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Ecodistricts in San Francisco: The Implementation of Neighborhood Regional Planning and Its Potential Effects on Environmental Resilience

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This Master's Project

Ecodistricts in San Francisco: The Implementation of Neighborhood Regional Planning and Its Potential Effects on Environmental Resilience

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Chapter 1: Introduction

History and Concept behind Ecodistricts

In 2010, the Portland Sustainability Institute, a not-for-profit based out of Portland, Oregon, was established with the intention to create the initial framework for a new model of city planning now known as an ecodistrict. Portland, being a progressive city with extensive history rooted in community sustainability, ecological awareness, and conservation, took on the concept readily, and has since designed five ecodistricts: Lents, Gateway, South Waterfront, Lloyd District, and South of Market (Portland State University, 2015). The Portland Sustainability Institute reformed in 2012 to become EcoDistricts, and in that same year created the Target Cities development program, aimed to establish new ecodistricts in several high density, metropolitan areas in the United States and Canada (Ecodistricts, 2014).

Ecodistricts are usually small segments of cities, anywhere from 2-5 square blocks of connected land. The parameters of these ecodistricts are determined by local governance after a process of planning, public hearings, designing, and implementation. The framework or delineation of these ecodistrict neighborhoods are decided upon by assessing building character, viable infrastructure, and the people that inhabit the area. In this model, strategies for sustainability are fulfilled on a neighborhood scale to effectively manage funding, risks, and environmental impacts. What makes an ecodistrict so unique is that the participants in the community such as residents and business owners strive to achieve very ambitious sustainability goals and maintain records of their progress to share with the city at large and with other global locations. These participants decide the shape they would like the neighborhood to take, and provide financial guidance for the new ecodistrict (Ecodistricts, 2013). As such, these ecodistricts have been instituted in urban centers of metropolitan areas that already have a developed urban footprint and an established built environment, but are looking to reinvent themselves for a community purpose.

The primary purpose behind creating ecodistricts is that society as a whole is trending toward city-living, meaning that the majority of the world's population is migrating toward living and working in high-density metropolitan areas. This increased population will consume more natural resources, inhabit more space, and require more social services. Therefore, vulnerable areas such as San Francisco should search for the best method by which to accommodate growth, and use technology, capital, and networking to make it sustainable. The manageable size of an ecodistrict may allow for sustainable development measures such as building green infrastructure to occur more rapidly, and for policy planning such as environmental protection to take action more efficiently. This neighborhood driven development is also intended to enforce a sense of place and form a community identity for the ecodistrict (Vinnitskaya, 2013).

While the practice of functional ecodistricts is relatively new on the global scale, the idea of urban, neighborhood-scale areas devoted to progressive sustainability and environmental conservation has long been discussed and active. Though the process of ecodistrict implementation is continually undergoing reiteration, there is already some evidence that they have an effect on environmental resilience in metropolitan cities.

Alternative Development Projects

Living City Block is a comparable organization to Ecodistricts which originated in Denver, Colorado out of the Rocky Mountain Institute as a development project that focuses on improving the general sustainability of a city by reinventing and retrofitting one block at a time. Like Ecodistricts, this planning system is a concept that can be readily adopted by different cities nationwide, and has ties to federal and city government organizations to support its mission (Alliance for Sustainable Colorado, 2015). Thus far, the organization has focused its efforts in economically disadvantaged cities that do not have the government support necessary to transform their neighborhoods. The integration of sustainable services by Living City Block helps these neighborhoods to address where the gaps in city planning exist, and where resources can be used more effectively (Grace, 2012). While the organization has found success in areas like Downtown Denver and New York's Gowanus neighborhood, and has been proposed as an opportunity for change within several San Francisco districts as well, it does not yet have the outreach potential that Ecodistricts has obtained. The organization does, however, provide services that aid areas to improve employment rates and improve their local taxation arrangement to produce a more economically viable block, and eventually city, for businesses and residents to enjoy (EHDD, 2012).

In contrast, the organization 2030 Districts based out of Seattle, Washington, has proven to have widespread reach similar to that of EcoDistricts. Spurred by the 2030 Challenge for Planning by Architecture 2030, the organization aims to meet ambitious water, energy, and greenhouse gas emissions target by the year 2030. The sustainable improvements rely on public/private collaboration between stakeholders and shareholders to redevelop cities by infill or infrastructure upgrade. The ultimate goal for 2030 Districts is to obtain measureable success in terms of millions of square feet, thereby converting entire cities into committed areas for sustainable development (2030 Districts, 2015). This methodology is all-encompassing of city structures and open space, and therefore relies heavily on action from and agreements with city government. There is less communication amongst minute districts to make marked change that can expand into the city at large, and more of an effort to drive holistic sustainability goals that will impact the city as a whole. Currently, there are plans for 2030 District integration in Cleveland, Los Angeles, Dallas, and other U.S. cities. Uniquely, the 2030 District in Seattle has instituted a Streamlined Permitting Services program which has been able to reduce permit processing time by 25%, making an efficient addition to the city's planning and programming (Environmental Protection Agency, 2014).

Each of these organizations has a unique approach to neighborhood- based sustainable development and planning, and presents positive policy creation as a route to more efficient neighborhoods. Ecodistricts emerges as a stronger candidate to deliver sustainable policies and services as they have been in existence longer, have connections to many major hubs of planning and innovation, and focus their energy on the district-scale. In theory, this district-scale size results in measurable environmental, social, and economic improvements for a community that can be feasibly scaled up to address the needs of a city as a whole (Grace, 2012).

Study Focus

While several reports have been performed on the successes of ecodistricts components (see: Bice, et al., 2011, Bolund and Hunhammar, 2009) this paper serves to assess the feasibility and practicality of ecodistrict design applied to San Francisco urban planning. This research project will therefore answer the following question: Will the implementation of ecodistricts in San Francisco County serve to improve its overall environmental resilience?

This study provides an overview of the process behind designing and implementing ecodistricts in a number of global locations to better understand how the environmental conditions in those locations were altered by the formation and activity of these districts. It also discusses varying metrics of environmental health, resilience, and stewardship, and whether they were improved in these sample areas so as to enforce and advocate for the implementation of ecodistricts in San Francisco County. This study evaluates the effectiveness of past and current ecodistrict implementation in large metropolitan areas such as Portland, Washington, D.C., and Sweden, among others, to see how similar methodology can be applied to San Francisco to increase urban and environmental resilience in order to adapt to and mitigate against future urban impact concerns such as sea level rise, population increase, global warming, and infrastructure quality decline.

In the following section, Chapter 2, the procedures behind building and maintaining an ecodistrict will be discussed to set the scene for how a new ecodistrict can form inside of an active city. The Ecodistricts Protocol covers eight components of sustainable development which include equitable development, health and well-being, community identity, access and mobility, energy, water, habitat and ecosystem function, and materials management (EcoDistricts, 2014).

In order to assess whether the ecodistrict model has thus far proven to have an impact on environmental resilience, case studies of ecodistricts which have been designed by the EcoDistricts Framework are evaluated in terms of their success for sustainable planning with regard to resilience. It is then possible to compare the policies and services in place in these new neighborhoods to those which are in place in San Francisco. Therefore, Chapter 3 will provide a panel of case studies on some of the more developed international and national ecodistricts.

Next, in Chapter 4, these sample ecodistricts and their sustainable projects will be reviewed in the context of their adoption into San Francisco city planning. Chapter 5 will discuss the prominent findings of the case studies, and will assess the challenges and changes necessary to apply current ecodistrict programming to future San Francisco planning. Lastly, this study will conclude with recommendations for the city of San Francisco pertaining to the implementation of ecodistricts.

San Francisco has already followed in the footsteps of Seattle, Portland, Washington D.C., and others by establishing its first ecodistrict in downtown called Central SoMa. This ecodistrict has many improvements to make, but intends to become a model for sustainable development and will place environmental conservation, most importantly the reduction of greenhouse gas emissions, at the helm of their mission. Through an extensive study on the trials and accomplishments of previously attempted ecodistrict designs, this paper will assess the practicality of applying this sustainable community structure to San Francisco, and measure its effect on environmental health and resilience.

Chapter 2: How an Ecodistrict is formed

Background

A metropolitan city can be broken up into subdivisions for review and alteration, with the city-scale providing an all-encompassing vantage over city operations and planning, the district-scale monitoring a singular neighborhood within the city, the block-scale observing a one block stretch of buildings, which can be residential, commercial, or otherwise, and finally the building-scale, which addresses a single structure on that block. As the pilot ecodistrict projects in Portland and Washington, D.C. are freshly developed and under review, Ecodistricts is currently monitoring progress towards sustainability on a district-scale as it remains unique from the city-scale. The block-scale and building-scale planning then become integrated into the fabric of the district-scale sustainability progress. The organization is also practicing a series of iterations now and in the future to ensure that methods for attaining overall sustainability are achievable and easily replicated. The minute nature of an ecodistrict proposes that the sample size tested is small enough to minimize risk, but impactful enough to foster change and manage improvement on the neighborhood level and beyond (San Francisco Planning, 2014).

The size of these districts depend on the neighborhood in question; the district can encompass up to five square blocks or just two to three. Generally, a set of blocks that have a similar economic structure, building scale, or congruous landscape can be organized as an ecodistrict. The orientation of an ecodistrict regulates how resources can be shared from building to building, and block to block. The task force assigned to the designation of the ecodistrict, as well as the city government, ultimately decides where the bordering lines of an ecodistrict exist. An example is the Kendall Square ecodistrict in Cambridge, Massachusetts, which is an area delineated by and filled with biotechnology companies and universities that all require large amounts of energy. This similarity amongst business needs in the area helped to define the area and its priorities in the creation of a more sustainable location (Kendall Square, 2014).

The implementation of ecodistricts is also being conducted internationally: this practice has shown to be popular in China, Europe, and the United States. The evolution of ecodistricts abroad has emerged as a deliberate plan to create a sustainable neighborhood which, through advanced infrastructure and land use design, helps to resolve environmental degradation and social inequity that may exist in the area. This is true of certain sites like Dockside Green, British Columbia, and Boucicaut, France which have experienced histories of industrial use and land contamination, and therefore received a green overhaul in the last decade (Making Lewes, 2014).

While this movement is growing in strength, the implementation of ecodistricts does not come without a cost. It can be difficult to adopt for countries whose economies are not as strong, or who do not have powerful cost-sharing partners to invest in the rejuvenation of a neighborhood. Since European nations are tied financially to the strong European Union, and the improvement and upgrade of neighborhoods in Europe leads to a stronger economy, many of these initial projects are located in countries like France, Sweden, and Germany. Metropolitan areas in these countries are also growing quickly in number as people transition toward compact city-living, making the investment for an ecodistrict more valuable (Eco-quartiers, 2015). As cost sharing becomes more flexible and options for sustainable infrastructure become less costly, it is likely that ecodistricts will begin to appear in South American, Indian, and African countries. As major cities in these locations expand due to population migration, and their economies begin to improve, the opportunity to drive ecodistrict formation and provide sustainable services to residents and businesses will become attainable (Van Der Voo, 2012).

Financing and Governance

In the creation of an ecodistrict, options for funding and financing are complicated and take years to establish. This is because there are multiple property, business, utility, and infrastructure owners that must adhere to a new payment strategy which services only the ecodistrict. These businesses also work together to manage agreements and contracts that define the terms each stakeholder must abide by in financing the ecodistrict. The first step of ecodistrict monetization includes the finances necessary to organize the district, including implementing a new governance structure and garnering stakeholder interest. It also includes any funding needed to perform a technical assessment of the area to gage where public priorities lie, and schedule a timeline of sustainability projects to pilot. Lastly, the first step also includes the monitoring of ecodistrict project schedules and progression as these projects evolve (Portland Sustainability Institute, 2011).

This first step of projects can be organized and funded by several types of capital, including grants from federal or private investors, cost-sharing partnerships, additional taxation, and voluntary contributions such as pro-bono planning services (Portland Sustainability Institute, 2011). This stage includes performing case studies on the city as a whole to assess where the ecodistrict is most needed and what sustainability efforts are required. The ecodistrict framework is then open to public opinion, and the projects that are of the most interest and applicability to the community are those that are chosen for consideration. The shareholders and stakeholders then perform a feasibility study to see how impactful each project will be and how they can be funded. Those that will bring the most positive sustainable change to the community are chosen as initial priorities to be implemented and monitored (Portland Sustainability Institute, 2012).

The second step of financing ecodistrict formation includes performing feasibility studies that can engage small-scale projects, such as Business Improvement Districts, that help to disseminate funding across a selection of property or business owners who can help to assist the entire district. Within the ecodistrict, this funding can be applied to high-value changes such as the updating of public infrastructure or building systems. Other example projects include parking benefit districts that take a large percentage of paid public parking fees and allots that toward neighborhood improvements (Portland Sustainability Institute, 2011).

Sustainable development charges, impact fees, and franchise fees can all be used in the second phase of financing to direct city-earned money toward the construction of a specific development district. In the case of Washington State's Climate Benefit District, the area is defined as an independent taxing authority which can regulate the property and business owners in the area exclusively without infringing upon the surrounding city (Mithun, 2014). Additionally, utility surcharges, the City General Fund budget, general obligation bonds, and other voter-approved financial assessments can contribute to the overall funding allotted to the second step of ecodistrict implementation (Portland Sustainability Institute, 2011).

