real estate and business leaders felt strongly that the public sector was essentially advancing an idea they had already developed. The Lloyd BID agreed to participate on condition that they (e.g. the BID Board) have a significant amount of control over implementing sustainability projects as well as governing any entity that would shape the EcoDistrict in the long term.[10] The Lloyd BID stated that any future, long-term governing entity must "(a) [be] representative of the private interests involved in district formation, with public sector participation, (b) assure that new sources of funding are harbored in the district and (c) expenditure of sustainability resources funded through new mechanism is based on the direct involvement and priorities for sustainability established by the partnership".[11]

So far, the EcoDistrict organization has been set up as a special committee of the Lloyd BID comprised of the Lloyd BID leadership and staff, the City of Portland, the Portland Development Commission (PDC), PoSI, and Metro, a regional governing agency that is a major property owner in the district. The public agencies committed in-kind planning, technical assistance, and policy work to enable projects while the Lloyd BID put forth the lion share of funding to support a professional and dedicated staff member; roughly 10% from the BID assessment and 90% from a once-off donation from major property owners in the district.[12] Essentially filling the role of a BID manager, this Sustainability Director reports to the EcoDistrict Committee and will manage the priority projects of the three-year pilot through the Lloyd BID/TMA office. Currently, the Lloyd BID is a 501-(c)(6) organization with a 501-(c)(3) arm (the Lloyd TMA) that implements its

[6] Mithun Architects+Designers+Planners, *Lloyd Crossing: Sustainable Urban Design Plan & Catalyst Project*, (Portland, OR, July, 2004). 8
[7] Oregon Solutions. "Declaration of Cooperation: Lloyd District EcoDistrict Pilot 2010." accessed December 10, 2011. www.pdc.us. 1-2
[8] Williams and Heinicke, interview.
[9] Ibid.
[10] Lloyd District property manager, interviewed by Genevieve Sherman, February 3, 2012.
[11] Oregon Solutions, "Declaration of Cooperation: Lloyd District EcoDistrict Pilot." 5
[12] Williams and Heinicke, interview.

projects. If the Lloyd Ecodistrict is still desirable after the pilot phase, it will likely establish as a separate 501-(c)(3) entity or merge with the TMA to form a comprehensive sustainable economic development agency that is closely connected, both through funding, staff, and governance, to the Lloyd BID.[13]

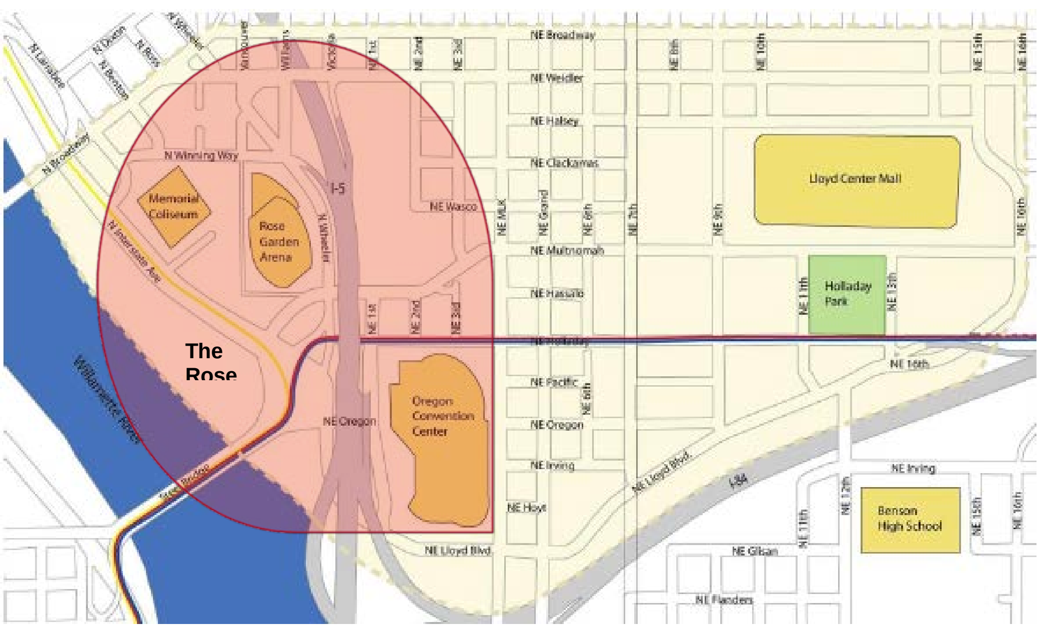
Rose Quarter Shared Thermal Energy System

In spite of the leading role private property owners and businesses are playing in the EcoDistrict, the first attempt to develop local energy infrastructure in the Lloyd district is being spearheading by the City of Portland and the PDC. These agencies and one private company, Portland Arena Management, are installing a shared thermal energy system (STES) – a district heating and cooling system – in the western portion of the district, the Rose Quarter (Figure 3-2). These stakeholders are pursuing the STES definitively through the single, independent provider model. The following section elaborates on why stakeholders chose this model for this particular system, considering each of the potential roles for an organization implementing energy infrastructure: ownership, operations, financing and rate setting, and management. The following section considers the implications of this set up for the potential of the EcoDistrict to act as a cooperative entity for developing shared energy infrastructure in the greater Lloyd district in the future.

<u>Background</u>

In addition to being a project contemplated in the *Lloyd Crossing* study, a goal of the City of Portland in their 2009 climate action plan is to pilot at least one district energy project.[14] During the same time as the Lloyd EcoDistrict stakeholder process, PoSI commissioned a high-level feasibility scan for district energy in Portland. This report found that the Lloyd District was a particularly good area and within it, the Rose Quarter was the most promising for the first node of a system.

Figure 3-2: The Lloyd District and the Rose Quarter



(Source: Portland Development Commission, *Request for Qualifications)*

[13] Naomi Cole, telephone interview, February 27, 2012.
[14] City of Portland and Multnomah County, *Climate Action Plan 2009* (Portland, OR, October, 2009), http://www.portlandonline.com/bps/index.cfm?c=49989&. 35

The Rose Quarter is comprised of the Oregon Convention Center (OCC) and two other event spaces – the Rose Garden (RG) and the Veteran's Memorial Coliseum (VMC) (Figure 3-2). The RG is home to the NBA Portland Trailblazers and the VMC hosts the Portland Winterhawks (a junior ice hockey team) as well as other events. The Rose Quarter was considered viable for several reasons: the large energy loads of existing facilities, the diversity of uses (and therefore load profiles) of those facilities and the proximal composition of the buildings. Furthermore, there were planned commercial and mixed use developments contemplated on the site in the near future that would significantly increase and diversify the square footage in the Rose Quarter, increasing the demand density for shared energy services.[15] Finally, the existing properties were planning either major refurbishments or routine replacement of heating and cooling equipment in the next five to ten years and had thermal distribution systems that were compatible with district energy interconnection.[16]

The Rose Quarter was also considered a good location because of the advantageous leadership and ownership structure of the facilities. The City of Portland owns the VMC while Portland Arena Management (PAM), a private company, owns the Rose Garden and its supporting offices. PAM operates both facilities, which also are on city-owned land and share underground parking facilities. The OCC meanwhile is owned and operated by a subsidiary commission of Metro Regional Government, a tri-county governing agency. The large public presence in this sub-district combined with a private company that is an acknowledge leader in sustainability practices form a tight knit group that has a history of collaborating on sustainability strategies. The Rose Garden recently completed a wide range of building efficiency strategies to become the first LEED Gold certified sports arena in the country in 2010. The OCC meanwhile, was the first convention center in the country to be LEED certified in 2003 and has reregistered and received this certification again at a higher standard in 2008.[17] The managers of both these facilities stated that their executive leadership pioneers sustainability strategies that others perceive as risky because they strongly believe sustainably operated facilities create critical environmental benefits, improve their bottom line, and drive value back to the community. They believe these benefits have been proven out and that this has become a brand for which they are well known.[18] Thus, in absence of a jointly operated organization, the political and social capacity for developing a shared energy system between these stakeholders was already in place.

At the time of this high level scan, the VMC was just starting to undergo planning for a major two-year renovation that included the need to replace both their boilers and chillers. Stakeholders realized they could capitalize on this opportunity to be cutting edge and pilot a district energy system[19] Since the VMC renovation schedule was driving the process, the Portland Development Commission – the agency charged with stewardship of the VMC – selected a private energy company, Corix Utilities, to complete a full feasibility study for developing a STES, which is now slated to be implemented by the end of 2012.[20]

Shared Thermal Energy System Concept Design

The feasibility study determined that a STES system for the RG, VMC, and OCC is cost effective under several physical composition and technology configurations. However the lack of government subsidies or grants combined with the interest of the Rose Quarter customers to maintain or lower their thermal energy rates made developing new capital-intensive infrastructure, such as a central generation plant, unfeasible. Considering also the short-term time requirements of the VMC renovation, Corix determined that the only

[15] Rose Quarter Development. "Rose Quarter Development Project Fact Sheet: Summer 2010." accessed May 19, 2012. www.RoseQuarterDevelopment.org

[16] Compass Resource Managment, Ltd., *Neighborhood Infrastructure: Doing More With Less*. 48

[17] Portland Development Commission, *Request for Qualifications: Shared Thermal Energy System for the Rose Quarter*, (Portland, OR: PDC, August 2011), www.pdc.us/RFQ-STES. 4

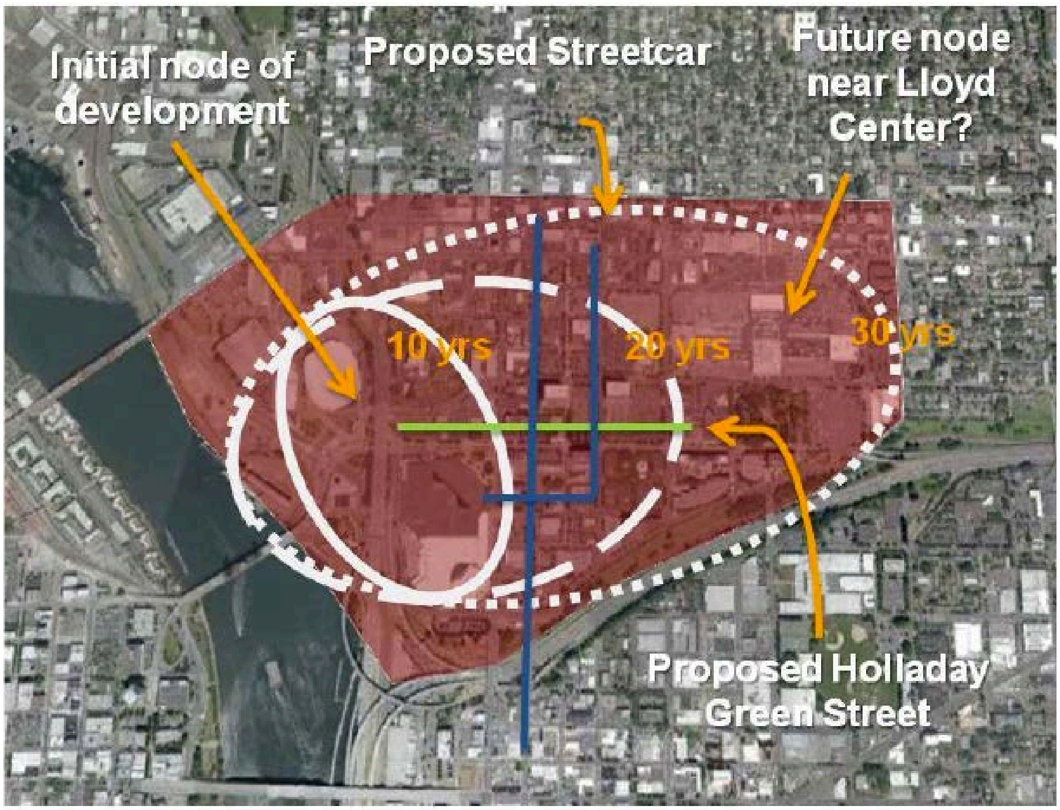
[18] Lloyd District property manager, interview; Brittin Witzenburg, interviewed by Genevieve Sherman, February 2, 2012.