The third funding step behind solidifying an ecodistrict in a metropolitan area is the financing of large-scale projects and overlying utilities that service the district. Equity investors and large financial institutions like banks and city government enable this funding process, making it more complicated than small-scale project funding. As there are large risks taken in the implementation of new city infrastructure, several banks will share the burden of equity financing. Examples of projects that enact the need for large-scale investment are sewage treatment plants and water infrastructure, new energy generation plants or cogeneration plants and corresponding transmission infrastructure, and district-wide heating and cooling systems. An example of the value of district-scale implementation of these projects can be seen in Portland where the city is integrating decentralized water treatment plants into the plans for their ecodistricts. These smaller plants will help to prepare neighborhoods for when their general treatment plant reaches capacity and can no longer service the city (Portland Sustainability Institute, 2011).

The funding sources for these initiatives involve unifying and diversifying ownership over some utility structures through either municipal, cooperative, third-party, or single-user management. For example, it will drive efficiency to divide ownership and maintenance, as a financial backer is able to manage the use of the resource in question, and an operational professional would be able to monitor the system to achieve efficiency and ensure service. These large-scale investments can also be financed through cost-sharing and the leasing of infrastructure. In order to ease the burden of these costs on the city, financing mechanisms such as energy service charges, tax breaks, and energy service performance contracting can be used to have energy saving companies pay the up-front costs of purchase and installation, and allow users to pay back the company while they use the equipment (Portland Sustainability Institute, 2011). An example of this service is Berkeley FIRST which sets an example for Property Assessed Clean Energy programming through PV installation that is paid for over time through a specialty property tax (City of Berkeley, 2011).

These three financing steps and their respective projects are monitored and initiated by Ecodistricts. The organization serves as a platform to invite distinct land use change into metropolitan areas, create large sustainability goals for that area with regard to public concern, provide guidance for the ecodistricts along the path to development, and track results from pilot projects so as to refine and alter them to improve efficiency and outcome (San Francisco Planning, 2014). The organization also promises to drive projects that create marked change on a community by severely decreasing the amount of greenhouse gases emitted and improving environmental conditions in the area. Social and economic goals are also set forth to establish a sense of place and a competitive market within the district so as to drive investment and incur the attraction of new residents (Greentopia, 2015).

The Ecodistricts organization asserts that, like finances, governance required to manage ecodistricts relies on constant communication between the residents, the district board, and the local city government. It is therefore necessary to find the best integrative ideas that depend on the cohesion of these entities to better adapt to changing environmental conditions, and decide on the best policy and governance implementations to ensure these adaptations become a reality. For example, Denver has created the "Building Owners Association" which intends to bring together owners into a legal group that is responsible for the infrastructure upgrades needed on their property to secure green or LEED certified buildings (Grace, 2012). By forming this organization, Denver has been able to capitalize on constant communication amongst businesses to efficiently derive solutions to the area's infrastructural needs.

Despite the fact that governing bodies will continually consult with one another to make ecodistrict decisions that are best for the community, there is an overlying entity that will review and mediate conversations amongst these factions. This overlying agency can be either not-for-profit or government organized, and will help to distill all necessary projects and policy reform into key priorities that can be managed and iterated as the ecodistrict is built (Central SoMa EcoDistrict, 2013).

Services Provided by Ecodistricts and their Planning Promises

Through the surveillance and guidance of the Ecodistricts Institute, there are currently 10 pilot programs initiated in 8 different metropolitan locations throughout the United States and Canada. In order to establish these projects, these areas initially had to undergo what is called the Ecodistricts Incubator. This Incubator involves a three day workshop that guides city planning teams through projects designed to improve the sustainability of a pre-determined district or neighborhood. These teams are looking to renovate the process of city planning in the general metropolitan area where this neighborhood lies, and the Ecodistricts organization supplies training and technical assistance to make this district a reality after the Incubator has finished (EcoDistricts, 2013).

Each chosen city has a subset of objectives to uphold in the process of creating an ecodistrict. These objectives, however, have been facilitated differently depending on where the metropolitan area is located. Some parameters which have determined neighborhood scale and organization are geological, financial, social, political, and environmental. The overall goal remains to achieve the eight framework components in order to make the ecodistrict thrive and innovate a center of sustainability that will permeate into the rest of the city. Once the ecodistrict is established, the businesses and residents that exist there are given ample support directly from the Ecodistricts organization in order to achieve these goals (Ecodistricts, 2014)

However, creating an ecodistrict is no small feat and requires cross-jurisdictional agreements to come to fruition. Multi-agency collaboration is needed on each level of planning, including block, neighborhood, city, and regional development entities. This collaborative governance is crucial as the EcoDistricts Protocol requires four distinct steps for the establishment of an ecodistrict, and this process is true in each of the Target Cities projects. First, the district must be organized, meaning that government leaders and key stakeholders, such as developers, designers, contractors, and residents, must take part in modeling and planning the ecodistrict. Then, the district plans must be assessed to determine where specific public projects and services should be located to make the most optimal decision that will appease many different social groups and satisfy sustainability goals. The next step requires the financing and implementation of these specific projects and services, and establishing a budget and timeline for each. Lastly, the ecodistrict must be managed, and therefore monitored for successes and failures that are reported to the governing bodies and to the public in order to reiterate and refine the existing policies. These steps lead to ecodistrict implementation and allow for creativity and innovation in the scope of future public planning (Ecodistricts, 2013).

There are three overlying sets of goals that the ecodistrict planners aim to achieve through neighborhood collaboration and innovative design. The first set involves the revitalization and retrofitting of the neighborhood through access and mobility, energy efficiency, and materials management. An increase in access and mobility ensures that all people living or working in the district can attain amenities and travel freely without the hindrance of ineffective public transportation or unsafe roadways (Transportation 2030, 2015). Through improving energy efficiency, these same people can reduce their ecological footprint by decreasing the amount of greenhouse gases emitted through buildings and technological uses in the ecodistrict. In the United States, around 41% of all energy is consumed by residential and commercial buildings, but almost 70% of that energy ends up unused as it is burned off as waste heat (EIA, 2015). The improvement of energy efficiency in these ecodistricts through the integration of renewable energy and the use of advanced technology can initiate an overall leverage against the inclement effects of climate change. Ecodistrict implementation has also shown to help alleviate energy concerns and reduce consumption in metropolitan areas by installing co-generation plants or biomass energy generators, thereby reducing up to 3,460 metric tons of greenhouse gas emissions each year and preventing the use of fossil fuels (Dockside Green, 2015). Lastly, more effective materials management can bring waste diversion to 100% by instituting a ban on non-recyclable materials, and integrating an extensive composting program into each building of the ecodistrict (San Francisco Planning, 2015).

The second set of goals includes those that influence community culture: equitable development, health and well-being, and community identity. As the topic of equitable development is an on-going social debate, its existence in the framework of an ecodistrict is key to guarantee the inclusion of public opinion from all residents and businesses in a proposed area. Marked improvement in social well-being and health conditions serve to increase the value of a location. As well-being improves with the development of an ecodistrict, additional businesses and residents will find the area desirable and settle there (Finley, 2014). As the area becomes more active and community-oriented, it will form an identity that can be branded and promoted. This makes residents and employers feel more connected to their neighborhood and more likely to make a long-term investment in the community (Ecodistricts, 2014).

The final and overlying set of goals that will enable an ecodistrict to show progress are concerned with environmental health: water conservation, and ecosystem functionality. Water use, conservation, and mediation is going to be a primary concern for every location on the planet as climate change impacts strike through drought, famine, heat waves, and flooding (Curran, 2014). Similarly, ecosystem functionality, along with biodiversity levels, are indicators of a stable climate environment with sufficient open green space, and good air and water quality (Tratalos, et al., 2007).

Chapter 3: International and National Examples of Ecodistricts

International Ecodistricts

The ecodistricts formed internationally provide examples which can inform and dictate the shape of those that form through the EcoDistricts Incubator in the United States. EcoDistricts has taken many of their Framework ideals and Protocol items from these examples, many of which formed with the sole intention of creating a new area that conserved resources and acted as a model neighborhood of the future. These neighborhoods contain dense, mixed-use buildings that achieve ambitious environmental management goals to address water, energy, recycling, and waste diversion needs (University of Oregon, 2015). Unique accomplishments include extended stormwater management and photovoltaic building paneling (Dockside Green, 2015).

This section presents international examples of ecodistricts, along with any major sustainability projects that have been initiated internationally that have not yet been replicated in the US, and can be used to benefit San Francisco's Central SoMa region with the help of municipal management and shareholder participation.

France

Starting in 2008, France adopted the ecodistrict model under the label of "eco-quartiers," which varies a bit from the traditional ecodistrict. While these ambitious plans are developed, built, and approved by the government, not every project earns the recognition of an eco-quartier right away. The projects must gain this title through initiatives that curb environmental degradation and institute neighborhood sustainability such as fighting urban sprawl and reducing greenhouse gas emissions. This process has been under review since its inaugural year and was solidified in 2012 through government protocol (Maaoui, 2015).

In order to begin developing the eco-quartier program, France began an environmental review of all parts of the territory. In doing do, they formed an action plan that laid the groundwork for rural versus urban land use and sustainability improvements. Before this time, the country had never established parameters designed for differentiating sustainable use on either type of land. France then determined the first set of eco-quartiers to be built in 2012, and studied the sustainability achievements made over the course of the next two years. There are now 30 projects planned for the coming years which will provide over 40,000 housing units

(Eco-quartiers, 2015). As developers must apply for the title and right to build a new sustainable neighborhood, France launched an application process that received 100 developer proposals, 72 of which were approved. The Minister of Territorial Equality and Housing ensures that these neighborhoods provide adequate housing in terms of availability and affordability, and this agency is crucial in the process of an eco-quartier receiving its official label as such (Maaoui, 2015).

Eco-quartiers and their means of sustainable productivity are, however, mostly based on securing efficient transportation, access, and mobility for their residents. The agency Eco-quartier has also developed broad issues to overcome in the next few years in order to address energy, conservation, and sustainability (Eco-quartiers, 2015).

One of the many French eco-quartiers that has been developed in the past three years is called Boucicaut. This area was prime for change since it originated as a patchwork of under-developed and abandoned buildings, and had ample opportunity for added mixed-use commercial development and open, green space. In the process of building this new community, France has added over 50% more housing to this general area with the addition of 514 more residential and commercial units, and consequently gained 4,000 m^2 of green roof space. This additional vegetation helps the eco-quartier to limit the urban heat island effect, enable a water catchment service on each roof, and provide sustenance from the roofs that become gardens (Boucicaut, 2015).

A second eco-quartier under development in France is called Clichy Batignolles. This area currently holds a primarily industrial, working class population, but is quickly turning to gentrification with the influx of high-profile developers and large budget capitalism. By 2017, the proponents of this community expect to have over 40,000 m^2 of solar panels providing a solely renewable energy system to the eco-quartier residents. The plans also call for 40% of all irrigation in the area to be conducted with rainwater, and a 50% reduction of stormwater discharges from today's levels (Clichy-Batignolles, 2015).

A French eco-quartier that provides a model framework for other ecodistrict planning is Lyon Confluence, a unique plot that sits at the juncture of the Rhone and Saône rivers. This area was initially a plain of untouched industrial land that, due to the influence of the ecodistrict model, has formed one of the prime international examples of urban infill, reuse, mixed use, and environmentally sustainable capacity. While the first phase of the project is complete, there is a second phase underway to bring even more ecological aspects to the area (Lyon Confluence, 2015). The central region of Lyon will encompass over 3,300 trees over a 14 acre parkland that is easily accessible. Another large undertaking in the second phase of the Lyon project is the integration of a co-generation plant that runs by the gasification of wood. This feat will help the city to become virtually net-zero in terms of carbon emissions and energy consumption. This co-generation will feed into a grid system that monitors and regulates energy usage to find the optimal balance of conservation for the city (Actu Environment, 2014).

While each of these eco-quartiers originated from differing stages of land use and development, they have all become examples of sustainable reuse and innovative urban planning. Through ambitious policy reform, these areas have stringent new plans to combat greenhouse gas emissions by the limitation of energy usage, the procurement of neighborhood-scale renewable energy, and the increased availability of public transit (Lyon Confluence, 2015). The maintenance and care of the natural environment is prioritized through specialized management, especially where urban and rural lands intersect. With exponential growth in housing and commercial real estate, these eco-quartiers have also recognized the need for efficient management of building materials, and as such have chosen only those that impose minimal environmental impacts for the new community (Eco-quartiers, 2015).

In an international context, these means of sustainable improvement have been effective for gaining long-lasting environmental resilience, as these initiatives have helped France make sustainably-conscious communities that branch their ideals out into the general city planning model (Lyon Confluence, 2015).

Malmö, Sweden

Scandinavia is home to some of the world's most evolved and modernized ecodistricts, and this is evident in the case of Malmö in Sweden. In this metropolitan area there have been two ecodistricts established since 1998, making these areas some of the oldest recognized ecodistricts to form under the European Union. The ecodistricts include Augustenborg and

Bo01- City of Tomorrow (Senthilingam, 2014). These areas are champions in the implementation of ecodistricts because of their history and continued effort behind involving residents in to design, review, and construction process. In doing do, residents are able to measure their individual carbon footprint through apartment meters that record the amount of energy used daily by heating and cooling air and water. The area boasts an extensive solar panel network called Solar City Malmö, and in 2009 the city installed their first wind power plant on the grounds of a community school (Malmö stad, 2014).

One of the most commendable and innovative accomplishments in all of Malmö's ecodistricts is the installation of plentiful stormwater channels and about 11,100 m^2 of living roofs that flow directly into ecologically dense streams and ponds. This change has prevented flooding in the city from their heavy rainfalls, and about 90% of all stormwater is diverted to canals which flow through the ecodistricts (Malmö stad, 2014).

In Augustenborg, there is a strong emphasis on food waste recovery, with the integration of extensive recycling and composting facilities. In 2008, the first biogas plant was created for use from composted food, and since its initial success, there has been an influx of biogas plants in every part of the city. Aside from biogas, there are more than 15 recycling centers that help to gather and sort glass, metal, paper, cardboard, plastic, electronic waste, hazardous waste, and florescent lighting tubes, all of which need specialized management (Malmö stad, 2014). The sustainable reuse of each of these labor intensive materials shows that the city is resourceful and able to become resilient in the case of a shortage of raw materials.

The second of the two major ecodistricts in Malmö is Bo01 along the Western Harbour, also known by residents as the City of Tomorrow. Over the last 20 years the Western Harbour has become a region developed around the concept of incredibly dense urban living with the intention of adaption the built environment to the natural environment. This concept in itself is a means of resilience because the city is anticipating any urban impacts that may occur due to environmental changes in temperature, climate, sea level, and so forth, and therefore has planned preliminary support and protection for its citizens. As this area was originally a contaminated venue of industrial use and irresponsible environmental degradation from businesses, the Bo01 ecodistrict has helped to transform this neighborhood entirely (Malmö stad, 2014).

All buildings in Bo01 have composting abilities on site, and so-called food grinders help to convert this food waste into biogas generated for use in heat generation and electricity. Also convenient and efficient is the refuse suction system that is installed in the area. Recycling and trash collectors do not need to drive into residential areas or perform home-by-home pick up because there is a unified underground system where refuse is dumped, and then collected through large pipes by trucks in a location on the outskirts of the city. This minimizes the need for large commercial vehicles to drive through neighborhoods, therefore lowering the amount of greenhouse gases emitted in the process of collection (Malmö stad, 2014).

The energy in Bo01 is fully renewable and generated within the ecodistrict through solar, wind, and hydroelectricity. There are varying levels of solar panel generation used for heating, a large wind turbine on the Northern Harbour that generates plentiful electricity, and a geological system in place (also in part powered by solar) to generate energy from underwater reservoirs to maintain heating and cooling in buildings. Also, in line with its mission to become entirely ecologically sustainable, Bo01 has a widespread green space system full of living roofs, open parkland, and green walls. Each of these components plays its own part in the connected system by serving a particular purpose such as nectar productivity and animal nesting areas to sustain biodiversity, or native grasses that help to deflect sunlight on walls and roofs.

Both Augustenborg and Bo01 provide exemplary insight into how an ecodistrict should be designed, built, managed, and maintained. These areas have the added benefit of technological advancement to improve and achieve their goals of environmental sustainability and are effectively independent cities that prioritize green thinking.

Vauban, Freiberg, Germany

Initiated in the early 1990's by environmental scientists hoping to recover community structure after many had flocked to Germany to escape the Chernobyl Nuclear Power plant accident in 1986, Vauban was one of the first attempts at living in an ecodistrict with sustainable ideals. This region of Germany had originally been a stronghold for the French military, but transformed over the last two decades into an area which practices extremely low carbon emission allowances and has an impressively low single occupancy vehicle user rate due to its public transportation network. This ecodistrict is very walkable, as it has pedestrian and bicycle paths in every part of the area, and actually prohibits driving and parking along some of the corridors and in the center gathering area. As a result, there is a district-wide average of 1.1 bicycle trips per day per person (Making Lewes, 2014).

Vauban is determined to keep its ecological health at a very high level, and therefore does not allow the use of herbicides or chemical-ridden fertilizers in its network of green environments. The community prides itself on high biodiversity and a dense open, natural corridor system that connects the major streets of the ecodistrict. The organization Forum Vauban has initiated several programs and policies of this kind that have changed both the appearance and the attitude in Vauban with regard to sustainable behavior. Much of the change that has occurred in Vauban is the result of a distinct shift in community behavior, and once again a strong effort to form a sustainable neighborhood (Vauban, 2013).

Because the Vauban ecodistrict was implemented as the result of an energy catastrophe, the subject of energy generation has always been vital and poignant for the residents. Thus, they instituted a system of co-generation that has taken the place of traditional wood, coal, or oil generated heat and electricity. The neighborhood has also taken on the concept of passive housing, or homes that face the optimal direction for sunlight, to avoid the need for excessive energy consumption by heating. All buildings in Vauban, including these passive houses, meet the Freiburg Low-Energy Standard (Vauban, 2013).

Vauban has many years of experience as an efficient ecodistrict and may provide a framework from which new or infilled developing cities can emerge with environmentally sustainable ideals for its residents and wildlife.

Dockside Green, Victoria, British Columbia

The Development Concept for the Dockside Green ecodistrict was created in 2004 with the help of several public hearings and reiterations. As this land was previously tainted with the chemical residuals of an industrial neighborhood, much work had to be done to rehabilitate the soil and make the area livable under environmentally sustainable conditions. Among the tasks necessary for readying the land, the developers had to apply for necessary zoning and land use changes in order to build the dense network of residential and commercial buildings entailed in the Master Development Agreement. The City of Victoria, B.C. worked with a number of architects, contractors, engineers, and developers to shape the blueprints into a feasible ecodistrict suited for the waterside environment (Bice, et al., 2011).

Since its initiation, the developers have committed 50% of all land in the area to open space parks and public passages with natural greenery. All 1,100 residential buildings and both mixed use commercial buildings in the proposed completed project are LEED certified, and Dockside Green received the very first platinum LEED certification to be applied to a Neighborhood Development plan. In terms of energy efficiency, the community has a biomass energy plant that will be centrally installed and will manage to reduce up to 3,460 metric tons of greenhouse gas emissions per year (Bice, et al., 2011).

Sustainability is primarily evident in this ecodistrict's water efficiency. Dockside Green has managed to loop treated water back into each building for reuse in the sewage system and landscape irrigation. The development also uses a membrane bioreactor wastewater treatment plant to absorb and reuse heat from dish, bath, and sewage water. All water will be treated on-site, and water that is not needed immediately in the community will be sold to neighboring parts of the city to offset the cost of using the wastewater treatment system. Aside from residentially and commercially used water, this ecodistrict treats its stormwater by an interconnected system of living roofs that lead into wetlands and waterways, or through permeable pavement to be reabsorbed as groundwater (Bice, et al., 2011).

Dockside Green has strict rules that designate limited vehicular use and encourage a no-car lifestyle. For example, residents must pay $25,000 for a parking spot which the city will buy back anytime if the resident no longer needs the spot. There is also little need to own a car with the interconnected bicycle, pedestrian, bus, car-share and ferry system that is in place. In order to limit the carbon emissions that are generated in the process of producing cement, Dockside Green's pavement is produced with fly ash instead of cement, which makes the end product stronger and last longer (Bice, et al., 2011). This neighborhood is still in the process of implementing phase two building and development, but has already collected several admirable accolades and will continue to serve as a model for sustainability that should be replicated in cities aspiring to integrate ecodistricts into their city plan.

As a direct result of the ecodistrict design and implementation, the neighborhood of Dockside Green transformed from a previously industrial coastal town with very few residents, to a bustling mixed-use community with LEED NC (New Construction) and LEED ND (Neighborhood Development) certifications. The district is on its way to becoming net zero and water neutral, and will work with developers in the future to ensure that all new phase additions or supplements to the ecodistrict meet and surpass the requirements of their previous achievements (Dockside Green, 2015).

United States Ecodistricts

Ecodistricts have expanded their reach of sustainable neighborhood planning by implementing the Target Cities Program. As one of 100 chosen Commitments to Action that will have a measurable impact on social and economic recovery in the United States, the Target Cities program was enveloped by the Clinton Global Initiative. In 2014, the Target Cities were selected in dense, metropolitan areas to increase efforts toward the development of sustainable centers of living (Clinton Global Initiative, 2014). These areas include: Los Angeles, Washington, D.C., Ontario, Atlanta, Boston, Cambridge, Denver, and Ottawa, Canada. (Eco-districts, 2014). A selection of these cities will be discussed in the case studies below.

In many of the following areas, a future ecodistrict was chosen due to economic or environmental hardship in that location, or because the amount of social services and programs that contribute to a neighborhood's well-being were insufficient. The city officials, in conjunction with guidance from Ecodistricts, took cues from successful international ecodistricts, determined the primary issues and potential solutions that could emerge as a result of ecodistrict implementation, and set out to revitalize these neighborhoods using the Ecodistrict Protocol (CityCraft, 2014). While each of these ecodistricts is still in the assessment stage, the public, private, and governmental shareholders in each location have determined a list of prioritized changes that could increase social and environmental sustainability.

All of these cities are diverse, with a bustling economy and a widespread demographic, much like San Francisco. They each anticipate large population increases in the next decade, and will need to find ways to accommodate this increase through the creation of civic services and housing. They will also need to strike a balance between ecosystem function in the urban setting and environmental protection (Hanscom, 2011).

AUC Vine City, Atlanta, Georgia

Atlanta was one of the first applicants to the EcoDistricts Target Cities Program, and as such was surveyed for its policy and planning weaknesses that could be addressed though the implementation of ecodistricts. The Midtown Community Improvement District was initiated in 2012 as a pilot project, which helped to identify the immediate challenges faced by Atlanta as a whole. These included water conservation, transportation efficiency, energy consumption, waste management, and open space availability (Sustainable Atlanta, 2013). The Department of Transportation & Sustainability then framed the planning for the Midtown ecodistrict in such a way that enhanced economic development through the supplementation of environmental stewardship. By increasing open space and green service value in the area, the Midtown district was able to attract a new crowd of residents and consequently, a fresh set of companies prepared to invest in a bustling community (Briskey, 2014).

Sustainable Atlanta, a not-for-profit organization that aims to improve the cohesion of economic, environmental, and social advancements in Atlanta and its surrounding areas, has taken on the role of spearhead agency for the new Atlanta University Center (AUC) Vine City ecodistrict along with two others, Lakewood Heights and Lithonia (Sustainable Atlanta, 2014). This organization has provided guidance and worked as a policy think-tank to assist these ecodistricts to develop cohesive strategies toward creating a neighborhood-driven sustainable location. To ensure that these districts are as efficient and environmentally stable as possible, Sustainable Atlanta will work to integrate the application of city government regulation with the mission of grassroots community initiatives. Items that are on the agenda for sustainable change include neighborhood farming, parkland creation, and energy grid alterations to improve efficiency (Briskey, 2014).

These ecodistricts also intend to adhere to the goals set forth by the Atlanta Regional Commission's Plan 2040 which includes all efforts initiated by the EcoDistricts Framework including economic, environmental, and transportation improvements (Atlanta Regional Commission, 2014). In addition, the ecodistricts look to the city of Atlanta's citywide sustainability plan, Power to Change (P2C), to frame their sustainable planning. Plan 2040 places the emphasis of community evolution onto neighborhood involvement, and as such, Sustainable Atlanta has created Look Up Atlanta. This is a social networking platform that exists online as well as in public forums which serves to engage the community in all policy decisions and design implementation for sustainable city planning. Look Up Atlanta has become an arena where decisions are discussed across jurisdictional platforms and where individuals, businesses, and property owners can begin to research, review, and act upon changes or movements that will impact the neighborhood (Look Up Atlanta, 2014). Power to Change has influenced these ecodistricts to dig deeper into the impact areas outlined by EcoDistricts and has added connectivity, education, smart growth, and communitywide awareness to the top of their list of priorities (Power to Change, 2014).

Through highly publicized civic action, the ecodistricts of Atlanta have become a pronounced part of the sustainable planning strategy for the city as a whole. In the coming years, Sustainable Atlanta intends to take on additional ecodistricts to supervise and guide toward the most effective means of sustainability and resilience for the city. Each ecodistrict will seek out recognition from the EcoDistrict Initiative, and follow through five stages of development (organization, assessment, feasibility, development, and monitoring) before being considered a functional ecodistrict, prior to which they will remain candidates (Sustainable Atlanta, 2013).

Seaholm District, Austin, Texas

The Seaholm area of Austin, Texas has been at the forefront of technological innovation for the last century with the use of a lime-application water treatment plant and the city's first electrical power plant. The integration of an ecodistrict in this area would re-instill a community driven to create new-age sustainable technology (Fisk III, et al., 2013).

This ecodistrict is defined by many of the standard Ecodistricts Framework ideals, but includes an additional discussion of functionality between sectors. For example, Seaholm would like to recognize where the relationships and overlaps between performance areas exist so as to utilize feedback looks that could improve efficiency and have an even greater impact on the area. Aside from functionality, the stakeholders of the ecodistrict have chosen to design more efficient distribution of natural and community resources. This increases availability and accessibility to all who work and live within the district (Fisk III, et al., 2013).