[19] Kevin Brake, Vihn Mason, and Development Manager of Portland Development Commission, interviewed by Genevieve Sherman, City of Portland, February 3, 2012

[20] Portland Development Commission and Corix Utilities. "Memorandum of Understanding." December, 2011.

feasible option was to use and enhance the existing boiler and chiller capacity of the RG to service the VMC through a shared pipe. As a second phase, the central plant of the OCC could then also interconnect with this distribution system, increasing the overall efficiency of the STES network.[21] As existing heating and cooling equipment in the OCC and RG become obsolete, they would be replaced with more efficient equipment or a different technology that can either serve the existing loads more efficiently, improving rates for customers, or through maintaining costs and serving a broader portfolio of buildings.[22] Finally, in the long-term, new STES nodes may be developed in the greater Lloyd area that eventually would be connected together through a shared pipe network.

Figure 3-3: Phasing of Rose Quarter Shared Thermal Energy System



(Source: Compass Resource Management, *Doing More With Less*)

<u>Ownership</u>

All stakeholders in the Rose Quarter expressed a definitive desire for a private company to own the STES. The City originally wanted an ownership stake in a pilot district energy system to ensure greater transparency in the setting of rates and to protect future customers that would have to share their energy use information. Nevertheless, post 2008, the City of Portland did not have the up-front capital to develop or acquire district energy infrastructure and did not foresee taking on this kind of project in the near future. Moreover, neither the City nor PAM were interested in owning infrastructure that they did not have the capacity or technical expertise to operate. Finally, from the City's perspective, the fact that there are companies like Corix that develop, own, and operate district energy systems profitably, suggests that this is a healthy private sector industry that should be able to thrive without public ownership. The City wanted

[21] Lloyd District property manager, interview.
[22] Corix Utilities, telephone interview, March 5, 2012.

to demonstrate that there is a business model for district-level projects that can confer triple-bottom-line sustainability benefits, and that it is replicable because it requires little public investment. [23] Therefore, a privately owned STES provided the City and PAM an opportunity to remove assets from their balance sheets, while pursuing the broader shared vision of local economic development and environmental sustainability.

Another key reason the Rose Quarter stakeholders sought a private developer/owner it that it provided them with a greater sense of security that the system would be well cared for. Since operating the STES profitably for a certain time period is essential for an independent owner to recover their acquisition/development costs, stakeholders felt it was less risky if an independent provider maintained ownership of the STES assets. Furthermore, the City and other stakeholders have felt that since there are opportunities for a future development or expansion of the STES, those economies of scale would be easier to take advantage of under a single owner.[24]

Operations

Third-party operation of a STES would remove the control property owners currently exercise over delivering thermal energy services to their tenants. Landlords view the reliability and control over this service to be paramount, particularly in event spaces like the OCC or the VMC, which hosts an ice rink. Thus, the logistics of relinquishing control to an independent operator and structuring legal guarantees for reliable and timely service was the most important concern regarding shared energy infrastructure in the district across stakeholders. Primarily, the Rose Quarter stakeholders were concerned about what would happen in the event of a service disruption and what the relationship would be between the independent operator and their own building facility management staff. Nevertheless, provided those logistical procedures could be well articulated, stakeholders actually saw independent operations as an economic staffing benefit, since it removed their own facility staff's responsibility for capital maintenance and planning, which would free up time and resources for other tasks. [25] Furthermore, for the same reasons as those pertaining to ownership, stakeholders expressed confidence that an independent provider would operate a system reliably in order to ensure they deliver energy profitably. All in all, the City and the PDC were primarily focused on finding a good partner that they felt could build and operate many district energy systems in Portland.

Finance

Rose Quarter stakeholders were interested in third-party financing the STES for much the same reasons as they wanted an independent owner. First, companies like Corix can provide capital to finance a system without public incentives, which provides the City with an opportunity to achieve their goals of competitive or reduced rates for thermal energy services and reduced green house gas emissions at no additional expense.[26] Second, if an independent provider finances the system, they have a greater incentive to operate the system profitably to recoup their investment. Furthermore, private financing of a STES would allow the VMC to remove a mechanical system upgrade cost off the ledger of their renovation; rather than repaying the capital cost of replacing their chiller and boiler plant through energy savings over time, hooking into a DE system would remove VMC's upfront capital costs for replacement while keeping their thermal energy-related operating costs stable. As a major capital cost associated with their renovation, this is an immediate cost benefit to the City of Portland.

Indeed, without private financing, the Sustainability Coordinator for the OCC suggested that neither the VMC nor the RG and OCC would have implemented a district energy system. From her experience conducting long-term capital planning for energy improvements to the LEED certified convention center, she

[23] Brake, Mason, and Development Manager of Portland Development Commission, interview.
[24] Lloyd District property manager, interview.
[25] Witzenburg, interview.
[26] Portland Development Commission, *Request for Qualifications: Shared Thermal Energy System for the Rose Quarter.*

stated that individual property owners would likely not want to finance district energy because the upfront capital outlay is simply too large and the pay back period too long for their capital maintenace budget cycles, which typically only handle simpler projects with paybacks of five years or less.[27] Regardless, it was important for the public agency stakeholders of the Rose Quarter that the project require no financing or capital investment from any of the Rose Quarter partners in order to demonstrate a replicable model for implementing DE systems elsewhere in Portland without public subsidy.[28]

Rate Setting

Under the independent provider model, an independent owner-operator such as Corix Utilities would charge rates for thermal services to the STES. In the model proposed by Corix, rates would be based on a standard cost-of-service model, wherein the owner-operator is remunerated according to their costs. These would include the upfront capital costs associated with purchasing RG's thermal energy plant, installing new thermal generating capacity, and constructing a pipe to the VMC, as well as asset depreciation, a fair return on capital invested, and operational and commodity costs (e.g. fuel). As part of the feasibility study for an independently owned and operated STES, Corix will determine whether the business as usual costs (BAU) for the VMC and RG – costs they normally incur to install, maintain, and operate their stand-alone thermal plants – would be competitive with or lower than the costs of implementing the STES.

While the feasibility study and cost-benefit analysis are not available, the efficiency, capacity, and lifetime expectancy of the existing thermal plants and chillers at the VMC and RG indicate that the STES will be competitive with the Rose Quarter facilities' BAU costs. A high-level building energy analysis showed that if VMC were to replace its boilers and chillers with more efficient ones, it would reduce cooling requirements by over 40% and heating requirements by roughly 30%. Heat and hot water currently represent 50% of VMC's annual energy consumption while cooling represents 10%, so replacing existing equipment would provide a significant O&M savings.[29] Since the existing thermal plant of the RG has the capacity to serve the VMC with only a small addition of supplementary generation equipment, a large portion of these savings will likely be realized, yet offset by the new capital expense for constructing the pipe connecting the two facilities.

However, even if STES rates match Rose Quarter BAU costs for producing and distributing thermal energy, it is likely that over time the RG and VMC would achieve savings elsewhere in their budgets from deferring activities like capital planning and maintenance that are instead the responsibility of dedicated private utility employee. Finally, as the system grows, additional cost reductions may also occur through purchasing fuel in bulk, managing commodity risk through diversifying fuel sources, and connecting new load to the STES network. The introduction of waste-heat recovery or cogeneration could further improve the cost-efficiency of the system, lowering rates in turn for customers. Corix suggested that while regulatory bodies prevent private energy companies from operating systems that are not competitive relative to customers' alternative options, DE system rates do not typically follow a standard trajectory. Depending on the interests of the stakeholder they serve – for example to use greener fuels or expand a network to serve new customers – DE systems are continually adding new costs that are passed through to ratepayers. For example, the Rose Garden and the OCC already pay for carbon offset credits, which are embedded in their BAU costs and can be compared with the environmental cost efficiency of DE.[30] The Rose Quarter stakeholders will not pursue the STES if rates are expected to be higher than their BAU. The OCC suggested that if the first phase could prove out a stabilization of rates, that alone be viewed as a benefit even if there were no drastic reduction.[31]

[27] Witzenburg, interview.
[28] Brake, Mason, and Development Manager of Portland Development Commission, interview.
[29] Portland Development Commission, *Request for Qualifications: Shared Thermal Energy System for the Rose Quarter*. Attachment E: Veterans Memorial Coliseum – Potential Energy Conservation Measures. Attachment F: Rose Garden Arena Analysis – Excerpt of 2009 Green Building Services Energy Analysis
[30] Corix Utilities, telephone interview, April 5, 2012.
[31] Witzenburg, interview.

Management

Managing the process of taking a district energy system from concept to completion requires a set of actions, from championing the technology, to convening potential customers, conducting high level cost-benefit analyses, vetting private developers, and various other tasks. While many of these roles could be played by a collaborative organization such as the EcoDistrict, the process for the Rose Quarter STES was largely managed by the City of Portland and the PDC with technical assistance from PoSI and Corix Utilities. In part this is because the Rose Quarter process preceded the formation of the EcoDistrict, however in the case of the Rose Quarter stakeholders, the physical and management proximity of the buildings and their facilities staff as well as a long history of collaboration was adequate to suit this purpose. The following section explores how the EcoDistrict entity may serve this and other roles described above if the STES were to expand out of the Rose Quarter or if new DE nodes were created within the broader Lloyd District.

Expanding into the Lloyd District: Feasibility of the Cooperative Model and Potential Roles for the EcoDistrict

Despite the fact that district energy in the broader Lloyd District was conceptualized in the *Lloyd Crossing* study, it is not currently one of the priority sustainability projects on the EcoDistrict roster for the initial pilot phase. Nevertheless, if shared energy systems are developed in the district in the future, the model used by the City, the PDC, Metro and PAM in the Rose Quarter will serve as a precedent. The stakeholders in the broader Lloyd district differ from the Rose Quarter however – they include a greater proportion of private commercial owners and the headquarters of two electricity companies. While these stakeholders recognized immense value in local energy infrastructure, they also associate it with multiple risks that color their views toward interconnecting into a shared system. The following section evaluates how these stakeholders view the independent provider model utilized in the Rose Quarter and to what extent the EcoDistrict may act in the future as a joint cooperative entity for developing shared energy infrastructure in the greater Lloyd District.

Property Owner Perceptions of Risk

Commercial property owners and businesses in the Lloyd District perceive many risks associated with independent, third-party ownership and operation a of shared energy system. One major concern is removing thermal energy generating equipment in their buildings. Property owners consider a building's energy plant as a basic component of their property they invest in to provide a service to their tenants. Owners are concerned about the impact of privately owned district infrastructure on the value of their properties. Essentially, while a property owner hooking into a district energy system would save capital in the short-term through avoiding the purchase of new heating and cooling equipment, does removing the energy plant impact the value of the building or create a barrier to resale? Alternatively, it may enhance property values and accelerate a sale.[32] Property owners in the district were equally concerned about relinquishing control over delivering thermal energy to their tenants to an independent operator. More specifically, they perceived the risk of a service interruption as a 'loading order' issue wherein the independent operator would have to make a decision about which customers within the DE network received services first. Finally, commercial stakeholders were worried they could become captive customers of an unregulated, third-party energy company with little control over their energy costs over time.