The district has a holistic approach to regional well-being and intends to support all entities in the triple bottom line – social equity, economic vitality, and environmental health – to help the area thrive. Seaholm shareholders intend to support each other in the mission of creating the district, and extend that support to new districts who will learn from the trials of this initial model. They would also like to make the ecodistrict distinct and interactive, so that its services are well identified and easily navigated by any and all. Ultimately, a primary goal of creating the Seaholm District is to make diligent use of renewable technologies and infrastructural additions that can aid in improving climate resilience and defend against the effects of global climate change (Fisk III, et al., 2013).

The shareholders of the proposed ecodistrict are looking into advanced technologies to achieve the social, environmental, and economic goals it has planned. One proposed innovation involves the implementation of building-integrated photovoltaic glazing on every new building to promote solar energy generation on every surface. This development would help to ease the issue of peak load energy consumption, and may help the area to become net zero or even net positive with regard to energy consumption. Another idea toward sustainable living in the area is the integration of living walls and roofs on major commercial buildings to aid in local food production, while also reducing the urban heat island effect by providing a conducive barrier from the sun. This food would then be sold to restaurants, increasing the regional economic value and sustaining the community. Greywater recycling would become a key factor in the issue of water conservation, and would help to irrigate public greenways and living roofs. In every part of the ecodistrict, interconnectedness is addressed to maximize efficiencies and ensure that needs are met for the entire area (Fisk III, et al., 2013).

Based on calculations performed by the Center for Maximum Potential Building Systems, the Seaholm District could potentially generate 3.67 MW of photovoltaic energy based on projected designs of south-facing vertical surface coverage, and 35.1 million KWh of solar thermal potential based on that of roof surface area coverage. In addition, through water catchment installations on roofs, the district could potentially harvest 8.98 million gallons of rain water per year, and another 36.6 million gallons per year could be recovered from stormwater capture and treatment. Lastly, if vertical surfaces and roofs were covered in agricultural plantings, the district could create up to 1.05 million pounds of food each year to sustain the community. These calculations are based on the fact that the district area receives anywhere from 740-1290 BTU/sf/day of sunlight and 52,950,000 gallons of yearly rainfall (Fisk III, et al., 2013). These forward-thinking resource utilization methods will increase the longevity and vitality of the district, and in turn, create an area that is resilient to drought, flood, famine, and climate change.

Kendall Square, Cambridge, Massachusetts

As home to large biotechnology and innovation employers such as the Massachusetts Institute of Technology (MIT) and Harvard, the Kendall Square ecodistrict intends to capitalize on the economy driven by this business, and engage shareholders to integrate sustainable ideals into the framework of the area. The direction of the ecodistrict is being monitored by a consortium of volunteers from varying arenas in the city including property owners, the Cambridge Redevelopment Authority, MIT, and several biotechnology companies (Kendall Square, 2014). The future of Kendall Square's zoning alteration is being shaped by the Boston Properties Rezoning for Broad Institute, which intends to increase the amount of residential housing available in the area, creating density. This density is key to maintaining the large biotechnology industry that exists in the area which requires hundreds of thousands of employees each year. This business leads to particularly intense energy usage, and thus the integration of renewable energy and increased energy efficiencies are of the upmost importance to this ecodistrict (Cambridge Community Development Department, 2013).

The ecodistrict sustainability goals include complete LEED certification for every building, cool roof requirements by either photovoltaic array or vegetation, and an 80% reduction in greenhouse gases emitted from current energy consumption in buildings. A retrofitting program is underway to ensure that energy consumption is reduced where possible. This energy consumption will also be affected through the installation of renewable energy sources, such as PV panels, that can generate what is needed on site without taking additional energy from the grid (Cambridge Community Development Department, 2013). In the coming years, the planning committee will look into alternate zoning for the area to allow cogeneration plants to be installed in many biotechnology and industrial spaces, and thereby maximize energy efficiency by using waste heat. Several institutions such as MIT and Biogen already contain cogeneration plants that service the buildings connected to their energy grid, and Veolia Energy runs a steam network that provides energy to businesses in Kendall Square (Cambridge Community Development Department, 2013).

As a method towards increased resilience, Kendall Square has looked to address flood and stormwater management by implementing permeable surfaces and monitoring peak runoff, groundwater recharge, and phosphorus management. Cambridge has infrastructural plans to divide stormwater and wastewater sewers to increase functionality, improve service, and reduce overflow. Green roofs and rain gardens, along with natural drainage elements such as bioswales, will help to control run-off from storms (Cambridge Community Development Department, 2013).

According to a report conducted by the Cambridge Community Development Department, through the initiation of the ecodistrict assessment and programming, Kendall Square has tripled its number of bicycle commuters, instituted a bikeshare system, and reduced its single occupancy vehicle ridership from 51% to 45%. As public transit is least prevalent and has the lowest frequency in Kendall Square, new modes of transportation have come into play to deter solo car commuting. Examples of which include the EZRide bus, with funding from the City of Cambridge and supporting businesses (Cambridge Community Development Department, 2013).

As an effort to increase sustainable living in the area, the Cambridge Community Development Department has defined strategies to improve wayfinding, increase access to public waterways, and draw attention to public spaces. To do so, the Kendall Square open space system, implemented as a component of the ecodistrict design, has been instituted to create plazas with central activity, bikeways and pedestrian paths for mobility, and informative signage. The renovation of older technology institutions to create a more inviting and open frontage is also underway to draw public attention and use of public spaces (Cambridge Community Development Department, 2013).

In order to address public space issues, low impact development will be installed to mediate stormwater runoff, public transportation options will be enhanced, and recycling and waste diversion services will become more efficient (Cambridge Community Development Department, 2013).

Little Tokyo, Los Angeles, California

In an area with prevalent single-occupancy-vehicle usage, Los Angeles is fertile territory for the integration of ecodistrict planning in the effort to enable sustainable living patterns and environmentally conscious development. The historic Little Tokyo district aims to begin this movement, and preserve its cultural identity while also enabling a bustling city district and the busiest transit stop in Los Angeles County. The redefinition of this area as an ecodistrict will drive a reduction in greenhouse gas emissions, a development of private-public partnerships, and an influx of goals met to strengthen environmental, social, and economic conditions (Little Tokyo Community Council Planning and Cultural Preservation Committee, 2014).

Aside from the preservation of cultural heritage, Little Tokyo plans to redevelop to become a complete community structure with mixed use buildings, public accessibility and mobility, and affordable housing. In doing so, the community will be intimately involved in the social framework of the ecodistrict, and will help to define programs for resource conservation and generation. The Little Tokyo Community Council, along with the help of developers such as Mithun, held a three day charrette to gather opinions, suggestions, and concerns from public agencies, community groups, businesses, residents, and cultural institutions in the neighborhood and determined the eventual identity of the area. This identity will encompass sustainable living, a complete and balanced community, economic vitality, and ample services for mobility. The ecodistrict intends to increase mobility through building complete streets which will provide protected lanes for bicyclists and pedestrians by placing a lane of parking in between these users and the motor roadway (Little Tokyo Community Council Planning and Cultural Preservation Committee, 2014).

The technical guidelines for the Little Tokyo ecodistrict were designated by the LEED for Neighborhood Development certification system, which led to integrated plans to quantify the amount of water saved, energy used, accessibility enabled, and affordability instated. Little Tokyo intends to achieve a 25% reduction in energy consumption, and a 10% rate of renewable energy production through the installation of solar energy in the ecodistrict. In terms of water conservation, Little Tokyo will conserve 36% more potable water and harvest 20% of stormwater through irrigation infrastructure and drought tolerant landscaping. It can achieve a gold or platinum rating if it manages to create a Parking Management District, incorporate green infrastructure, establish an efficient street grid, and several other sustainable measures (Little Tokyo Community Council Planning and Cultural Preservation Committee, 2014).

DowntownDC Ecodistrict, Washington, D.C.

One of the first established ecodistricts to take hold in the nation, the DowntownDC Ecodistrict, is world-renowned for its public transportation options, mobility, and accessibility. The area has been able to reduce greenhouse gas emissions by distributing the extensive Capital Bikeshare program which makes over 1,800 bicycles available to citizens at around 200 different stations throughout the system. The amount of Washington D.C commuters who chose to travel by public transit instead of car in 2012 was 55%, and by the year 2032, the city aims to achieve a 75% rate of non-single occupancy vehicle drivers, with 50% taking public trains and buses, and 25% walking and biking to work. The city also boasts a $1 per ride bus service called the Circular which rotates through a series of key business locations and is very well ridden, with over 5.7 million users in 2012 alone (DowntownDC, 2014).

This ecodistrict is also considered a Business Improvement District (BID), and as such has undergone extensive changes to establish a high level of efficiency and sustainability that benefits all shareholders in the area. In 2010, the ecodistrict reformed to adhere to the U.S. Department of Energy's Better Buildings Challenge and will reduce the general energy consumption of the district by 20% by 2020, even while the population of the area grows yearly. Buildings such as the Hotel Monaco and Macy's have increased their energy efficiency, installed new HVAC systems, and improved upon their cost savings by making more sustainable choices. In DowntownDC there are 99 LEED certified projects out of a total of about 550 residential, commercial, and industrial buildings, making this an exceptionally sustainable area (DowntownDC, 2014).

In order to enhance the overall social well-being in the ecodistrict, open space planning was integrated into the scheme of land usage. Currently, the 5 acres of open space known as Franklin Park is a major project for the ecodistrict taken on by the National Park Service to involve public programming and educational discussions as a way to manage and utilize the outdoor area. Within open space areas, waste management is crucial to maintaining a safe, clean, and healthy public environment, and as such, the ecodistrict has employed Safety and Maintenance employees to monitor the local recycling and refuse bins, and educate the public on the waste sorting system (DowntownDC, 2014).

Due to the polar vortex and inclement climate of 2014, the DowntownDC ecodistrict is pushing forward with advanced technology to upgrade the energy grid. This new "recharged" proposal will distribute renewable energy sources throughout the district, and eventually the city as a whole, to increase resiliency and prepare for emergency situations that continue to alter and damage the current energy grid. The options available for refreshed infrastructure include solar cells, micro wind turbines, and fuel cells that would all be linked to smart meters, and improve both efficiency for the city and pricing for users (DowntownDC, 2015).

Overall, sustainable improvement via ecodistrict implementation can be seen in this ecodistrict through its improved public transportation, increased access and mobility, and enhanced materials management systems. The city has increased resilience because it has strengthened its governance by communicating with its citizens on a district-scale, and responding through civic action (Eco-districts, 2014). This organizational structure can be replicated in San Francisco's Central SoMa region to positively influence the same challenges.

SW Ecodistrict, Washington, D.C.

This ecodistrict contains an amalgamation of several federal offices and entities, which makes its mission toward sustainable living and environmental consciousness very ambitious and also challenging. The SW Ecodistrict Task Force has taken on the role of assessing how federal natural resources and capital can be used to create a more sustainable and economically stable area in Washington, D.C. Over the next 20 years, the SW Ecodistrict Plan will be used to re-evaluate the needs of the area in terms of social, environmental, and economic improvement, and attempt to change conditions to fit these goals. The crucial elements of the Plan include creating a well-connected neighborhood that is a cultural destination with advanced environmental performance and a prosperous economy (National Capital Planning Commission, 2013).

Through redevelopment, infill, repurpose, and rehabilitation, the SW Ecodistrict will enable a new culture of densely functional living with accessibility to all amenities, including public open space. The Task Force has identified several green linkages throughout the city that aid in the connection of walkable and bike-ready park spaces that will be either historical and thus used for preservation, or active and used for recreation. The transit station will be innovatively used to manage stormwater and generate electricity through the installation of living roofs and solar panels, and main corridors and roadways will be revised to provide continuous civic usage including shopping, transit, recreation, and cultural landmarks. Along with green corridors, the ecodistrict will expand rail lines to increase service, place transit services closer together to manage efficiency of transfer, and upgrade street infrastructure to include bicycle lanes and parking in all parts of the area (National Capital Planning Commission, 2013).

In conceptual models, existing buildings can reduce their total average energy use from around 77 kBTU/sf/yr to 30 kBTU/sf/yr through energy efficiency upgrades. This increased efficiency will have a direct impact on the amount of carbon emitted by building energy usage, and could reduce existing levels from 25.4 lb/sf/yr to 6.0 lb/sf/yr. At this time, coal-fired energy is still the prominent fuel for electricity generation in the SW Ecodistrict. As this usage is converted to renewable energy, the district will begin to move away from greenhouse gas producing energy. The first building to initiate this movement is the U.S. Department of Energy which hosts a rooftop covered in solar panels. Executive Order 13514 also requires that all federal buildings under design from 2020 onward must reach net zero energy by 2030. The ecodistrict is also interested in using ground source heat and a central utility plant to supply and share energy amongst buildings on any block of the area (National Capital Planning Commission, 2013).

Block-scale water collection systems will be integrated into the framework of the ecodistrict to ensure that stormwater is captured on both roofs and streets, and that permeable planters can absorb rainfall to replenish underwater cisterns. This collected stormwater will be reused for landscape management in public areas, and greywater will be collected from sinks and showers for the same non-potable purposes. Each of these changes will result in an approximate 63% reduction in overall potable water use in the ecodistrict. Also, waste management diversion rates are forecast to raise to 80% in the ecodistrict, and 75% of all construction waste will be recycled to be used in rehabilitated buildings (National Capital Planning Commission, 2013).

Lloyd Crossing, Portland, Oregon

EcoDistricts is a Portland-born venture, and thus, the primary investigation behind whether ecodistricts would be practical in the context of regional planning in North America was initiated in Portland as well. The conception for Lloyd Crossing began in 2002 with the developer Mithun, and the team set out to create a neighborhood that established sustainability services beyond those that qualified for LEED certification (Mithun, 2014).

The groundwork for ecodistrict implementation in the Lloyd Crossing area began around 2012, and with it came a customized set of public priorities that would increase the sustainable value of the area. In order to enhance the functionality of standing building conditions in the area, an Existing Building Efficiency Program was planned to perform retrofits that would aid in achieving a 60% reduction of building energy consumption in the district by 2035. Also helping the district to achieve this goal is the implementation of a high performance standard on new construction in the area, an aggregate renewable energy program that consolidates efforts for solar installation, and a system to convert single-building thermal systems to district thermal system (Portland Sustainability Institute, 2012).

The development of a united district water utility project would aid the ecodistrict in obtaining an overall reduction of water consumption of 58%. In addition, the integration of a green site, street, and corridor program helps the ecodistrict to support the goal of obtaining 80% green infrastructure for the area (Portland Sustainability Institute, 2012).

Lloyd Ecodistrict also recognized the need for car and bicycle sharing programs which greatly aid in the reduction of greenhouse gas emissions and reduce congestion on roadways. Also, overall reductions goals are supported by the eventual use of a district dashboard which monitors environmental conditions in the ecodistrict and reports the energy, water, and waste consumption of every building in the district. Once project implementation has reached completion, and programs can be monitored and amended for efficiency, the ecodistrict intends to instate an eco-concierge who will be able to assist as a centrally located staff person from which to obtain information on promoting sustainable practices and applying conservation efforts to new buildings. This person would also conduct outreach to ensure that all parts of the ecodistrict are performing upkeep on their sustainable practices (Portland Sustainability Institute, 2012).

The sustainable planning and progressive thinking assessed for practical application in each of these ecodistricts could be strategized to fit the needs of San Francisco. In several instances, the initial prevention factor would be capital expenses, but it is possible that the resiliency needs of the city outweigh the financial burden recognized through environmental, social, and economic service upgrades. A summary of the more advanced ecodistricts along with their current successes can be found below in Table 1.

Table 1. Established international and national ecodistricts and their accomplishments as a result of ecodistrict planning and implementation.

Ecodistrict Name, Year Initiated	Sustainability Accomplishments Thus Far	Results or Savings from Ecodistrict Implementation
Malmo, Sweden (Bo01 and Augustenborg), 1998	• Solar City Malmö • Wind power plant installed within city • Extensive stormwater canal network • Biogas plants in every neighborhood • Specialized recycling management • Underground refuse system uses tubes and high powered suction	• Extensive rooftop and building-panel photovoltaic network • 11,100 m^2 of living roofs • 90% of all stormwater diverted into canals and green infrastructure • Composting on site of every building • Refuse collected remotely in single location, minimizing GHG emissions from truck collections
Dockside Green, British Columbia, 2004	• Biomass energy plant installed • Used water treated and looped back into buildings • Bioreactor wastewater treatment to absorb heat from dish, bath, sewage water • Permeable pavement and fly ash used instead of cement • $25,000 per dedicated parking spot	• 50% open space and greenways • 1,100 LEED certified buildings at completion • Platinum LEED Neighborhood Development • 3,460 metric tons of GHG emissions reduced per year • Fly ash more sustainable to produce than cement • Public transit, walking, and biking incentivized to avoid parking fees
DowntownDC Ecodistrict, Washington, D.C., 2012	• Capital Bikeshare program • Circular $1 per ride bus • Business Improvement District goals • Intensive waste management planning and Safety and Maintenance Employees designated to keep public spaces clear and welcoming • Large open space and park network (over 5 acres)	• Over 1,800 public bikes available at 200 stations • 55% of all residents are public transit riders, goal of 75% by 2032 (50% train/bus, 25% bike/walk) • Circular bus- approx. 5.7 mil users in 2012 • 20% reduced energy consumption by 2020 • 99 out of 550 buildings are LEED certified • Resilience planning- integration of new energy technologies (solar and fuel cells, micro turbines) and smart meters to guard against climate emergencies
Lloyd Ecodistrict, Portland, OR, 2002	• Existing Building Efficiency Program • High performance Standard on new construction • Aggregate renewable energy program • System to convert single building thermal to district thermal • District water utility project • Green site, corridor, and street program • District Dashboard to monitor all utilities and their consumption	• Measured beyond LEED certification needs • 60% reduction of energy consumption by 2035 • Efforts for solar installation consolidated • 58% reduction in water consumption • 80% green infrastructure in the city • Soon: Eco-concierge to help enable outreach on sustainability practices and improvements for the district, and city as a whole

Sources: Mithun, 2015; Portland Sustainability Institute, 2012; DowntownDC, 2015; Dockside Green, 2015; Malmö stad, 2014.

Chapter 4: Applicability of the Ecodistrict Model to San Francisco

San Francisco Ecodistrict Planning Model

San Francisco has several sustainable regulations and programs in place in its general city planning, but has enhanced this model with the integration of ecodistricts in its Sustainable Systems Framework for the future (San Francisco Planning Department, 2014).

While international ecodistricts are determined by the top-down approach to urban planning, San Francisco and the EcoDistricts Target Cities program locations follow a bottom-up method of city planning. This entails conducting workshops, informational meetings, and public hearings to integrate shareholder and stakeholder accounts and opinions into the preliminary set up for an ecodistrict. Whereas the European Union and higher governing bodies would have first and final say in the structure and funding of an ecodistrict, the community within a proposed ecodistrict in the United States would be the strongest proponent of advising the design direction (Maaoui, 2015). Many of these ecodistricts also spring from grassroots ideals and efforts that gain favor with general city government (Eger, 2013).

The San Francisco Planning Department has identified four potential types of ecodistricts for design reference in the city. The first ecodistrict is called the Blank Slate, and this land is likely to be owned by a single entity (individual or business) and devoid of development. These features allow for future linear development across the land, which can be primarily horizontal instead of vertical to accommodate mobility and transfer of large-scale goods. This is an area that may be keen for industrial purposes or may be useful in the means of delivering resources across different district types (City and County of San Francisco, Sustainable Development). Much of Hunter's Point and the Bayview area could be identified as a Blank Slate ecodistrict.

The second ecodistrict type is identified as the Patchwork Quilt, and is the defining ecodistrict type for the Central SoMa Project. This ecodistrict has several purposes and states of development within its borders. It also practices the process of infill development and coordinates new development to minimize its overall environmental footprint as a new community. There are several different qualities to the character of this area, and those are derived from the existing businesses and residents. The Planning Department therefore attempts to enrich this type of ecodistrict while also retaining the original cultural atmosphere of the area (City and County of San Francisco, Sustainable Development).

Type three is called the Strengthened Neighborhood. It is named as such because these areas are already as developed as they will become, but through supplementary focus on urbanism and unity, they can transform into a beacon of environmental sustainability and bustling culture. The San Francisco Planning Department has partnered with the Office of Economic and Workforce Development to promote the "Invest in Neighborhoods Initiative" in these areas to rejuvenate residential neighborhoods and their surroundings (City and County of San Francisco, Sustainable Development). Areas that are progressing toward the identification of a Strengthened Neighborhood ecodistrict are the Haight, the Castro, and the Marina.

The fourth and final San Francisco ecodistrict type is identified as the Industrial Network. These areas are vital to the city's functionality and economy, and therefore have a specialized need for attention and support. The businesses that are prevalent in the Industrial Network are those that perform production, distribution, and repair (PDR). These neighborhoods are a main focus of the Planning Department, and therefore the efficiency of their operation and distribution systems are of the utmost importance to the city as a whole (City and County of San Francisco, Sustainable Development). One example of an Industrial Network is the Dogpatch.

Each of these ecodistrict types, if adopted into city planning, will become more defined and identifiable as they grow and develop.

Moving Forward: Central SoMa Plan

In 2011, the SF Planning Department deemed "Central SoMa" to be the first ecodistrict in San Francisco which would boast improved streets, additional open space, and a vibrant economy to represent a model of sustainable growth. This first attempt shows a change in perspective for the city of San Francisco to operate sustainability efforts on a district basis.

In the creation of the Central SoMa ecodistrict there are five main goals that serve to enhance human health and well-being. They include shaping the area's urban neighborhoods, supporting workplace and transit-oriented growth, maintaining neighborhood diversity and economic strength, improving streets and open space, and creating a model of sustainable growth (City and County of SF, The Central SoMa Plan 2014).

As a result of a lengthy and exhaustive study performed by the San Francisco Planning Department, through funding provided by Caltrans, a Draft Plan was established to lay the groundwork for what was originally called the Central Corridor Plan. The plan area is defined by Market St. to the northwest, Townsend St. to the southeast, 6th St. to the southwest, and 2nd St. to the northeast. Through this plan, the city of San Francisco intends to implement the first efforts toward neighborhood-scale management of city-wide issues such as climate change adaptation, preservation of historic sites, and sustainable community building through residential and commercial cohesiveness.

The plan has been thoroughly reviewed by regional, city, and hyper-local representatives, and has received years of community input in order to achieve approval for placement. Through dozens of meetings with community groups, surveys, public meetings and hearings with the Planning Commission, the plan received input from community members and stakeholders aiming to develop in this upcoming area. The plan itself was renamed to Central SoMa to reflect the neighborhood characteristics and to keep with the community appeal of the area, and the Central SoMa Eco-District Formation Task Force was created (San Francisco Planning, 2015).

According to both international and nationally-based ecodistrict planners, community involvement will make ecodistricts successful, as many changes will be made within the district stakeholders to innovate sustainability practices. Thus, the city is continually collecting input on land use that includes building hotels, affordable housing, retail, community facilities, commercial buildings, and the repair of remaining buildings. The primary concern of the Planning Department is the distribution and addition of privately-owned public open spaces and the establishment of park networks (City and County of SF, The Central SoMa Plan 2014).

In 2014, an Environmental Impact Report of the Draft Plan was submitted as a mandatory component of the California Environmental Quality Act. The results of the EIR will be released in summer of 2015, but the anticipated study topics that could experience an impact due to the construction and implementation of the Central SoMa plan include land use, cultural resources, utilities, air and water quality, noise, wind, and shadow. The impacts that are expected to result in impact include hazardous materials (due to construction) and biological resources (due to high natural resource use in building materials and infrastructure). The areas where there are no anticipated negative effects, but potentially many positive ones, include recreation, public services, agricultural resources, population and housing, and energy resources among others. Once the results of this EIR are obtained, the Draft Plan will be revised and the Planning Commission will hold conferences and meetings to discuss the outcome and subsequent development (City and County of SF, The Central SoMa Plan 2014).

Jon Swae, Lead Planner at the San Francisco Planning Department and spearhead behind the integration of ecodistricts in San Francisco, states that construction of the Central SoMa Ecodistrict is set to begin by early 2016. This plan will showcase a new form of San Francisco land use development that is oriented around transit, as the area is located directly next to the new Transbay Terminal that is set for completion in late 2017 (Transbay Transit Center). Inside of the ecodistrict, construction is set for new high rise office spaces, multi-level residential housing, and mixed-use commercial shopping centers.

Community interest in the potential effects of ecodistricts is growing, and the Central SoMa EcoDistrict task force has worked extensively with EcoDistricts to create a full recommendation report for the priorities to address in the development (San Francisco Planning, 2015).

The Purpose of Ecodistricts in San Francisco

The San Francisco Planning Department has assembled an Environmental Sustainability report that states all of the achievements San Francisco has reached by instituting strict energy and retrofit codes, water conservation methods, and waste diversion programs (San Francisco Planning, 2015). This report also acknowledges the hurdles that the city faces in terms of increasing wild habitat corridors in an urban landscape and improving efficiency for increasing water and energy needs. The challenge that San Francisco faces is there is no direct path or program that implements multi- faceted sustainable services and ensures that they are monitored after their inception (Swae, 2015).

For this reason, the city is conducting research to assess whether the EcoDistricts model is the best match for attaining this overall sustainability in San Francisco. The build out of Central SoMa is in between project planning and implementation, and public open houses have helped to identify next steps for the city to take. Many agencies will be involved in the integration of this ecodistrict into the fabric of San Francisco, with the two most prominent being the SF Department of the Environment and the SF Municipal Transit Authority (Swae, 2015).

In order to enhance the existing research, this independent study has drawn on the successes of current international and national ecodistricts to evaluate their applicability to San Francisco. The public agencies that are just now beginning to integrate long-term sustainability planning into the city are, for the most part, jurisdictionally distinct (San Francisco Planning, 2014). Therefore, the implementation of ecodistricts could be more sensible for progressing these initiatives compared to a new, unified, city-wide agency. The forward-thinking examples discussed previously, such as Dockside Green and Kendall Square, offer an innovative approach to retrofitting outdated and underperforming neighborhoods of cities to become green.