To mitigate these risks, property owners suggested they would want to exercise a greater deal of control over the interconnection of their property to a shared energy system. It is a possibility that property owners in the Lloyd district would seek an ownership stake in some portion of a DE system (for example, maintaining ownership of generation infrastructure) or would consider a joint ownership structure among multiple property owners. From Corix's perspective, full ownership of the assets they operate is not a necessity; in cases where private ownership may burden customers, Corix has operated under a concession

[32] Wade Lange, interviewed by Genevieve Sherman, February 3, 2012.

model where they have an exclusive right to maintain and operate separately owned assets. Corix owns DE infrastructure because customers have no interest in owning it themselves. However, Corix stated that joint ownership occurs in projects where customers have an equity stake in the infrastructure either to maintain some level of control or to make a long-term investment. That said, Corix warned that customer ownership becomes onerous once there are more than one or two property owners involved.[33]

The perception of a 'loading order' risk in a DE operations is a bit of a false analogy since the cause and location of a breakdown in the system would dictate which customers lose service; for example, a pipe break between a central plant and one branch of a distribution network would necessarily adversely impact those customers and not others. District energy also has a solid reliability track record (the reliability rate is over 99%) and service disruption risk can be mitigated through building in redundancy, co-locating generators within buildings, or employing frequent professional maintenance.[34] While the Rose Quarter stakeholders felt the overall reliability risk in the STES was no different from what they currently face with the gas utility network, commercial property owners suggested that if they were to hook into a district energy system, they may require redundant heating and cooling equipment as well as retaining their own maintenance staff.[35]

Risk surrounding rates and energy service agreement contract language may be mitigated through the successful implementation of the Rose Quarter STES. Since the Oregon Public Utilities Commission (PUC) has few precedents for the Rose Quarter, it will likely employ 'light-handed' regulation over its owner and operator, meaning the independent provider will not be fully regulated, but its contractual service agreements with customers will be subject to PUC review. Thus, it is unlikely that customers of an independent DE system will be treated in any manner deemed unfair by the PUC and their costs will remain competitive. Customers will absorb costs associated with system expansion or stranded assets (from lost demand), however only to the extent deemed fair by the PUC in approving the independent provider's cost remuneration.[36] In addition to PUC oversight, another independent body, such as the EcoDistrict, could act as a watchdog on behalf of STES customers within its boundaries.

Driving Value to the Lloyd District

Commercial property owners individually shared Rose Quarter stakeholders' disinterest in financing district energy and preferred the private financing model.[37] However, based on their past difficulties courting new development to the district, the Lloyd leadership felt strongly that local sources of financing would be necessary to implement DE in a cost attractive manner that would drive new investment in the district. Owners and the Lloyd BID advocate for some form of joint financing. Similar to their view on ownership, having a financial stake in shared energy infrastructure would allow commercial owners a platform for exercising some control over the system development. For example, owners could provide funds dedicated to installing new distribution infrastructure in particular areas of the district they wanted to develop. Or, they could direct shared funds into a pool for lowering interconnection costs in order to provide a general financial incentive for development to take place in the Lloyd District.[38]

They felt that such a joint funding effort should be spearheaded by a cooperative governing entity, such as the Ecodistrict or the Lloyd BID. Since the efforts of the EcoDistrict are intended to drive investment to the area, the Lloyd BID suggested that increased revenues to the City from new development should go the EcoDistrict entity to support future projects. They suggested that if the EcoDistrict survives its three-year pilot, the City should negotiate with the EcoDistrict leadership to designate new revenue streams. Currently, the Lloyd BID is legally able to float bonds but the annual assessment from the district is not large enough to pay overhead costs. The TIF district is sunsetting next year, so it will also not be available to bond

33 Corix Utilities, telephone interview.
34 Ibid.
35 Lange, interview.
36 Corix Utilities, telephone interview.
37 Williams and Heinicke, interview.
38 Lloyd District property manager, interview.

against to finance new infrastructure. Since DE is so capital intensive, the Lloyd BID and owners have suggested that system development charges, normally paid by property developers to the City for the provision of infrastructure, should be funneled to the EcoDistrict, which they can bond against to finance new DE nodes. Alternatively, the Lloyd BID members renew their voluntary assessment every ten years, and they may choose to increase the assessment in order to finance EcoDistrict projects. However it is more likely an increased assessment used for DE would be employed to lower interconnection costs for businesses or to lower the costs for a private independent owner who can then pass that benefit on to customers.[39]

Managing the Implementation Process

While the Rose Quarter stakeholders required little external organizational support to implement the STES, the Lloyd District would require a cooperative organization like the EcoDistrict to manage the process of implementing DE in the greater district. Lloyd commercial property owners and anchor businesses are accustomed to working within the structure of a BID wherein they convene to make decisions and an organization representing their interests acts on their behalf.[40] In the Lloyd district, the Lloyd Executive Partnership has traditionally provided this "forum" while the implementation mechanism for joint decision-making among the Lloyd CEO leadership is the Lloyd BID.

The BID management also has expertise that helps guide decision-making among the district leadership. As the BID director stated "only we can convince business owners to change the way they're doing business," pointing to the two years of negotiations the Lloyd BID instigated to convince property owners they needed to hire and pay a full time sustainability director.[41] The staff of the Lloyd BID and TMA are trusted experts on policy, finance, and innovative program design for non-motorized transportation because they understand goals and interests of both public agencies and private owners and businesses. For Lloyd to become a sustainable district, its leadership required a dedicated representative with technical expertise in energy, water, and waste planning that could understand their interests and navigate projects for them.

The Lloyd BID has stressed that for a DE system to be implemented in the Lloyd District, decision-making about the appropriate ownership, operating, and financing model must be viewed as a privately driven process. The hiring of a dedicated Sustainability Director for the EcoDistrict is a significant step in this direction. As an example, one of the first projects the Sustainability Director is spearheading is a commercial building retrofit program that will benchmark energy consumption of all major properties in the district and then develop a specially tailored retrofit program. In the event that they pursue a performance contract with an independent energy efficiency provider that aggregates multiple retrofits into one contract, the EcoDistrict will act as an owner's agent – submitting RFQs, reviewing contracts, and monitoring project delivery. These are key management roles it could play for implementing DE.

Corix agreed that having a local organization that represents multiple customers is critical for implementing shared energy infrastructure at a district scale. They view organizations like the Lloyd BID or the EcoDistrict Board as crucial entities that foster the environment in which district energy can thrive. Beyond acting as an agent for anchor properties and businesses, these entities have influence over and insight into the politics of a community, and can spearhead efforts that enable DE – such as lowering interconnection costs for new customers.[42] Having the addition of staff with technical knowledge about how energy fits into the business models of their members (i.e. how district energy may impact their bottom line) eases negotiation between a private provider and property owners. This entity may also play a direct role in outreach and marketing to new potential district energy customers.

In any cooperative management entity, the City will still have to play a significant role. The City and PoSI suggested that in most cases in Portland, PDC would be best suited. City-wide, the PDC has the closest ties

[39] Williams and Heinicke, interview.
[40] Lange, interview.
[41] Williams and Heinicke, interview.
[42] Corix Utilities, telephone interview.

to property owners and acts as the predevelopment consultant for greenfield developments – convening city agencies, utilities, and land owners around planning the implementation of streets, water, waste and transportation infrastructure. A next logical step is negotiating the outlay of district energy systems, and the PDC is currently fulfilling this role in other neighborhoods. Still, given the politics and history of the Lloyd District, PoSI stated that the PDC should play a back seat as the stakeholders are more receptive to business to business conversations and see the BID as a credible and trusted negotiator. [43] Even if the EcoDistrict entity drives a DE process, the City must still enable DE through approving franchise agreements and permits. Therefore, while there are clearly some adversarial relationships, both the City and the Lloyd BID/EcoDistrict have critical and complementary roles to play toward managing the process of enabling shared energy infrastructure.[44]

Conclusion

The Rose Quarter STES will serve as a precedent for how future DE systems may be implemented in the broader Lloyd District. Since it developed outside of the EcoDistrict process however, its implementation model does not currently fit all the requirements of commercial properties and businesses in the greater district. The interests of the Rose Quarter stakeholders differ in some significant ways from the broader commercial owners in the Lloyd District. The Rose Quarter stakeholders were primarily interested in the environmental benefits of DE and wanted to take a risk as first movers to test the efficacy of privately owned, operated and financed DE; the City in particular was less concerned with rate decreases as they were with getting a project in the ground at no upfront cost. These interests mesh well with the business model of an independent provider. Meanwhile, commercial stakeholders in Lloyd insist on having a significant amount of control over sustainability project implementation. They are uncomfortable with third party ownership over thermal energy generating equipment either within their buildings or a central plant and similarly they would not want to completely relinquish control over operating these systems to third-party maintenance staff. They are also concerned about the resale of buildings interconnected to DE and long-term contracts with third-party energy providers. Langley, the developer of the forthcoming Superblock project in Lloyd, said that the evolution of the Rose Quarter STES may illuminate certain advantages or disadvantages of the technology, however its success will not dictate the process for other owners.[45]

DE fits with commercial stakeholder goals to implement projects that offset the cost of new development through efficient and environmentally friendly resource provision and it reinforces a brand of district-scale sustainability. However, it is not currently a priority project for the EcoDistrict pilot phase, so it remains to be seen whether the EcoDistrict governing organization could act as a cooperative organization for implementing DE projects. The most important role the EcoDistrict can play in the near term will be investigating technology, legal, and financial options for DE implementation that address these concerns – for example vetting language for "collapsible contracts" that would allow owners to opt out of a DE system at point of building sale through paying an exit fee. Moreover, the EcoDistrict can educate commercial stakeholders about the technological functionality and potential value of DE to their properties and the district. Beyond these management roles, it is unclear the extent to which commercial stakeholders would want to utilize the EcoDistrict as a cooperative entity for shared energy system development. It seems very unlikely that the EcoDistrict will operate or own shared energy infrastructure.

However, it is interested in developing innovative financing models that draw collectively on district resources. Commercial stakeholders feel strongly that they must have a financial stake in district projects in order to guide the future development of the district. They are interested in utilizing the BID assessment for EcoDistrict programs, which in the future could include a fund to lower DE interconnection costs, and they want value from new development in the district to be funneled back to the EcoDistrict entity. Innovative financing models that involve public funds like developer charges require negotiation with the City as well

[43] Cole, telephone interview.
[44] Corix Utilities, telephone interview.
[45] Lange, interview.

as careful planning to time revenues and DE system expansion correctly.[46] While the City currently feels there is an evident business case for private financing, they are not opposed to stakeholders in the Lloyd District developing and employing new financing models, and are ready to help EcoDistricts reach project goals through financing if funding gaps are reasonable and public funds absolutely necessary.[47]

Therefore, it is possible that commercial stakeholders in the greater Lloyd District will pursue a hybrid model that includes joint ownership, operations, and finance between an independent provider and individual property owners. The EcoDistrict could act as an owners' agent – convening customers, gathering project information, writing RFQs, vetting contracts – and may pool resources to lower project costs or increase owners' equity. While the success of the independent provider model at the Rose Quarter may ultimately shape these decisions, it seems then that a better precedent for the feasibility of using the EcoDistrict to facilitate DE will be its success in galvanizing district stakeholders around other energy projects – such as an energy efficiency program – in the next few years.

[46] Cole, telephone interview.
[47] Brake, Mason, and Development Manager of Portland Development Commission, interview.

4. Energy Improvement District: Stamford, Connecticut

The state of Connecticut recently passed legislation allowing for the establishment of district-delimited organizations called Energy Improvement Districts (EID), which provide a framework and platform for property owners and businesses to share in the costs and benefits of establishing shared energy infrastructure. Like its cousin the Business Improvement District (BID), an Energy Improvement District (EID) is at its core a geographically delimited area within which businesses and properties are empowered with unique tools to implement local energy projects. The City of Stamford was one of the first cities to establish an EID for its downtown, which is home to many premium power users – businesses that operate expensive equipment, data centers, or 24/7 trading floors – requiring high quality, reliable power. This chapter first explores why both the state of Connecticut and the City of Stamford support EIDs and the development of local energy infrastructure. This chapter then describes the planned pilot microgrid for Stamford's Government Center and evaluates why the prime stakeholder, the City, chose not to pursue the joint cooperative model as allowed for by the EID. Finally, this chapter considers how private stakeholders view interconnecting into a microgrid, and what implications these views hold for the future role of the EID in Stamford.

Energy Improvement Districts

In 2007, Connecticut passed Public Act 07-242 to help remedy severe problems with Connecticut's electric generation and transmission infrastructure that are causing high-energy costs, frequent brownouts, congestion issues, and long-term capacity concerns. Connecticut has the highest electricity rates of any state in the continental US, averaging over 17 ¢/kWh, which is roughly 74% above the national average.[1] Demand growth has outpaced the expansion and maintenance of transmission infrastructure, while the state has a local generation capacity shortfall of 700 MW.[2] Addressing these issues at the traditional generation and transmission scale is costly and slow, since newly constructed plants take time to come on line and siting new plants or transmission facilities is politically difficult to implement.[3] Therefore PA 07-242 pushed for the development of alternative energy resources such as energy conservation, energy efficiency, and distributed renewable energy that can remove demand pressure from the grid and supply local sources of energy in demand-heavy areas. In particular, the Act classified on-site cogeneration and waste heat as alternative energy resources, which are core technologies used in local energy systems.

Critically, the Act also established EIDs as legal entities in order to facilitate implementation of distributed generation in key areas of the state. The transmission network in southwestern Connecticut is particularly constrained, creating the need to run less efficient plants in that region more frequently, the high cost of which is passed on to ratepayers. Furthermore, the aging distribution infrastructure in southwest Connecticut causes significant energy reliability problems in the communities that require the greatest amount and quality of energy. These communities consume nearly 50% of all electricity in the state and host many of the state's main commercial centers, whose electricity intensive financial firms and bio-tech industries require high quality, reliable power.[4] Southwest Connecticut is recognized as one of four problem areas for electric reliability due to frequent brownouts and blackouts. In 2011, Connecticut suffered two major storms within months of one another that each left more than 800,000 customers without power for more

[1] Kevin McCarthy, *Connecticut's High Electric Rates and the Legislative Response*, (Hartford, CT: Office of Legislative Research, January 20, 2010), http://cga.ct.gov/2010/rpt/2010-R-0015.htm.
[2] Michael A. Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State* (Albany, NY: New York State Energy Research and Development Authority, September 2010), www.nyserda.org. A-59.
[3] Mike Freimuth and Guy Warner. "Progress Report on CHP Development in Stamford" (September 19, 2011). accessed February 14, 2012. http://www.epa.gov/chp/documents/wbnr111909_stamford_presentation.pdf.
[4] Ibid.

than nine days.[5] These events are costly enough to premium power users that they may relocate, threatening cities' tax base. Legislatively establishing EIDs provided the organizational, financial, and political means for city governments and commercial stakeholders in these areas to lead the implementation of alternative energy systems.

The Connecticut EID Law: Roles and Responsibilities

EIDs equip property owners to share roles and responsibilities of implementing alternative energy systems. Under the terms of 07-242, EIDs and their geographical boundaries are established by vote of a municipality's legislative branch. Participation in the EID is voluntary however, and any existing or new owner may opt out at any time. EIDs are administered by a board that is appointed by the mayor and that serves without compensation. EIDs must lead a comprehensive planning process to develop and finance distributed energy resources (DERs). The size, technology choice, and configuration of these DERs are at the discretion of the EID but cannot exceed 65 MW. It is allowed and encouraged to develop DERs through ownership, leasing, operating and/or financing directly or via subcontracts with public or private partners.

EIDs are provided several means to finance projects. They may issue revenue bonds to finance DER acquisition or construction and they can fix rates and/or collect fees from leasing DERs to recover the full cost of energy provided by DERs. The scope of costs that may be recovered through rates and fees are detailed in PA 07-424, however they are not subject to regulation by any department or agency of the state.[6] Municipalities may also sell, lease, grant or convey its land to the EID, which may be necessary for building new distribution networks.[7] EIDs may also lend owners or businesses money to develop their own DERs. Finally, EIDs may directly operate DERs and hire staff toward this end, or any other EID purpose, or it may contract out for services. It is important to note that EIDs are not authorized to be an electric distribution company or a municipal electric utility.

There are a few key differences between Connecticut's EIDs and BIDs as cooperative organizations that merit noting here. First, while BIDs, like EIDs, are empowered through state lawmakers, local BID designation, leadership and activities are not governed by public agencies. In Connecticut, local lawmakers establish EIDs and their leadership is appointed by the mayor. BIDs, on the other hand, generally require a majority vote of district owners or businesses to become established and they are governed by a self-elected board. Another key difference is that participation in a designated EID is not mandatory, where membership in a BID is generally mandatory. This is because BIDs are established around a collective, dedicated revenue stream that must be spent on mutually beneficial projects.[8] EIDs are allowed to charge and collect fees, however only as payment for services rendered to energy customers. Without a dedicated revenue stream or mandatory requirement for owners or businesses to participate in alternative energy systems, it may be prohibitively risky for an EID to develop, own and operate local energy infrastructure without support from municipal or private partners. Finally, while EIDs are allowed to hire dedicated staff, without a source of working capital, they will likely be run by their Board leadership, which serves without compensation. One of the most frequently cited reasons for the success of BIDs are that they are run by private managers and this may also be critical for the ability of an EID to operate as an energy system development entity.[9]

[5] Joe McGee, et. al., *Report of the Two Storm Panel* (CT, January 2012), www.ctsprague.org/two_storm_panel_final_report.pdf. 8
[6] An Act Concerning Electricity and Energy Efficiency (2007), Connecticut General Statutes: Chapter 585, Sec. 32-80, http://search.cga.state.ct.us/dtsearch_pub_statutes.html.
[7] Kevin McCarthy, *Energy Improvement Districts*, Research report (Hartford, CT: Office of Legislative Research, November 30, 2007), http://www.cga.ct.gov/2007/rpt/2007-R-0672.htm.
[8] Lawrence O Houstoun, *BIDs: Business Improvement Districts, 2nd ed.* (Washington, D.C: Urban Land Institute and International Downtown Association, 2003). 10
[9] David Feehan, *Making Business Districts Work: Leadership and Management of Downtown, Main Street, Business District, and Community Development Organizations.* (New York: Haworth Press, 2006), 13.

The Stamford EID

Stamford passed an ordinance creating an EID in November 2007.[10] Stamford is located in the southwestern portion of the state in Fairfield County, where the driving factors behind PA 07-242 are particularly acute. In addition to high electricity prices, large commercial buildings and firms face large transmission charges, which total 300$ million annually for residential and commercial customers in Fairfield County.[11] The distribution grid in Stamford is also old and increasingly faulty; during a heat wave in the summer of 2006, downtown Stamford suffered forced blackouts because spikes in electricity demand caused underground distribution wires to overheat and catch fire.[12] The local electric distribution utility, Connecticut Light and Power (CL&P) estimated it would cost $2.2 billion over 10 years to upgrade the older parts of their distribution system.[13]

This situation has become a major problem for attracting and retaining businesses in downtown Stamford, which bills itself as an alternative destination for financial services firms to Manhattan's midtown and downtown financial districts. Stamford currently hosts the trading floors of the Royal Bank of Scotland (RBS) and UBS (originally the Union Bank of Switzerland), which are some of the largest in the world, including several thousand monitors and computers.[14] Power disruptions pose serious costs to such companies from general business interruption, damage to sensitive equipment, and necessity of running expensive and dirty backup generators.

While the mayor of Stamford was pursuing distributed generation to satisfy his administration's green goals, the economic development branch of the city was the dominant champion of the EID because it viewed it as a critical tool for retaining their anchor businesses and attracting similar ones searching for office areas with reliable, cheap, and flexible power supply. Former economic development chief Michael Freimuth stated that "Power generation [in southwest Connecticut] has become more important to businesses than taxes, transportation, the price of real state, and even the talent pool in the labor force," and that several companies had removed Stamford from their list of potential locations.[15] Existing businesses shared the City's outlook and local real estate firms sought ways to retain major tenants and attract new ones at competitive rents. Furthermore, commercial stakeholders recognized that the city had limited financial means to incentivize economic development and that public-private partnerships would be necessary to tackle this issue.[16]

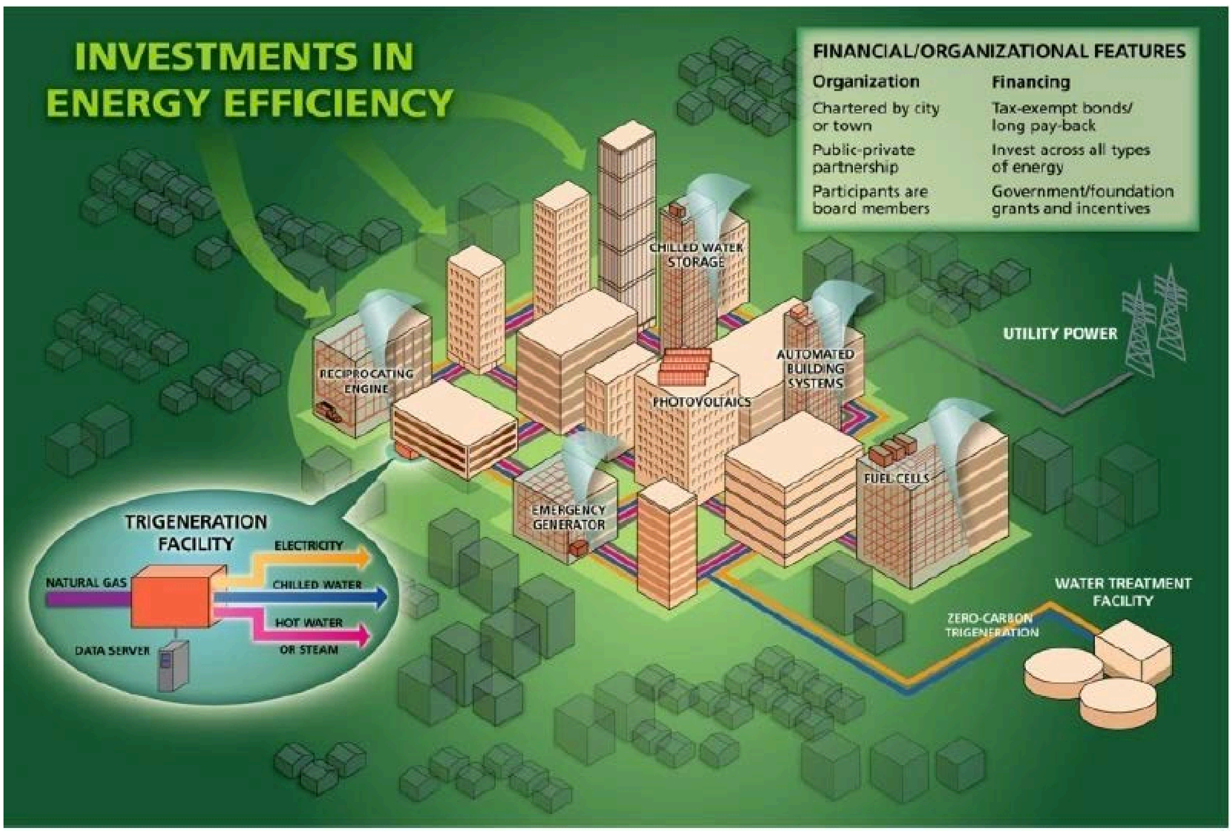
The Business Council of Fairfield County – an advocacy organization chaired by major businesses in the area – convened their energy committee with a company called Pareto Energy, a microgrid design and finance company. Pareto pitched microgrids as a technology that could address Stamford's reliability and high energy cost issues but also that would be suitable for the physical and ownership composition of Stamford's commercial district (Figure 4-1). As a network of distributed generation resources, a microgrid in Stamford would allow multiple users to house generation technologies that utilize diverse fuels, increasing the resiliency of the system. Energy costs would be reduced through the optimal use of on-site power and thermal energy generation and distribution. Finally, the network would be able to operate