In public discussion, conversations have prompted new initiatives that the city can envelope into their current planning to uncover where the gaps in conventional planning may exist. Examples of which include green roof installations, voluntary agreements for energy grid sharing, and changes to water, energy, and habitat systems (San Francisco Planning Department, 2015).

City Hall is currently working to increase programming focused on adaptation planning that concerns sea level rise and disaster preparedness, which are both areas of vulnerability and concern for the city as a whole, and relevant risks to the Central SoMa ecodistrict. Urban heat islands and congestion via population increase are impending issues due to climate change, as well, and each of these items would be analyzed under the assessment of ecodistrict implementation (Swae, 2015).

In order to prepare for San Francisco's continuing population increase, a sustainable systems mediator such as Ecodistricts will be necessary to facilitate future efforts toward green living in the city. Central SoMa, as a rough Patchwork Quilt environment with very few environmental amenities, would be a prime area to invest in the kind of neighborhood planning that could have positive impacts on social well-being, economic competition, and ecosystem functionality.

Current Environmental Programming and Organizations in San Francisco

In order to understand how the results of city-wide planning and sustainability efforts will be altered by the implementation of ecodistricts in San Francisco, it is important to know how these programs and services are currently organized. At this time, the public services or projects that exist in San Francisco to improve sustainability are costly and very time consuming. They are, however, entirely necessary for general welfare and the programs in place are making good progress toward creating a sustainable city structure. These agenda items range in focus from transportation efficiency, energy generation and use, waste minimization and diversion, toxic substance control, and public health. San Francisco also addresses the built environment, with emphasis on sustainable building materials and operations. There is also ample planning and emphasis placed on climate change adaptation due to San Francisco’s vulnerable coastal location. Each of these areas is pertinent to the topic of environmental resiliency and stewardship, and should be of utmost importance in the creation of an ecodistrict through community effort and vision. Within these areas, there are several programs and services that operate through NGOs and government organizations to enhance sustainability on a city-wide basis:

Transportation

Increased means and efficiency of transportation is one of the main goals of San Francisco City and County. This means that public transportation (buses, commuter rail), independent travel (bicycling), and automotive vehicle commute (cars, vans, rideshares) usage are monitored. Examples of transportation innovation offered by the government and non-government organizations are offered below:

<u>Commuter Benefits</u>

In order to encourage the use of public transportation, many public and private companies have taken on commuter benefits such as reduced or free transit passes, bike parking, vanpooling, ridesharing, or parking passes. Many businesses now offer emergency ride home, a program that will reimburse any expenses to an employee who needs to take a trip home in the case of personal emergency (SF Environment, SFCCC).

San Francisco Clean Cities

In order to better mitigate emissions and limit congestion, this government-centered coalition works to reduce petroleum consumption and progress the economy and environmental conditions toward healthier options. This includes turning to clean fuels, such as biofuels that are generated from biomass, liquids, and biogases. Included in the transition to cleaner fuels is the promotion of cleaner burning, lower emission vehicles (SF Environment, SFCCC).

SF Electric Drive

Electric vehicles release no emissions and have a relatively low carbon footprint compared to conventional vehicles. City government and large corporations that depend on transportation services are transitioning into electric vehicle fleets. This government initiated program installs electric vehicle recharge stations around the city and is increasing the infrastructure available to ease the public's transition into electric vehicles (SF Environment, Transportation).

Energy

There are several benefits and incentives offered to homeowners and landlords to update the lighting fixtures and appliances in their homes to Energy Star-rated and highly efficient models to conserve energy and keep electric bills low. These incentive programs can come in the form of monetary pay-out to the homeowner, or they can act as a long-term benefit through raised re-sale value on the property once it is placed on the market (SF Environment, Energy Efficiency).

Residential:

Residential Energy Efficiency Rebate

Pacific Gas & Electric will offer Green Home Assessments to residents who wish to improve their home energy consumption by sealing air ducts, replacing insulation, or updating heating and cooling systems. The resident will then receive a monetary incentive for performing these energy conserving upgrades (DSIRE, 2015).

Solar Energy Incentive Program

Residents must apply for and receive approval by the state-governed California Solar Initiative in order to participate in this program. Once approved, the San Francisco Public Utilities Commission provides incentives of varying amounts to residents. The amount received can depend on their annual income and the installation company used. This incentive is also offered to commercial and multi-family residential buildings, and these incentives can differ between for-profit and not-for-profit institutions (DSIRE, 2015).

While these are ambitious programs that aim to limit energy usage from a large proportion of city infrastructure, the emphasis for achieving and improving energy efficiency has been placed on commercial and multi-family buildings.

Commercial and Multi-Family Residential:

SF Energy Watch

This government-oriented program has an impact on general energy usage by encouraging and aiding businesses, apartment complexes, and other large buildings along the course to becoming energy efficient through the installation of updated equipment. They provide supervision and maintenance of all energy services, and offer financial incentives to building managers who wish to participate in this program (SF Environment, Energy Efficiency).

Energy Upgrade California Multifamily

A state-monitored program which offers $750 in rebates per unit to property owners in order for them to more effectively perform energy efficiency updates. This program also offers technical support and advice as the buildings are renovated to meet efficiency goals (SF Environment, Energy Efficiency).

Different from incentive programs are ordinances to which property owners must adhere. Examples include:

<u>Existing Commercial Buildings Energy Performance Ordinance</u>

The requirements mandated by this ordinance include the building receiving an energy audit every five years, and reporting on the benchmark of the building's energy use each year. By taking these figures into account, city planners and auditors can monitor energy usage of several different building sizes and use that data to mitigate emissions by controlling energy pricing. Some examples of energy pricing are increasing-block rates, seasonal rates, and time of day pricing (EPA, Pricing Structures 2012).

<u>Commercial Lighting Ordinance</u>

San Francisco also requires non-residential commercial buildings to use fluorescent lighting that meets a specific efficiency standard (SF Environment, Energy Efficiency).

<u>American Recovery and Reinvestment Act</u>

This act ensures that inefficient steam boilers are also replaced by the city (SF Environment, Boiler Replacement).

<u>Renewable Energy Task Force</u>

In terms of renewable energy, the renovations necessary for the transition of city buildings away from conventional grid energy are still relatively in the planning stages. Mayor Ed Lee established this group in 2011 in order to acquire a 100% renewable energy supply for the city by 2021 (SF Environment, San Francisco Mayor's…)

CleanPowerSF

This city-governed organization is a Community Choice Aggregation which allows the city and county to leverage its citizens' requests to purchase only renewable energy. There are several renewable options available to the city, and many of them have moved into the general energy market. These include solar, wind, hydro, geothermal, and biomass or biofuel.

GreenFinanceSF

This program offers finance options in the form of municipal bonds to property owners for renewable energy, traditional energy, and water projects, and allows them to pay back their debt through their property tax account (SF Environment, Renewable Energy). This is the most prominent San Francisco organization that is initiating the overhaul of conventional energy and transforming it into green energy.

San Francisco's Public Utilities Commission

The city also operates nine municipal solar installations which produce up to 7.2 megawatts of energy each year, and feed into the general grid of the city. Solar panel installation is largely incentivized to homeowners through tax breaks and monetary compensation. This transition to solar is recognized as one step toward fully renewable energy, but there are active wind generators in and around San Francisco that feed into the grid and can be observed on the San Francisco Energy Map. (San Francisco Energy Map, 2014) (SF Environment, Energy Efficiency).

Zero Waste (Including Food Waste)

San Francisco is heavily invested in the reduction of waste, especially concerning plastics and consumer packaging, and has therefore implemented various ordinances to reduce the use of these items in local businesses.

Checkout Bag Ordinance

One of the most heavily enforced waste reduction strategies that San Francisco has engaged. It has encouraged the use of reusable bags in all grocery and retail stores by charging the customer extra for a paper bag. Plastic bags have been banned entirely.

Food Service Waste Reduction

A supplemental ordinance that has required restaurants and food service providers to provide compostable utensils and containers.

SF Food System Policy Program

Aside from waste generated from production, the large priority in minimizing waste in San Francisco is based on reducing valuable food waste through an efficient food system policy program. In order to ensure that food is used efficiently and sustainably, an urban food system implements all processes of food including production, processing, distribution, consumption, and recycling. The SF Planning Department has an established this policy program that encompasses both community gardens and large farms surrounding the Bay Area, along with all types of food producers in and around SF County. There are studies in place to investigate food aggregation and food industry clusters, and these will ultimately help to determine where food resources can be conserved and better managed (City and County of San Francisco, Food System Policy Program).

San Francisco Urban Agriculture Program

This city program operated by San Francisco Recreation and Parks oversees all community gardens and agricultural efforts from rooftops to backyards to schools, and maintains regulations on these entities. Overall, this organization serves to strengthen the general intention of San Francisco food policy and services. This means the ability to provide healthy, community building, sustainable, and economical access to food for all social groups in San Francisco. SF Rec & Park performs community garden programs, extends outreach and news on local gardening, and supplies advice for city resources and urban agricultural centers that can help aid individuals or organizations in starting or maintaining their own garden (San Francisco Recreation and Parks, 2015).

Mandatory Recycling and Composting Ordinance

This government ordinance amendment to the San Francisco Environment Code (Chapter 19, Sections 1901 – 1912) ensures that residents and businesses sort their trash, recyclables, and compostable waste. The business who runs this city-wide program is called Recology, and they operate their trash collection daily, alternating neighborhoods for pickup. The same waste recovery is applied to construction and demolition debris recovery, and large events that require recycling and composting such as music festivals. The city government has the intention of achieving zero waste in the city by the year 2020, and hopes to place greater emphasis on toxic waste derived from businesses and home products. Consumers can also opt into a program that prevents unwanted junk mail and phonebooks from being delivered to their homes. (SF Environment, Zero Waste).

Toxic Waste

Toxic wastes in San Francisco are commonly generated in households and businesses, and these materials can be picked up by the city through the Department of Public Health.

Very Small Quantity Generator Program

If a business qualifies, it can have a licensed hazardous waste officer haul away the toxic materials. Businesses also have other initiatives to meet including using chemically safer products, prioritizing employee health, and managing pests.

Green Business Program

Businesses have the option to apply for this certification if they would like to achieve that goal. They must undergo rigorous inspection by city representatives to ensure that their operations are sustainable and environmentally conscious.

Residential homes have several toxic materials guidelines for products to adhere to including personal care, flame retardant chemicals, motor oil, cell phones, children's products, and plastics, among others. City staff and policymakers follow many of these same principals with the addition of monitoring local businesses such as chemicals from nail salons and garment cleaners, fats and oils from restaurant kitchens, and mercury from dentistry operations (SF Environment, Toxics & Health).

Buildings and Environments

There are four components of sustainable environment principals that are followed in San Francisco which include green buildings, urban forestry, urban agriculture, and the natural, unbuilt environment. San Francisco buildings are greener than many in the world, through assistance from the sustainable workforce and green contracting businesses. Many buildings also receive incentives, financing, rebates, and resources from the city to update their infrastructure and facilities. This applies to both new construction as well as existing residential and commercial buildings. The city government intends to represent these ideals and show a progression of green building by creating their offices and buildings to the highest possible standard and providing leadership and tools to other buildings hoping to achieve these same goals. Policies and guidelines are also in place to encourage the development of green roofs with water catchment and rooftop gardens.

<u>Urban Orchards Project, Friends of the Urban Forest</u>

These non-government organizations protect urban forests and help to establish a denser canopy in the urban core. This means planting new trees in parks, sidewalk spaces, backyards, rooftops, etc.

<u>The Landmark Tree Program</u>

This organization preserves the best, rarest, and oldest trees in the city that warrant historical, ecological, or social protection.

The Urban Forest Plan

A program currently being enacted as a way to focus on the health and management of street trees, and to hopefully increase their numbers (SF Environment, Urban Agriculture).

Water Efficient Irrigation Ordinance

Urban agriculture must adhere to certain zoning laws and permitting ordinances, and this one ensures that designers of new landscape projects will install and maintain efficient means of irrigation and use native, drought-tolerant species on the land (SF Water Power Sewer, 2013).

SF Public Utilities Commission, SF Planning Department, and SF Department of Public Health

Each of these government organizations has stakes in the regulation, placement, and safety of community gardens and green spaces. The city has resources and support available to urban farmers to teach them proper growing and harvesting technique, along with continual education services that community members can use to turn their agriculture ventures into personal income or sustenance (SF Environment, Urban Agriculture).

The Urban Agriculture Alliance

This supplementary non-government organization provides the above-listed educational services, and the project San Francisco Food plans many of the same programs through the Interagency Healthy and Sustainable Foods Working Group. Social implementations through natural resources such as composting, farmers markets, and sustainable building and landscape materials are all a part of urban agriculture. Seed banks can also offer reserves for special natural resources that can be used to harvest gardens in years to come (SF Environment, Buildings and Environments).