[10] The City of Stamford, CT. "Energy Improvement District: Letter From Mayor Malloy", accessed November 27, 2011. http://www.ci.stamford.ct.us/content/25/50/258/92789/93725.aspx.
[11] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. 538
[12] Tanya Paglia, "Energy Improvement Districts and Local Energy Production" (research paper, Cornell University, January 2011), https://catalog.library.cornell.edu. 88
[13] Richard Weizel, "Microgrid Could Keep Lights On in Fairfield County," *The Daily Norwalk* (Norwalk, CT, February 4, 2012), http://www.thedailynorwalk.com/news/microgrid-could-keep-lights-fairfield-county.
[14] Advanced Trading, "UBS Trading Floor", http://www.advancedtrading.com/photos/trading-floors/ubs.
[15] Donna Porstner, "District Gathers Businesses for Energy Savings," *Stamford Advocate,* November 12, 2007, www.cityofstamford.org/filestorage/25/50/258/.../EIDAdvocate.pdf.
[16] Henry Ashforth III, interviewed by Genevieve Sherman, February 28, 2012.

independently, buffering users from outages or shocks from CL&P's grid. Meanwhile, establishing an EID would allow multiple property owners to jointly enter into a contract with Pareto to build a microgrid.

Businesses in Fairfield County were generally excited about the prospect of microgrid, albeit nervous about the potential risks of an unfamiliar technology. While it is possible the businesses community may have eventually signed on to build a microgrid the mayor of Stamford, Mayor Malloy, and his economic development team preempted them by offering to build a pilot microgrid in the city's Government Center.[17] After PA 07-242 passed, Mayor Malloy signed Ordinance 1076 establishing an EID in Stamford. Mayor Malloy established an EID Board and appointed its members, including a member of the City's Board of Representatives, two major downtown property owners, and a UBS executive. At this time, the City also signed a contract with Pareto Energy to conduct an energy audit of Government Center and explore the potential for a microgrid there.[18]

Figure 4-1: Energy Improvement District Framework



Source: Freimuth and Warner, 2011

The Stamford Microgrid Project

Despite the legal and financial tools the Stamford EID could employ to spearhead an energy infrastructure project downtown, the EID and the City pursued a design, build, own and operate arrangement with a single, private independent provider for Government Center. The following section elaborates on the how

[17] Shalom Flank, telephone interview, February 27, 2012.
[18] City of Stamford. "Pareto Energy Contract" (August 31, 2007). accessed March 13, 2012. www.boardofreps.org/committees/statecomm.

and why stakeholders chose the independent provider model for the Stamford microgrid within each role introduced in Chapter 2: ownership, operations, financing and rate setting, and management. Given the evolution of this project, the final section considers the feasibility of the joint cooperative model and the potential role of the EID if a microgrid were to expand out of Government Center and interconnect with private, commercial properties.

Microgrid System Design for Government Center

The mayor offered Government Center, a 250,000 square foot office building housing city agencies, as a pilot site because it was a facility over which the City had authority but also because it acts as an emergency refuge during extreme weather events, and thus must have 24/7 reliable power supply. The goal was to pilot a microgrid that could demonstrate to the downtown real estate and businesses community the reliability of DERs, the viability of a microgrid interconnection with CL&P's distribution grid, the real potential for energy savings, and process of financing projects through a third party microgrid developer.[19]

Pareto, the EID board, and the City settled on producing power and thermal services through a single phosphoric acid fuel cell and a single reciprocating engine, both fueled by natural gas and both with heat recovery capability. An existing diesel generator would be kept in good working order to act as a back-up generator or supplemental generator during emergency peak events.[20] The fuel cell and gas engine would provide electricity to Government center and waste heat from both generators would be captured to provide hot and chilled water to the building for space heating and cooling. Essentially, the microgrid would replace the City's electricity purchases from CL&P with natural gas, and would displace the building's existing boilers used for space heating with waste heat distribution. Because building enough generation capacity to satisfy Government Center's total peak demand would be very costly, the fuel cell and gas engine were deliberately undersized so that the City would continue to purchase some electricity from CL&P. During a peak or emergency event however, Government Center could temporarily shed load in order to start the back-up diesel generator and bring essential activities back on-line.[21]

Pareto intended to accomplish this seamless transition from using CL&P power to operating autonomously through a unique interconnection technology they have pioneered called 'GridLink.' Unlike the conventional microgrid interconnection hardware discussed in Chapter 1, that require microgrids to shut down and restart in order to operate in island mode, or to reconnect into the macrogrid, GridLink allows for simultaneous, yet non-synchronous connection of the microgrid to the utility distribution grid while also preventing the possibility for back-feed. Therefore the microgrid could be connected to CL&P's grid safely without additional interconnection devices. Thus the Stamford microgrid could continue to operate autonomously of the macrogrid without physically islanding or needing to shut down and restart.[22]

Ownership

Despite the legal authority of the EID to own energy infrastructure on behalf of its members, the City of Stamford prepared to sign an individual Energy Services Agreement (ESA) with Pareto Energy that gave Pareto full ownership over all the generation assets over the 20-year contract term at which point they would transfer to the city. While the City at one point expressed a desire for a mid-term purchase option, this was abandoned because it was deemed unlikely that the City would be able to afford the assets. It

[19] Laure Aubuchon, telephone interview, March 9, 2012.
[20] Freimuth and Warner, "Progress Report on CHP Development in Stamford."
[21] Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. A-60.
*Building larger generating units would have been more expensive, given how infrequently the additional capacity would used, than purchasing electricity from CL&P during flat demand periods (e.g. when electricity prices are low).
[22] Freimuth and Warner, "Progress Report on CHP Development in Stamford."

was estimated that after 20 years the generating units would be at the end of their useful life.[23]

As a group of private citizens volunteering time without dedicated staff with energy infrastructure expertise, the EID did not feel equipped to take on the legal or financial responsibility of owning infrastructure. As for the City, energy generation and control infrastructure is not their core competency, and they were uninterested in the liability of owning assets that it did not know how to operate or properly maintain. The fact that the EID in its current form is so strongly connected to and driven by the City's agenda, however, also played a role. It was Pareto's perspective that with Government Center as the sole project under the guidance of the EID, the EID essentially operated within the City's hierarchy as an advisory board, not as a separate autonomous entity developing energy resources for the use of downtown stakeholders at large, as described in the EID Ordinance.[24]

<u>Operations</u>

The operation of a microgrid that interfaces with multiple distribute energy resources, load entities, and a larger electric distribution grid, a complex undertaking that requires technical expertise. The operations portion of the organizational model for implementing a microgrid was a component the EID had neither interest nor capacity to have responsibility over. Pareto was given an exclusive right to operate the microgrid, which it intended to contract out to the manufacturer of the generating units. Therefore, operations would occur remotely. Pareto was also responsible for maintenance and repair, however it was to reimburse the City up to a fixed amount annually for a City engineer to review operations and maintenance of the microgrid.

The software controls interfacing with CL&P's grid were of the greatest concern to both the City and CL&P. As discussed before, from CL&P's perspective, the issue with these controls are interconnection risks posed by back-feed into the distribution grid. However, CL&P has accepted GridLink and expressed willingness to participate in the Government Center microgrid pilot. From the City's perspective, the operability concerns were two fold: one, that they were able to instantaneously receive continuous and reliable power from CL&P in the event that the microgrid generation units were unavailable or if CL&P power were more affordable. The second pertains to who is controlling the microgrid generation, energy monitoring, and grid interface infrastructure. There was some concern over the fuel cell, which as the baseload power generating unit would generally either be on or off and would be operated remotely by the manufacturer. The greater concern however was anxiety over the remote, real-time operation of the controls linking building energy systems requirements (such as HVAC and thermostats) to the gas engine and CL&P power. Facility managers, or in this case the City engineer, are normally on-call to operate, maintain, and expeditiously respond to unforeseen problems with building systems. At Government Center, there was a general discomfort with the displacement of this day-to-day role and the assurance that Pareto's software would operate as advertised.[25] As discussed below, this was a major reason the project did not go through at Government Center.

<u>Financing</u>

The financing mechanisms authorized for the EID were not employed in the Government Center microgrid; Pareto applied for state and federal incentives, which covered roughly half of the upfront project costs, and sought private financing to satisfy the remaining portion. This arrangement was partially due to the nature of the customer – the City – and partially due to the nature of the project. The City was not in a position to expose itself to debt directly, nor to secure bonds issued by the EID. Moreover, projects cost would have needed to be five times larger in order to warrant paying the overhead costs associated with underwriting bonds. Even if the EID had exercised its bonding authority, they would have had little success

[23] City of Stamford. "Energy Services Agreement: Pareto Energy LTD and City of Stamford" (August 27, 2009). accessed March 13, 2012. www.boardofreps.org/committees/statecomm.
[24] Flank, telephone interview.
[25] Ashforth, interview.

of selling the bonds, because the City could not guarantee payments. As described more below, the City's payments to Pareto were subject to annual appropriations in the City's budgeting process, and the inability to work around this 'defunding clause' in the ESA eventually made the project unfinancable.[26]

Either way, the City had no desire to finance a microgrid project. Furthermore, the EID Board emphasized that the Government Center was always considered a once-off transaction to implement a pilot, whose successful implementation was needed to demonstrate the generation technologies, the controls, the interconnect agreement with CL&P, and the potential cost-savings *with private financing* to other stakeholders in the district.[27] Given the financial environment post-2008 and the high cost of energy delivery in Connecticut, the EID felt it was critical to show that these kinds of projects could be privately financed.

Rate Setting

As the EID was not going to own or operate the microgrid system, Pareto planned to charge and collect fees for providing electricity, heating and cooling to Government Center. In this arrangement, the City would pay Pareto its annual business as usual costs (BAU), meaning the total electricity payments and gas payments it would give to CL&P and Yankee Gas Company, respectively, if the microgrid had not been built or was out of service. These payments consist essentially of monthly electric and thermal *usage* charges plus monthly electric and gas *capacity* charges. While Government Center would continue to be charged capacity payments while the microgrid was in operation, its actual usage charges would shift depending on the quantity of electricity Pareto produced onsite through purchasing natural gas and the quantity it imported from CL&P. At the end of each year, Pareto would accept an independent audit of its operating costs, which could be additionally reviewed by the EID Board. If total costs were less than Government Center's BAU costs, the City and Pareto would share profit on a 70/30% split, respectively.[28]

As the ESA did not stipulate any energy savings performance target, benefits to the city would have depended largely on the debt structure for Pareto's financing and the cost of electricity and natural gas. At the time of the Pareto/Stamford ESA, the city purchased electricity for roughly 90% of its energy requirements, and gas for 10%.[29] The microgrid would have essentially reversed this scenario, and since gas is much cheaper than electricity in Connecticut, the City's energy use costs would have been cut roughly in half. Since natural gas prices have also been reduced by 50% since 2009, these savings would likely have been even larger. Depending on the debt repayment structure for Pareto's initial investment, it is very likely these energy use savings would have translated into direct profit over all or some part of the 20-year contract, leading to significant savings for the City.[*]

Management

A joint cooperative implementing shared energy infrastructure among multiple stakeholders requires an entity to manage the process: from advocating for the technology, to convening and educating potential customers, conducting high level cost-benefit analyses, coordinating projects and contracts, vetting private developers or financiers, and various other tasks. The Stamford EID was able to take on this role to a limited degree, in helping to manage the Government Center process. The EID vetted different DER options for the microgrid, reviewed contracts, and essentially operated as a forum for dialogue between Pareto and various City representatives.[30] Nevertheless, the ability of the EID to affect the implementation of a

26 Flank, telephone interview.
27 Ashforth, interview.
28 City of Stamford, "Energy Services Agreement: Pareto Energy LTD and City of Stamford."
29 Hyams, *Microgrids: An Assessment of the Value, Opportunities and Barriers to Deployment in New York State*. A-68 – A 69
*Electricity and natural gas price estimates are taken from the U.S. Energy Information Administration: http://www.eia.gov/electricity/monthly/. http://www.eia.gov/dnav/ng/NG_PRI_SUM_DCU_SCT_M.htm
30 City of Stamford Energy Improvement District. "Minutes of Meeting of the Board," (Meetings of 2009-2011) accessed January 5, 2012. http://www.cityofstamford.org.

microgrid as managers was seriously constrained by the fact that the microgrid had only one customer, and that this customer contracted directly with an independent provider, not through the EID as an agent of a district member. If the microgrid had been envisioned to serve multiple, unaffiliated customers, the EID could have served a larger role in facilitating its implementation. These limitations were also symptomatic of the fact that the EID is still currently a volunteer committee serving without compensation and without dedicated staff that have technical energy expertise.

Termination of the Pareto Microgrid Project at Government Center

The ESA between Pareto Energy and the City of Stamford was approved by Stamford's Board of Representatives and Board of Finance in late 2009; meanwhile the parties waited for the completion of financing review before signing. In the summer of 2010, a new mayor, Michael Pavia took office. With this change in administration, concerns arose over the financing structure of the ESA, such as the lack of energy savings benchmarks below business-as-usual costs for Pareto's performance. Most critically however, the city's legal office viewed the microgrid contract as a procurement process that would have to be subject to annual budget decisions of the legislative branch of the city, rather than a straightfoward commcerical contract for services rendered, as envisioned by Pareto and the EID.[31] Essentially, procurement contracts in Stamford are subject to a defunding clause, wherein the City's obligation to make payments under such a contract are subject to annual appropriations. This clause was inserted into the Pareto-City ESA including the ability for the City to terminate the agreement without penalty.[32] As Pareto was financing the microgrid with third-party non-recourse debt, this clause made the project too risky and essentially unfundable.

Meanwhile, concerns from the City's engineers pertaining to the reliability and day-to-day procedures of a remotely controlled system pervaded. While the EID Board minutes indicate that the City never fully overcame this discomfort, the ESA suggests that an arragement was drafted allowing a city engineer to oversee the operations and maintenance of the system. Between these concerns and the parties' inability to resolve the financial structure of the ESA, the City of Stamford decided the terminate its contractual arrangements with Pareto Energy in late 2011 and the EID decided to shelve the idea of building a microgrid out of Government Center.

Expanding into Downtown Stamford: Feasibility of the Cooperative Model and Potential Roles for the EID

The original goal of Stamford's EID was to increase energy reliability and quality downtown in order to retain and attract new premium power users. Therefore, whether the Government Center microgrid had succeeded or not, the independent provider model utilized by the City of Stamford and Pareto must be evaluated in the context of how a microgrid would interconnect with multiple, unaffiliated commercial properties downtown. While these stakeholders share general goals for energy reliability and lowering costs with the City, the current level of understanding around microgrid functionality is lower and the Government Center project did not address many areas of risk perception among commercial owners. The following section evaluates how these stakeholders view the independent provider model utilized at Government Center and what the implications are for the EID to act as a joint cooperative entity developing future shared energy infrastructure in downtown Stamford.

Property Owner Perceptions of Risk

Commercial property owners and businesses in Stamford were generally interested in minimizing direct involvement in local energy infrastructure, and therefore favored an independent provider model like the

[31] City of Stamford Energy Improvement District. "Minutes of Meeting of the Board, 7 January 2011." Accessed January 5, 2012. http://www.cityofstamford.org
[32] City of Stamford, "Energy Services Agreement: Pareto Energy LTD and City of Stamford."

City and the EID. However, they had serious concerns over sharing energy infrastructure that may require some modifications to this model to succeed in downtown Stamford.

One major source of concern centered around hosting energy generation infrastructure. Property owners were uninterested in owning energy generation infrastructure. Since their primary interests are to access reliable high quality power, not invest in local energy production, a seamless, cost effective provision of power was more important than the service provider.[33] One stakeholder stated that in the absence of CL&P developing distributed generation, microgrid development was a clear business opportunity with possibilities for moderate economies of scale in commercial districts. While there is no reason an EID could not succeed in this arena, this stakeholder suggested that a single company with a business model to expand a microgrid in the EID profitably would likely have a greater incentive to own assets it might later sell to the incumbent distribution utility. Nevertheless, owners expressed concern over hosting privately-owned DERs in their buildings because of potential barriers to the sale of their properties. This latter issue is similar to the concerns of property owners in Portland around removing stand-alone thermal energy plants from their buildings and hooking into a distribution network, except the concern is the asset value impact of attaching an on-site DER to a building, such as a solar installation or cogeneration unit. If these assets are pledged in physical or commercial long-term contracts to provide power, owners worry this may negatively impact the sale of the property.[34]

Property owners, like the City, also did not demonstrate any desire to finance a microgrid project, mostly because they consider the risk profile of these systems to be too high to carry on their balance sheets. Pareto suggested that once the perception of risk among the business and real estate community diminished, local stakeholders might decide to cut out third party financing and reduce financing costs through bankrolling projects directly. Until then, they are convinced that third party financing is the vehicle that is going to build momentum for microgrid development in Stamford.[35] Nevertheless, Pareto's financing model may not work for commercial property owners, who are also uncomfortable with long-term power purchase or energy services agreements. One property manager suggested that third-party energy service agreements for building retrofits are more amenable to owners than for generating equipment like a solar installation, because their payback periods require shorter contracts and do not involve physically linking capital assets to the property.[36] On the other hand, microgrid developers such as Pareto need long term contracts because as unregulated generation and distribution entities, they are not guaranteed remuneration for their costs over the lifetime of the infrastructure they build and own. Therefore the feasibility of the independent provider model is dependent on the ability of customers to sign long-term contracts.

Using a joint cooperative model for financing would face similar issues under the current EID framework. Theoretically, joint financing through the EID is possible. If a microgrid node were sized to accommodate some of the anchor financial services firms as originally envisioned, the EID could have used its bonding authority. Nevertheless, the EID does not specify how fees may be collected, other than payment for energy services and/or revenues from leasing EID-owned energy resources. Without long-term energy service agreements similar to an independent provider, the EID would require another guaranteed source of funds. In the absence of a municipal guarantee, the EID Ordinance could seek mandatory membership and levy assessments on properties, similar to a BID; however Stamford's current EID ordinance deliberately did not include an assessment mechanism to avoid objections from major property owners.

The biggest risk perceived by owners was in interconnecting to a discrete, shared distribution network. Since the current power reliability issues in Stamford stem from problems with CL&P's distribution infrastructure, stakeholders are wary of signing up for a new, potentially faulty network. Employing a directly accountable entity such as the EID to operate a shared network did not mitigate this concern.

[33] Ashforth, interview.
[34] Jay Black, telephone interview, March 21, 2012.
[35] Flank, telephone interview.
[36] Black, telephone interview.

Owners felt the decision-making complexity of sharing power produced in multiple nodes under diverse ownership would be too arduous for a cooperative management entity comprised of the customers it serves. As one property manager explained, it was already extremely difficult to implement on-site DERs that service more than one building within the same real estate company portfolio.[37] Overall, EID members, owners and property managers felt that this arena was best suited to a single utility company owning and controlling all assets in a network.[38]

Still, given their concerns with interconnecting to other properties, the EID suggested that in the near term, major facilities downtown would likely avoid the risk of shared distribution infrastructure and opt to continue using grid-based power with stand-alone, low-tech back up solutions like diesel generators over which they exercise direct control. To the extent that facilities chose to generate clean energy on-site, they would likely size the DER to meet only their load requirements and would share power only in emergency situations (for example UBS and RBS expressed an interest in receiving back-up energy from the Government Center microgrid if their existing diesel systems failed).[39] This however, would remove much of the technical and efficiency benefits of a microgrid configuration.

Interconnecting multiple DERs and properties is essential to designing and operating a microgrid efficiently because of the need for load and energy resource diversification. Furthermore, operating multiple DERs on CL&P's grid as it is currently configured would remove the reliability benefit of a physical microgrid, which could island in event of a grid disturbance.[40] Although installing private distribution networks remains a fuzzy legal issue in Stamford, Pareto has recommended several solutions, such as allowing an independent company an exclusive right to operate new or existing wires owned by CL&P through a special tariff. Ultimately defining the ability for separate entities to own and/or operate alternative distribution networks is an issue that must be decided by the electric utilities and Connecticut's Public Utilities Regulatory Authority.[41]

Education and Engagement

Despite the concerns over microgrid functionality, downtown Stamford stakeholders are still extremely interested in developing local energy projects to improve reliability conditions. To convene and guide interested stakeholders from this concept to the completion of a project, the EID can play an active role educating property owners about microgrid functionality and engaging them around developing solutions to mitigate risk, for example through structuring acceptable long-term energy agreements. Even if an independent provider is used for shared energy project implementation, the EID is clearly well suited to manage the process.

The EID has been able to articulate multiple ways in which they might serve in a management capacity. Through their long process vetting a microgrid, the EID Board realized there are many energy strategies aside from shared physical infrastructure they could test out in the district for the benefit of its members. The EID sees themselves as leading a paradigm shift in the way district stakeholders and the utility conceive of energy generation and distribution and feel that their most important role my be acting as an honest broker for new technologies and testing different options to explore the most suitable possibilities for downtown Stamford.[42] Currently, they are considering new ideas, from energy efficiency performance contracting for public buildings in the district, to installing the city's first electric vehicle charging station, to conducting an energy masterplan for downtown Stamford. Beyond pioneering new energy technologies,

[37] Ibid.
[38] Ashforth, interview.
[39] Aubuchon, telephone interview.
[40] Flank, telephone interview.
[41] Ibid.
[42] Aubuchon, telephone interview.