Biodiversity and Natural Resource Policy

The natural, unbuilt environment offers many ecological services to the residents of San Francisco, and it is therefore protected by the city. This includes natural spaces like gardens, nurseries, national parks, biodiversity, and wild spaces. In order to benefit future generations of

San Francisco residents, the city and county has created this cohesive plan to integrate land protection, environmental stewardship initiatives, and urban greening into the existing city planning (SF Environment, Background & Need).

Climate Change

San Francisco is one of the leading cities in the world in the race to prepare for the effects of climate change, and takes government action to ensure that community members and businesses do their part to reduce their carbon emissions.

San Francisco Carbon Fund

This city-organized fund allows conventions or gatherings to contribute money toward local projects in order to mitigate the carbon emitted by participants travelling to the event. This payment can be generated via ticket service fees or a general flat rate, depending on the event organizer. The fund finances projects which reduce the general carbon footprint of the city and adds services such as community parks and trees which sequester carbon. The city also recognizes the need to prepare for adaptation to alterations in climate trends. Therefore, these funds can be applied to projects which mitigate environmental impacts such as storms, flooding, urban heat islands, sea level rise, and more (SF Environment, Climate Change).

SF Adapt

The primary organization that facilitates progress in climate adaptation efforts including biodiversity studies, sidewalk garden installations, and local restoration projects. This organization works very closely with the government agencies in San Francisco to create a cohesive plan toward adaptation, especially in regard to sea level rise (SF Environment, Adaptation).

Business Council on Climate Change

This city-driven nonprofit aims to limit emissions from transportation and energy use by working with businesses, residents, and government agencies to achieve reduction goals. They also work to provide assistance to have electric vehicle charging stations installed at businesses in parking lots and at commercial and residential locations (Business Council on Climate Change).

Each of these priority sustainability areas provide an optimistic vision for the future of San Francisco, but the city has experienced delays in service efficiency and effectiveness due to site-by-site policy revision instead of long-term vision (San Francisco Planning, 2014). By implementing a program for the facilitation and monitoring of sustainability services like Ecodistricts, the city will improve upon its civic duties including waste management and open space planning, along with the development of energy grid and water conservation methods. This potential will be discussed ahead.

A Need for Strategy Change in City Planning

While San Francisco has made advanced progress on disseminating citywide sustainability measures, it has not yet been as successful at neighborhood development and sustainable measures on a district scale. This has prevented cohesive planning for integrated neighborhood energy grids and water conservation systems. As a vulnerable metropolitan location, San Francisco needs more effective methods for instituting environmental stewardship and resilience.

The value of community building and environmental stewardship is more crucial than ever with the onset of climate change and its severe effects. San Francisco is subject to sea level rise, urban heat islands, and a slew of other climate-related issues that can affect its dynamic population in a multitude of ways. It is therefore necessary to find the best integrative processes that allow for sustainability, vitality, and longevity in the urban landscape so that city and regional planners can better adapt to and mitigate against environmental stressors. Since environmental health is one of the major indicators of social health, it is important to look at the incorporation of regional planning into environmental sustainability, and ensure that the resources that keep a society thriving are protected and can provide for future generations. Factors such as population increase, degrading quality of public infrastructure, energy demand,

and sea level rise are all crucial in designing the improvement plans for San Francisco's urban and ecological future.

A one-size-fits-all approach to sustainable development does not serve all areas in the city equally. There are very diverse areas of San Francisco, and each of these areas has different topography, environmental concerns, financial status, and population count, among many other metrics. For example, in 2009 there were over 45,000 people living in the Sunset District with a median income of $73,000 each year, while during that same time there were nearly 23,000 people living in the Marina who made an average of $102,000 each year (SF Planning Dept., 2009). Though these numbers have changed in the last five years since this census was conducted due to an average increase of over 10,000 people moving to the city every year, these facts represent the demographic diversity in San Francisco (Barmann, 2014). In light of this diversity, the implementation of ecodistricts in San Francisco has the potential to provide more social services and encourage collaborative effort to ensure equity amongst the people living in a specific district. Human health may also improve due to increased green space and environmental services which promote good air and water quality, and effective waste management systems. Vinnitskaya (2013) found in her report on ecodistrict assimilation in metropolitan areas that a community-driven development pattern would be crucial to the success of an ecodistrict, from which a holistic approach to support and improvement can be generated. Through working together, a sense of urban identity and unity can be established.

As San Francisco is one of the most heavily regulated cities in the world, its government is well aware of the environmental challenges that it is up against in the next few decades. At this time, the public services or projects that exist in San Francisco to improve sustainability are costly and very time consuming. Though the system for public planning is very advanced, jurisdictional conflict and capital expenses can lead to piecemeal development and short-term policy creation (San Francisco Planning, 2014).

Priority Sustainability Areas

The areas of priority for the city as a whole continue to be water conservation, energy efficiency, and ecosystem functionality. This is because the majority of San Francisco is a dense metropolitan location with very few green linkages, minimal springs and waterways, and dated infrastructure (Swae, 2015). All of these factors make Central SoMa a location with very low biodiversity levels and an inefficient built environment that supports a large part of the growing population in San Francisco (San Francisco Planning, 2015). As the Central SoMa district unfolds, the value of integrating details such as micro-wind turbines, solar panels, green roofs, and permeable walkways into the neighborhood will need to be addressed and formally planned in order to initiate positive sustainable change for the city as a whole. A summary of these three priority sustainability areas, along with the recorded added benefits of ecodistrict implementation, can be found below in Table 2.

Energy Generation and Consumption

Currently in Central SoMa, only 3% of total yearly commercial and residential building energy demand is met by renewable energy resources (San Francisco Planning, 2015). The majority of electricity is produced by carbon-based fuels, with the largest subset of energy purchased from natural gas-burning and nuclear providers. As the population increases in density in the downtown region, greenhouse gas emissions will be amplified if sustainability measures are not put into place. Recognizing this environmental and social setback, the city intends to reach a city-wide goal of 80% reduction of greenhouse gas emissions by 2050. The Central SoMa district, however, will take on a more disciplined approach to emissions reductions by becoming an entirely carbon neutral neighborhood through the offset of any activity in the area. This means that any and all carbon emissions will be removed or sequestered through technological efforts and natural habitat expansion (San Francisco Planning, 2015).

While it is not definite that ecodistricts will help the city to achieve this ambitious goal for the Central SoMa neighborhood, they have actively and successfully reduced greenhouse gas emissions and set up renewable energy networks for other existing ecodistricts (Dockside Green, 2015). The implementation of an ecodistrict can ensure that the goal of 50% of all renewable energy used in the area is also produced in the area via rooftop solar and micro-wind turbines. This measure would help the neighborhood to prevent future energy disasters or shortages, and improve general resilience for the district by keeping energy resources localized, as opposed to purchasing from large regional energy plants that may experience overload or shutdown (San Francisco Planning, 2015).

A primary environmental and infrastructural initiative of ecodistrict formation is the observable reduction of energy consumption. Living City Block and Ecodistricts alike are looking into creating areas of independent energy called Clean Energy Districts and Solar Empowerment Zones, which rely solely on renewable energy (Grace, 2012). Urban researchers from these organizations have studied neighborhoods that can be powered through geothermal or micro-solar power grids, which limit the need for extensive and expensive region-wide systems. Places like Denver and New York are envisioning retrofits of run down neighborhoods which incorporate solar panels and micro-wind turbines for independent energy generation (Hanscom, 2011). Creating an ecodistrict in San Francisco presents the opportunity to create a local supply of resources and help to attain the goal of 100% renewable energy supply in the city by 2021 (SF Environment, San Francisco Mayor's…).

By orienting the scope of city planning into the district-scale designation of ecodistricts, it is also possible for the Central SoMa area to retrofit older buildings to improve efficiency, and construct new buildings that adhere to the carbon neutral goal of the neighborhood. As seen in the Kendall Square ecodistrict example, buildings consume the majority of energy in cities and can be altered and upgraded to minimize their impact. Ecodistricts can help to manage this retrofit activity by developing new energy auditing guidelines, locating funding sources and tax incentives, and monitoring progress of construction, all in a centralized neighborhood. They can also work to develop regenerative buildings which produce renewable energy and feed excess, unused energy back into the neighborhood grid. Alternate renewable energy production methods such as photovoltaic window paneling and geothermal systems have also been seen on buildings in ecodistricts (Malmö stad, 2014).

In preparation for renewable energy capabilities, ecodistricts will help Central SoMa, and in turn the whole of San Francisco, to transform their energy usage and update their utilities connections. These changes, witnessed in some of the more successful ecodistricts to-date, can be achieved in San Francisco and would increase the impact of sustainable planning and resilience for the Central SoMa ecodistrict as a starting point.

Water Conservation and Usage

In San Francisco as a whole, rainwater collection is virtually non-existent. This is especially true of the Central SoMa region, where over 90% of the area is covered in impervious surfaces such as cement. Also, there is currently minimal graywater recycled, and seldom is this water used for public land irrigation and toilet flushing. In California, where drought conditions have subjugated cities to mandatory reductions in water usage, San Francisco has successfully reached below the 2020 urban water use standards for daily per capita water usage in the city (San Francisco Planning, 2015). However, it has not achieved the same standards for all neighborhoods. Implementing an ecodistrict in Central SoMa will have a beneficial impact on the measures needed to retain rainwater, manage stormwater, and conserve irrigated water that is used in buildings.

The combined stormwater and sewage system in San Francisco is over 100 years old, and therefore requires constant attention and maintenance to ensure its efficiency and functionality (MuseumCA). As the ground in the Central SoMa region is largely impervious, all stormwater floods into drains which then is redirected to the ocean. This water could be used to irrigate public landscapes, flush toilets, water urban gardens, etc. The integration of ecodistrict planning in this area will make water recycling and management more streamlined for the city as a whole. With the multitude of new development projects that will be conducted over the next few decades in the Central SoMa area, there is room to engage new technologies that will make this necessary water management more feasible.

In aiming for water efficiency, an ecodistrict can help this neighborhood to install only the most sustainable versions of toilets and showers, and integrate a network of green infrastructure to obtain water in the public landscape. This means that, like in the SW Ecodistrict in Washington, D.C., building roofs will have rainwater catchment systems and gardens that absorb water, and roadways will have permeable surfaces that help water to percolate into the groundwater storage. By working with existing utilities agencies such as the

San Francisco Public Utilities Commission and the Department of Public Works, Central SoMa can become one of the first neighborhoods in the city to reduce its overall potable water usage and initiate a Low Wastewater District (San Francisco Planning, 2015). Low wastewater would indicate that the district could manage the capture, filtration, and distribution of stormwater in its own district parameters.

As the drought can make water more expensive and harder to access, ecodistricts can also help Central SoMa to diversify their water supply through the extensive recycling of all water on site, and eventually develop a treatment plant that is exclusive to the Central SoMa area (San Francisco Planning, 2015).

Habitat & Ecosystem Functionality

Many of San Francisco's open lands are unmanaged or are managed by multiple entities which may not prioritize the control of invasive species and other threats to biodiversity. Many of these threats, such as species range shift, will emerge as climate change becomes a more prominent factor in shaping cities and their policies (SF Environment, Background & Need). In the Central SoMa Corridor, there is less open space and parkland than in any other neighborhood of San Francisco. These setbacks lead to low biodiversity levels and a lower sense of well-being and effectiveness through city policy planning (San Francisco Planning, 2015).

Tratalos et al. state in their study on ecosystem services that generally, high density urban development, like that seen in Central SoMa, correlates with negative environmental performance in terms of green space availability and environmental services provided. There are low biodiversity levels in most urban landscapes and human well-being is damaged by a lack of environmental concern. Central SoMa exemplifies this issue by consisting of 90% impermeable surfaces and extremely low access to green, open space (San Francisco Planning, 2015). This indicates that there is hardly any natural landscape on which native flora and fauna could thrive or reproduce. This is why the implementation of ecodistricts in this dense metropolitan area is necessary as a means toward the general improvement of city living, as well as the formation of a sense of place. Through a collaborative effort between governments, NGOs, not-for-profits, and community members, neighborhoods in downtown San Francisco can begin to enhance environmental protection through education, restoration, and conservation. This effort in an urban setting leads to more sustainable communities who work together to improve their general well-being and benefit from green space (Eco-districts, 2014).

Central SoMa ecodistrict implementation will help this area to double its tree canopy coverage and extended green spaces by 2030. In doing so, the district will develop a network of rooftop and street-level vegetative surfaces, including on the sides of buildings and on the tops of bus stops and transit hubs. Cement sidewalks and other impermeable surfaces will be replaced by pervious pavement and low-emission construction elements such as fly ash in the Dockside Green ecodistrict. By 2025, the district anticipates increasing the amount of permeable surfaces by 100%, and as such, developing increased biodiversity levels in the new green habitats (Swae, 2015).

The San Francisco Planning Department, with the assistance of the SF Department of the Environment and other city agencies, has initiated the Central SoMa Habitat Plan, which intends to make these goals a reality within the next 25 years. Unfortunately, there is no single agency that is allotted the responsibility of initiating contracts and agreements with all stakeholders in the area to make this vision a reality (San Francisco Planning, 2015). Ecodistrict implementation would help to overcome this challenge by delegating an agency to mediate efforts between responsible parties, perform research to maximize efficiency, and reiterate projects to improve them along the way to sustainable success.