EID board members suggested that they could also help test ownership, operations, and financial models for shared energy infrastructure, including cooperatively owned and operated distributed generation.[43]

Another obvious role for the EID is to bring the expertise of downtown businesses, real estate professionals, and city officials together to support the development of local energy infrastructure. For example, the Director of Economic Development suggested that if the EID had decided to issues revenue bonds, the expertise of board members representing the financial services firms in Stamford would have been essential. Meanwhile the EID members from the real estate industry are reviewing how investing in on-site generation impacts their own bottom line, property resale, and how their business model and lease structures may have to change to enable these kinds of projects. Finally, the City has expertise in urban development processes associated with installing infrastructure.[44]

Finally, the EID feels it is the best entity to court and convene stakeholders in the district around shared energy infrastructure. While the Business Council of Fairfield County led this process with the major real estate companies and businesses in the region prior to the formation of the EID, the EID can now serve as a similar forum for the stakeholders concentrated in downtown Stamford.[*] Bringing multiple stakeholders together requires more than a common forum and a shared agent however. It also requires properties and businesses to have a good enough relationship to be networked to one another in shared system. Hank Ashforth, Chair of the EID and Vice President of the Ashforth Company underscored the importance of fostering a degree of unification among commercial stakeholders in order to convince them to share energy infrastructure. Alluding to the example of Portland, he stated that the development of other commercial districts at the expense the Lloyd District provided a glue that brought all the major players together around game-changing economic development strategies for their district. Ashforth did not feel that the major property owners and businesses in Stamford currently exhibit this degree of organization, and therefore he could not estimate the degree of influence the EID might have. Given that downtown Stamford sits in the shadow of Manhattan however, he believes the EID should be able to rouse enough interest to get major players like UBS and RBS to pioneer projects that prove out energy savings and attract new users.[45]

In Pareto's words, bringing customers of new energy infrastructure together requires a locus for cooperation, particularly for private business. Pareto suggested that catering to a single customer, that happened to be the City, was not the best use of the EID as a managing entity because it created confusion about who was driving the process, who was making decisions, and where an additional third party customer would enter the picture. Involving multiple city officials, from the City engineer, to the law department, the economic development department, and the Board of Reps made the process read externally like an internal government project rather than an example of how a building would hook into a shared energy system. Pareto suggested that if the EID had oriented the project toward private sector stakeholders, the hurdles that arose through contract language and technical uncertainty could have been overcome. Ashforth echoed this sentiment, stating that a shared energy project may be more likely to succeed if the EID could bring diverse private stakeholders to the table through *leveraging* the participation of the City, rather than depending on the City to execute a pilot. He felt that if the EID could communicate the economic development, energy reliability and cost savings opportunity of shared local energy infrastructure, those stakeholders would come to the table and pressure the City to do what they need to do to enable these kinds of projects.

[43] EID Member, telephone interview, March 8, 2012.
[44] Ibid.
[*] Stamford already as a business improvement district – the Stamford Downtown Special Services Development – however the EID leadership felt that, unlike the Lloyd BID, this group has little experience with sustainability initiatives and ultimately does not have the vision or passion to champion economic development projects as novel as a microgrid.
[45] Ashforth, interview.

Conclusion

The Government Center microgrid offers potential insights about the feasibility of a joint cooperative model for shared energy infrastructure in Stamford's commercial district. First, despite crafting the EID as collaborative governance framework geared toward commercial stakeholders, the City acted alone as a first mover, favoring an independent provider model to design, build, own, operate, and finance the district's first microgrid in a single public building. The City pursued this model because neither the EID nor the City had the financial resources, staff capacity or technical expertise to handle the risk or responsibility of implementing a microgrid. To an extent, this strategy had merit since the goals of the City were in line with commercial stakeholders: the project was intended to demonstrate the power reliability and quality of a local energy system requiring no upfront investment for property owners. The City hoped the Government Center would provide a replicable model for future microgrids in the district. However, as this chapter showed, the choice of a single public institution set an undesirable precedent, both from a technical and process perspective.

Meanwhile, it seems that commercial property owners in Stamford would also favor an independent provider model. Owners are not interested in owning, operating, or financing energy generation infrastructure. However, they also expressed concern about interconnecting to microgrid distribution infrastructure as well as hosting stand-alone generation systems in their properties that were not used solely for back up power for that property. To some extent, this is due to general unfamiliarity with microgrids, discomfort with change, and the perception of risk. However, this is also due to real legal and financial concerns of property owners, such as guaranteed reliability of service, barriers to property resale, and issues with long-term energy service agreements. Commercial owners and businesses in Stamford require a better understanding of the technical functionality of microgrids. Commercial stakeholders in Stamford must investigate these issues – through research in other cities, building pilot projects and creating suitable contract language – as optimal microgrid functionality requires the interconnection of multiple properties to multiple DERs.

Within this context, the EID clearly can still play a critical role as a cooperative entity through educating district stakeholders about the value and functionality of microgrids, as well as convening potential customers of a shared system and generally championing technologies they feel will meet EID stakeholder goals. On its own, the EID has yet to be tested as a true joint cooperative organizational model for implementing shared energy infrastructure. In order for the EID to be successful in this capacity, the Government Center project suggests it will have to undergo some structural changes. First, EIDs as defined by Connecticut law, are primarily publically driven agencies. While this has some benefits, such as political financial support from the City, it may also have drawbacks, such as a weaker appeal to commercial stakeholders. Secondly, EIDs do not mirror BIDs in a few critical ways that hampers their ability to be active project development agencies: both their leadership and their membership is voluntary and they have no dedicated revenue stream that is connected to properties. If the EID were a true energy cooperative, and a microgrid reached a scale at which all demand in an area would have to interconnect in order to make system expansion economical, the EID would benefit from contract language that minimized developer risk. For example, allowing EIDs to set mandatory interconnection requirements in designated areas or to levy assessments to contribute to a fund for building interconnection costs. This may be necessary even with the ability of the EID to access low-cost debt.

5. Conclusion

Comparing the suitability of two organizational models through the lens of core roles and responsibilities – ownership, operations, financing, rate setting and management – revealed that in the cases of Portland and Stamford, the independent provider model is currently preferred by commercial district stakeholders than the joint cooperative model. However, the cases also reveal that this has less to do with the capacity of a cooperative entity to successfully fulfill those roles as it does with the current capacity and interest of local commercial district stakeholders to be directly involved in shared energy infrastructure – either as developers or customers. It is clear that there is a high level of unfamiliarity and risk perception among commercial property owners and businesses associated with shared energy infrastructure that advocates for district energy and/or microgrid technology must address if projects are to be successful. This chapter first summarizes these issues and describes the extent to which risks are real or perceived. This chapter then addresses the implementation approach pursued in both Portland and Stamford – a publicly driven pilot project – to distill lessons for those and other cities contemplating shared energy infrastructure. Finally, this chapter offers a reconsideration of the EID/EcoDistrict concept, and suggests how these organizations may be adapted to be a stronger implementation mechanism for shared energy infrastructure.

Independent Providers and Perception of Risk

The independent provider works for the unique context of commercial districts, because the goal of an independent provider is to serve multiple, unaffiliated customers. The stakeholders implementing pilot projects in both case cities saw clear benefits of the independent provider model. These companies have expertise that public agencies or commercial building managers currently lack in designing and operating shared energy systems. These companies also have access to private financing and remove the upfront costs of project implementation as well as the long-term risk of infrastructure ownership from customers. This was particularly attractive to public building managers, who are cash-constrained, as well as commercial property owners who do not want to finance long-term energy projects off their balance sheets. Finally, independent providers also have a business model for rate setting that allows customers to experience an easy transition from their current energy delivery arrangement to a new, shared energy system. As property owners, whether public or private, do not consider energy generation and distribution their core competency, this ease of transition was generally seen as a benefit.

Nevertheless, commercial district stakeholders also associated the independent provider model with several risks. Many of these are perceived risks, due to a general lack of familiarity and knowledge about DE/microgrid functionality while others reflect real risk to property owners and managers that must be resolved for independent providers to be successful. The biggest issue is the independent provider financing model. Their ability to finance the high upfront costs of a new system while keeping energy rates competitive depends on recouping costs through long-term energy contracts with customers. At the small scale of an initial DE/microgrid node, independent providers are not currently regulated as energy utilities, and thus do not have the legal rights or protections that guarantee them remuneration for their costs over the lifetime of the infrastructure they build. Meanwhile both public and private commercial buildings have concerns signing long-term energy contracts. On the public side, cities are limited in the length and type of contract they can sign with third party vendors; if these laws limit the ability of an independent provider to be made whole, the process may break down, as in Stamford. On the private side, owners are loath to link their properties to long-term energy contracts, especially if they involve removing energy generating equipment or physically linking it to the property, because of potential barriers to sale. This perception of risk around long-term contracts and interconnecting properties to DERs is a real barrier to project implementation. If private and public stakeholders are interested to prove out the viability of private financing, they must find a way to enter into long-term power purchase agreements that protect DE/microgrid developers from stranded assets but also protect their property values.

Other risks associated with the independent provider model center around system reliability, control and operator accountability. Some property owners are uncomfortable relinquishing control over providing energy services to their tenants. Some commercial property owners are uncomfortable with third-party ownership of energy generation equipment in their properties, while others have no interest in hosting equipment in their buildings at all. Similarly, some property owners are willing to interconnect to a discrete, privately operated distribution network, while others worry about the reliability and prefer to build generation nodes that serve only their building. These concerns vary across different owners and according to different technology configurations (i.e. central plant versus dispersed DERs) however they reflect more a perception of reliability risk than a real risk. As described in the case chapters on Portland and Stamford, there are multiple system design or operational structures that can address these issues, such as co-locating generators in individual properties or deploying dedicated, professional maintenance staff. An independent provider can work with customers to make decisions regarding system design that fit their interests, including requirements for cost minimization, carbon reduction goals, system reliability, or even profit sharing – as was done in the Pareto contract with the City of Stamford.

Still, without clearly articulating these concerns and vetting them across the full range of commercial properties in a district, it may be difficult implement shared energy infrastructure at an optimal scale. For example in the Lloyd District, the second best choice for a DE node in terms of demand density is too far away from the Rose Quarter for an independent provider to economically justify interconnecting the two systems. While this will allow commercial owners to explore the issues with ownership, operations, and energy service agreements in a separate pilot, it may result in a project with a completely different business model or one owned and operated by a separate entity than the Rose Quarter's. This may make it difficult to combine nodes, yet optimal DE/microgrid design requires the aggregation of diverse energy supply technologies and demand profiles, therefore interconnecting nodes may be desirable for district DE/microgrid owners in the future. To limit this, it may be useful for commercial districts to establish organizations that are empowered to articulate and represent stakeholder interests in the long-term. Both the Stamford EID and the Lloyd EcoDistrict can serve as models for this kind of organization, as discussed in the following sections.

The Pilot Project Approach

In Portland, stakeholders were broadly interested in shared energy infrastructure in order to lower costs, reduce environmental impacts, and attract new investment through branding sustainable neighborhoods. Stakeholders in Stamford had similar interests – to bring in new development through providing reliable energy. In both cases, this led to the creation of a broad organizational framework resembling a cooperative that provided diverse stakeholders within a commercial district a role in decision-making and management over the process of implementing projects. In both cases, this organization was modeled to some extent after a business improvement district (BID) – in Portland, through the use of an existing BID to manage the EcoDistrict and leverage funding from the BID's assessment and in Stamford, through legislatively creating an EID and empowering it with legal and financial tools to develop energy projects.

Despite the fact that city government drove this process, which was geared toward serving commercial property owners and businesses, each City offered to implement the first pilot shared energy project, and a separate arrangement was created between them and an independent energy provider. Each pilot was tailored to the property management goals of the pilot customers, predominantly public buildings in both cases, which clearly differ from commercial stakeholders.[*] Essentially, in both cases public agencies were interested in being a first mover to prove the efficacy of local energy infrastructure and spur its expansion or replication in the broader commercial district. Since neither had the financial resources or operational expertise to develop energy infrastructure, they employed an independent provider who tailored the

[*] The Rose Quarter project includes one private property owner and manager – Portland Arena Management.
[1] Henry Ashforth III, interviewed by Genevieve Sherman, February 28, 2012.
[2] Will Wynn. "Urban Revitalization / Economy." accessed May 19, 2012. http://www.willwynn.com/urban-revitalization-

system design toward their specific energy goals and building requirements and not those of commercial property owners and businesses.

As discussed, these pilots do set some precedent for system implementation, however they undermine the original intention of establishing cooperative district organizations, through shielding commercial stakeholders from addressing barriers to implementation within their own properties, or through piloting a business model that ultimately does not works for commercial owners and is not replicable. The early involvement of public agencies is paramount to implementing local energy infrastructure as it may require legislative changes, financial incentives, or championing among public agencies, regulatory bodies, utilities, and district level stakeholders. Nevertheless, at the project implementation phase, it is critical for commercial stakeholders to perceive that they are driving the process. In Portland, the Lloyd commercial leadership has a slightly adversarial relationship with public agencies and asserts that the Rose Quarter STES will have little bearing on how shared energy infrastructure may be implemented in the broader district. In Stamford, implementing a microgrid out of Government Center marginalized commercial stakeholders completely, who thus far have largely ignored the process. As Hank Ashforth, the chair of Stamford's EID and a former property owner in the Lloyd District stated, pilot projects will be more likely to succeed in the long term if cooperative organizations can encourage commercial owners to participate in new forms of energy infrastructure through leveraging, rather than depending on the City as an enabler.[1]

Cooperative District Organizations for Implementing Shared Energy Infrastructure

Given that commercial stakeholders are reticent to implement pilot projects and that cities wish to show leadership, how can cities work with property owners and energy providers to successfully build a replicable model for project implementation? Some cities have taken a 'if we build it they will come' approach and built oversized systems in existing commercial areas to drive new development; this has been effective in cases such as Austin's downtown district cooling system or Vancouver's Southeast False Creek DE system.[2] These projects however required the cities to muster significant resources to develop the system and they had the advantage of building from the foundation of a municipal utility. Additionally, these cities used the construction of new, not existing, buildings to anchor the system. As the case of Portland and Stamford show however, many cities lack the resources to create a utility subsidiary, to pay for system development, or to leverage the construction of new public buildings. Meanwhile, a private utility company will not oversize a system without a firm agreement with existing or future developers to supply demand. Where no new development is proposed, independent providers must work with existing properties – each with a different building owner, mechanical system, and operational structure – and they will thus tend to prefer a nodal approach to minimize the number of customers they interface with.

In this scenario, the EID/EcoDistrict organizational model provides a starting point for how public and private stakeholders can drive implementation of shared energy infrastructure projects. As cooperative entities, the EID/EcoDistrict model conceptually promises to catalyze collaboration among diverse stakeholders to facilitate projects with shared benefits. A strong mechanism for collaboration will be absolutely critical toward implementing shared energy systems at scale in existing commercial districts. Rather than simply deploying existing models, such as BIDs or other special purpose vehicles, to arrive at an optimal financing or governance structure, stakeholders themselves must consider what is needed in their location-specific context to bring a project from concept to completion, and then shape the organization to provide those services.

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[1] Henry Ashforth III, interviewed by Genevieve Sherman, February 28, 2012.

[2] Will Wynn. "Urban Revitalization / Economy." accessed May 19, 2012. http://www.willwynn.com/urban-revitalization-economy; Chad Comeault, *QUEST ICES Business Case: Southeast False Creek Neighbourhood Energy Utility* (Vancouver, Canada: Sauder School of Business, October 2011), http://isis.sauder.ubc.ca/research/carbon-management/quest-ices-business-case-southeast-false-creek-neighbourhood-energy-utility

Given the high level of unfamiliarity with shared energy infrastructure, this process should begin by convening all relevant stakeholders to educate and build awareness among them about the technical functionality and value proposition of shared energy infrastructure. This engagement process should further identify areas of risk, in particular to commercial property owners, and potential roles and responsibilities different stakeholders may play to enable project implementation. For example, the "Declaration of Cooperation" among the Lloyd EcoDistrict stakeholders included roles and responsibilities each agency agreed to provide during the pilot phase of the EcoDistrict. Institutional partners like PoSI are investigating policy barriers to DE implementation, public agencies will provide planning, technical assistance and policy changes, and private stakeholders pledged money to support dedicated staff.[3] These efforts have produced studies such as "Development, Ownership & Governance Models," which highlights how DE is implemented under current regulation in Portland and what changes city agencies should make to ease this process.[4] These investigations could focus more heavily on commercial property owner concerns, such as examining how interconnecting to DE/microgrids impact property values or surveying contract language for long term power purchase agreements.

Investigating potential roles, responsibilities and barriers to project implementation should draw heavily on the expertise of commercial owners and property managers and this engagement should be utilized as a method of educating and involving these individuals in district organization leadership. District organizations should also include regulatory bodies and energy utilities early on in their stakeholder engagement and educational process to understand the political and legal context of shared energy infrastructure. It is clear that for many commercial district stakeholders, utility representatives, and public agencies, district energy and microgrid systems represent a radical shift from the status quo. Vetting concerns and educating stakeholders broadly about the functionality and benefits for each stakeholder group individually will significantly improve the feasibility of project implementation in commercial districts.

To avoid the possibility of multiple nodes that are not compatible, the next step in a district organization led process would be to help property owners of key buildings with large energy demand move from having a high level understanding of DE/microgrid benefits to understanding how DE/microgrid interconnection would alter their existing building operation and financial structure. This requires conducting prefeasibility studies of existing buildings in the districts that could act as initial nodes of a shared energy system; understanding their current lease structures, energy mechanical systems and energy consumption patterns. Energy consumption data in commercial properties is generally proprietary information, however one of strongest aspects of the BID model is it encourages collaborative effort among actors that are otherwise competitive. A first step a cooperative district organization could undertake would be to conduct high-level audits that would allow multiple buildings to understand the compatibility requirements and financial opportunities they would face interconnecting to a shared system.

This process is becoming commonplace in many cities where individual properties to join together to form a single contract for energy efficiency retrofit services, which are often not cost-effective enough at the single building scale to employ an independent provider. Called 'owner's agents' or 'owner's representatives,' these organizations prequalify buildings, help properties prepare and issue RFQs for independent provider services, evaluate vendor proposals, vet technology options, manage contracts, and evaluate and monitor results.[5] In the case of DE/microgrids, an owner's agent could help multiple buildings identify their existing energy consumption patterns and long-term energy management goals, draft a joint RFQ, assist in negotiations with an independent provider to approve system design, help owners enter into joint ventures for partial ownership or financing, assist in crafting energy service agreements, monitor rates and act as a consumer protection advocate. In the event that the cost of these services cannot be covered

[3] Oregon Solutions. "Declaration of Cooperation: Lloyd District EcoDistrict Pilot 2010." accessed December 10, 2011. www.pdc.us.
[4] Portland Sustainability Institute, *Development, Ownership & Governance Models*, (Portland, OR, March 2011). www.portlandonline.com/bps/index.cfm?a=349828&c=54886.
[5] Southeast Energy Alliance and Clean Energy Solutions, Inc., "Energy Performance Contracting." accessed May 19, 2012. ieenonline.com/wp-content/uploads/2011…2520Series.pdf.

pro-rata by an independent energy provider, the cooperative organization could also craft innovative financing strategies to address this gap.

All of these tasks require a high level of energy and real estate expertise. Therefore a cooperative district organization must have financial resources to hire technically competent staff in this area or to partner with another group that can assist with these services. In this respect, structuring the organization like a BID may be useful for project management. The strengths of the BID model are mandatory participation, dedicated revenue streams, and private management. All three of these aspects can empower a commercial district organization to implement shared energy infrastructure. The use of the Lloyd BID for example, allowed the EcoDistrict to leverage the (mandatory) BID assessment revenue into additional funds from commercial owners to hire a full time sustainability director with the expertise to lead energy projects. By contrast in Stamford, the EID does not require any form of participation from district stakeholders and has been run by volunteer members with little energy expertise.

Finally, in order for a cooperative organization to lead the process of engaging stakeholders, conduct prefeasibility studies, or help property owners craft ownership, operating, or financing agreements with independent energy companies, they must be considered an open forum for dialogue and a trusted representative of their membership. While this thesis did not investigate the relationships aspect of the EID and EcoDistrict members, it does seem clear that the Lloyd District was fortunate in having highly organized anchor owners and businesses. Without existing, strong relationships through some form of district organization, it may be more difficult to engage stakeholders.

Other Implementation Models and Future Research Areas

Implementing DE/microgrid systems in existing commercial districts is challenging. However it is clear that cooperative district organizations can play a key role in overcoming some of upfront barriers to implementation, through engaging stakeholders, investigating areas of risk, identifying roles and responsibilities, and acting as an owner's agent. Beyond these roles however, cooperative organizations are unlikely to become DE/microgrid developers or operators, unless they are structured to have significantly greater funding and/or expertise in operating shared energy infrastructure. Project implementation may also require innovative models for structuring ownership, operations, governance and financing. Chapter 2 introduced the idea of municipal or utility-led hybrid models that combine independent provider ownership and/or operations with collaborative governance and potentially joint financing, including the use of municipal finance instruments like the Stamford EID model.

Exploring the full range of combinations of stakeholder roles in a hybrid configuration would shed light on multiple options that may appeal to different cities. The potential role of utilities in particular is not well understood and would be extremely valuable to the field. Utilities are regulated entities and they respond to larger policy mandates that are germane to local energy infrastructure, such as cost minimization, emissions reductions and system reliability. Utilities are also just coming to understand the potential role local energy infrastructure could symbiotically play with their networks. For example, the state of Connecticut now requires electric distribution utilities to procure a portion of their electricity from cogenerating units.[6] These utilities may be interested in partnering with an independent provider that could build a cogenerating unit, sell the power to the utility, and capture the waste heat for a district heating and cooling system; in this scenario, additional parties such as an EID may be the owner or financier of the cogen unit, while an independent provider could operate the system. Similarly, an electric utility managing aging distribution infrastructure may welcome the presence of a microgrid that can reduce demand during system peaks or on critical areas of the grid. Therefore, a broader investigation of how district energy systems and microgrids interface with utilities, benefit a broad range of utility interests, *and work with utilities to build and operate systems* is a critical area of future research.

[6] Database of State Incentives for Renewable Energy. "Connecticut Renewables Portfolio Standard." accessed April 30, 2012. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CT04R&state.

The concerns expressed around long term energy contracts by both public and private property owners in the two cases in this thesis and the impact of DERs on property values also merit further research. Each DE/microgrid system that has been or is being developed has had to address this issue, each in a different locational context. Therefore, multiple solutions have been developed, ranging from linking an energy service agreement to leases rather than to the property, inserting balloon payments or exit fees for contract termination, or passing local ordinances to establish mandatory interconnection requirements for properties within designated energy districts. A greater understanding, particularly from the viewpoint of property owners and managers, of the enabling conditions that have motivated or allowed owners to sign long term energy contracts would be useful for urban commercial districts contemplating shared energy systems.

Beyond organizational design, a final area of study to contemplate is new state, regional and federal level policy that would enable all the stakeholders described in this thesis to more easily implement shared energy infrastructure. There is a good deal of literature in this field regarding regulatory changes to enable DE/microgrids, however less on supporting cities and districts in developing them. Conversely, a more technical appraisal of microgrid and DE systems could estimate the extent to which these systems could help meet existing policy goals, and therefore merit support through new policies or policy changes.

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