One of the ways that an ecodistrict-devoted agency as an overseeing entity can help to achieve Central SoMa sustainability goals is by developing the guidelines necessary to streamline the addition of new vegetation planting, parkland orientation, and urban gardens (Portland Sustainability Institute, 2012). As natural habitat is integrated into the civic landscape, the biodiversity levels will rise, and the ecodistrict meditators will ensure the health of the new flora and fauna that inhabit the area. This lead agency can also help to ensure that any added habitat is connected to existing open space like the Bay waters or Mission Creek so that the migration of species is made possible without urban interference (San Francisco Planning, 2015).

The growth of public parklands in civic locations has documented health benefits and helps residents of cities to feel a deeper connection to their surroundings (Maller, 2005). The integration of ecodistrict planning in the Central SoMa area will aid residents and employees who spend time in the district to connect with the landscape, and see it within the context of the cultural history of the area (San Francisco Planning, 2015).

Table 2. Current sustainability challenges in the Central SoMa area, the policies in place to improve them, and the potential outcome for water, energy, and habitat conditions through the implementation of the Central SoMa ecodistrict.

	Priority Sustainability Areas		
	Water (Consumption and Retention)	Energy (Generation and Usage)	Habitat (Ecosystem Improvements and Green Space)
Current Challenges	• 90% impervious surfaces • No graywater recycling • No organized rainwater catchment systems • Water demand expected to rise to accommodate population growth	• 3% of total yearly usage from renewable sources • Majority of energy generated from fossil fuel sources • Energy usage expected to grow with population incline	• 4.7% open space compared to 22.8% for all of San Francisco • Lowest biodiversity levels in San Francisco • Area prone to sea level rise, drought, extreme heat events
Current City Policies in Place to Regulate These Challenges	• Required fixture repairs and replacements toward high-efficiency options in residential and commercial buildings • Replacement of old or leaking plumbing • New landscaping must use drought tolerant plantings • Permitting process streamlined to allow water catchment and graywater recycling • Dual plumbing "purple pipes" (for future recycled water systems) must be installed in all new construction for buildings over 40k sq.ft. and irrigated areas over 10k sq.ft.	• 25% GHG Reductions below 1990 levels by 2017, 40% by 2025, and 80% by 2050. • 100% renewable energy by 2030 • All newly constructed buildings must meet or exceed CA Title 24 Energy code by up to 10% • Mandatory retrofits and energy audits for older residential and commercial buildings over 10,000 sq. ft. • Financing provided for efficiency updates by the Property Assessed Clean Energy program	• Target of 50,000 new street trees planted citywide over the next 20 years (one tree for every 20 ft. of building façade) • New Green Connections program strategies underway to bring natural spaces into 24 city corridors (3 in Central SoMa) • Bird-Safe Building Standards to prevent collisions • Improved accessibility to parks and green improvements by the Urban Forest Plan • Minimize water waste through green infrastructure

Potential Outcome with the Implementation of Ecodistricts	• Only non-potable or recycled water used for non-potable uses (landscape, toilets, etc.) • Efficient and audited water usage systems • Diversified water sources (graywater, stormwater, blackwater, etc.) to reduce potable H2O use • Foundation drainage can be used to run heating and cooling systems • Stormwater infrastructure to capture natural drainage • Low Wastewater District	• Create a net zero energy and carbon neutral district • 100% of energy consumed by buildings produced by renewable sources by 2030, 50% by rooftop solar, and 50% purchased • Efficient and audited energy systems by 2020 • Energy Efficient Construction Retrofits program in place by 2030 • All energy usage benchmarked and disclosed to the city for all buildings	• Double the tree canopy and overall greenery in Central SoMa by 2030 by planting trees, creating green roofs, and building habitat along paved surfaces • 100% growth of permeable surfaces by 2025 • Use of green or living walls to increase biodiversity levels and viable habitats • More privately owned public open park spaces

Sources: San Francisco Planning, 2015; Central SoMa Ecodistrict, 2013.

Chapter 5: Discussion

Assessment of Environmental Improvements through Ecodistrict Implementation

While the integration of ecodistricts into San Francisco will not have an immediate impact on environmental resilience for the city as a whole, the components of this neighborhood planning method will help to ease the impacts of climate change for the future residents of San Francisco. The Central SoMa Ecodistrict exists as one part of the Central SoMa redevelopment design. While they are concurrently planned, the ecodistrict will be a large component of the sustainability framework that goes into the creation of this new San Francisco neighborhood. The ecological footprint of the Central SoMa area will be reduced by instituting services that establish a regenerative community (San Francisco Planning, 2015). Also, the addition of district scale infrastructure can provide additional resilience for the city as a whole over the long run by correcting the damage done by importing water and energy into the city (Tam, 2015).

Ecodistrict implementation will offer the opportunity to experiment with adaptation requirements and sustainable programming to improve upon city services. New technologies would be made possible in an area like Central SoMa, where density can make these ventures worth the investment. The implementation of ecodistricts in San Francisco will be helpful in the mission to conserve and recycle water through greywater systems and groundwater preservation policy. They may also be able to facilitate the scaling up of local renewable energy by serving as a template for the rest of the city to follow (Tam, 2015). Natural habitat and ecosystem functionality will also increase in density and quality as the integration of green spaces in urban settings is imperative to the ecodistrict plan. The implementation of ecodistricts helps to enforce sustainable integration and innovation at the neighborhood level, and develop cohesive solutions for resilience issues that the city faces as a whole.

Energy

The energy component of greatest concern for the Central SoMa area is the integration of renewable energy sources to alleviate the usage of fossil fuels and reduce the area's yearly greenhouse gas emissions. This region of San Francisco emits relatively few greenhouse gases by comparison to the rest of the city since there is less residential housing and more accessible public transit, hence fewer single occupancy vehicle drivers. Despite this fact, current residents in Central SoMa use 37% more electricity annually than residents of other neighborhoods in the city, 2,416 kwh/cap compared to just 1,762 kwh/cap (Central SoMa Ecodistrict, 2013). As stated previously, only 3% of that energy consumption is derived from renewable energy sources. Ecodistrict implementation in this regard can be the most sustainable way to achieve patchwork improvements that can aid the city in its mission to reach 100% renewable energy consumption by 2030 (San Francisco Planning, 2015).

San Francisco has the opportunity through ecodistrict planning to reshape the entire Central SoMa area, and can use many of the sustainability projects from established ecodistricts to plan the course of change. The SW Ecodistrict in Washington, D.C. is a neighborhood that is in a similar planning stage to San Francisco. In conceptual models for the SW Ecodistrict, existing buildings can reduce their total average energy use from around 77 kBTU/sf/yr to 30 kBTU/sf/yr through energy efficiency upgrades and the integration of renewable energy into the neighborhood grid. This increased efficiency will have a direct impact on the amount of carbon emitted by building energy usage, and could reduce existing levels from 25.4 lb/sf/yr to 6.0 lb/sf/yr. At this time, coal-fired energy is still the prominent fuel for electricity generation in the SW Ecodistrict (Capital Planning Commission, 2013). The Central SoMa area is predominantly run on natural gas electricity, and thus has several opportunities, including financial incentives, for energy upgrades toward renewable energy. Alternate energy projects from aforementioned ecodistricts are biogas plant installations as in Malmö, Sweden, and biomass reactor plants in Dockside Green, British Columbia. As Central SoMa infrastructure will eventually be retrofitted to accommodate green spaces and permeable surfaces, these options lend both dispersed (building to building) and consolidated (district-run) opportunities to minimize energy consumption and capitalize on future technologies to benefit the neighborhood.

Water

Due to California's current drought status, the preservation and harvesting of water is of the utmost importance. While San Francisco as a whole has successfully reached a daily per capita water usage below the 2020 urban water use targets, the Central SoMa area remains covered with nearly 90% impermeable surfaces (rooftops, streets, and infrastructure, etc.) and has no city-organized method for water recycling (San Francisco Planning, 2015). Though there are plans to retrofit older buildings with purple pipes to accommodate a pending recycling water system, and to build stormwater infrastructure to capture and treat natural drainage, the Central SoMa region can speed these measures along through the help of a dedicated ecodistrict agency (Central SoMa Ecodistrict, 2013). The Central SoMa Task Force can work together to streamline water conservation tactics that adhere to the ecodistrict protocol, procure the necessary funding, and delegate responsibilities to the agencies needed to make sustainable changes. Dockside Green can provide a model for Central SoMa to follow concerning planning direction toward graywater reuse, stormwater channel networks, and landscape irrigation with non-potable sources.

One example of advanced water management and resource conservation can be seen in the TNT Innovation Ecodistrict in Boston, MA, where new bus stops with living roofs have been constructed to capture rainfall and increase green coverage in the city (Boston Redevelopment Authority, 2013). This can be adopted into Central SoMa transportation hubs as public transit begins to expand to accommodate San Francisco's growing population. Another example of forward-thinking water management exists in the Lloyd Ecodistrict where they developed a district-wide water utility plant to provide for potable water needs to residents and businesses within the area. This differs from traditional water utility infrastructure in most metropolitan areas, as many cities have their water treated and transported from a remote location that supplies water to the entire city (Portland Sustainability Institute, 2012). By dispersing the water utility plants amongst districts in a city, water emergencies can be more quickly ameliorated as water can be transferred between districts, and treatment can be conducted in a smaller-scale, less energy-intensive manner. Ecodistrict planning can help to facilitate the construction of these water features to strengthen resilience against climate prone disasters.

Habitat

The Central SoMa ecodistrict is deprived of green, open spaces, and thus has a very low biodiversity level. Only 4.7% of the area is composed of open space, whereas the rest of San Francisco contains 22.8% open space (Central SoMa Ecodistrict, 2013). Studies by the San Francisco Planning Department have shown that human health is improved by increased green space and environmental services which promote good air and water quality, and effective waste management systems (San Francisco Planning, 2014). Therefore, the integration of natural areas and living surfaces is imperative to improving the rate of carbon capture and well-being in the ecodistrict.

One of the most effective ways to increase the amount of open, walkable, and green spaces is to minimize the lanes of roadways in favor of parklets and green infrastructure. A partner project to this endeavor would be to maximize public transit opportunities, along with expand bike lanes, walking paths, and shared transportation services. An ecodistrict that exemplifies this method is Vauban, Germany, which has a very low single occupancy vehicle ridership rate due to its expansive network of alternative options, and limited roadways (Vauban, 2013). In claiming its roadways for green spaces, Central SoMa can follow in the path of the Lloyd Ecodistrict by instituting green sites, streets, and corridors that have led the city to an 80% green infrastructure rate (Portland Sustainability Institute, 2013). Since the Central

SoMa ecodistrict currently contains 90% impervious surfaces, reducing the amount of automobile-accessible roadway and increasing the amount of green space would benefit the city immensely. Ecodistrict protocol and examples of successful ecodistrict projects surrounding habitat improvements and biodiversity enhancement can serve to influence the amount of natural spaces integrated into the Central SoMa area as it is formed.

A crucial method of integrating green surfaces into this area will be through constructing green roofs and walls, as buildings cover approximately 30% of the surface area of San Francisco (Tam, 2013). The Bo01 ecodistrict in Malmö, Sweden has successfully coated their buildings and passageways with stormwater managing green spaces such as rooftop flow channels and living walls. This ecodistrict has had a proven impact on the ability to increase habitat area, along with manage water, with its 11,100 m² of living roofs which assist the district to achieve a 90% diversion rate for stormwater into canals natural irrigation and recycling (Malmö stad, 2014). Central SoMa has the opportunity to replicate this drastic increase in green roofs through ecodistrict implementation.

Environmental Resilience

In an ecosystem, there is no wasted product and everything that is generated is consumed or becomes available for the next cycle of life. In a city district, there is a regulated and monitored system that produces, consumes, and recycles. In the future of ecodistricts, these two entities are fused to provide a dense operation which is self-reliant and can more easily achieve efficiency through effective land use and utility policies (University of Oregon, 2015). Case studies such Dockside Green, Vauban, and Bo01 show that density can also lead to resilience in terms of energy, water, and habitat efficiencies, and that ecodistrict implementation can help to facilitate that density in the best way possible.

Transit-oriented-development, or TODs, further reduce greenhouse gas emissions by presenting an immediate housing and business location option for those looking to invest in city living. When TODs emerge, as with the placement of the Central SoMa Ecodistrict next to the Transbay Terminal, they are prone to infill development. Infill encourages growth toward renewable resources and livable cities, and can occur in underdeveloped areas in large cities to revive them. The resulting neighborhoods that emerge can be transformed into functional and efficient ecodistricts that focus on environmental stewardship as they grow, and are models of walkable, livable city living that do not interfere with ecological health (Greenbelt Alliance, 2008). For example, as a direct result of a new transit line installed near the TNT Innovation Ecodistrict in Boston, MA, the neighborhood has begun the process of redevelopment and community integration to create a technologically and environmentally appealing ecodistrict. There will be a retrofit of 15% or more of the present housing to install energy efficient infrastructure which will reduce the financial burden on residents. Other sustainable projects will be reviewed for practicality such as green roofs, local power generation, and mixed-use housing developments that take advantage of the mobility provided by the new transit line (Boston Redevelopment Authority, 2013).

The development of any ecodistrict involves meeting, if not surpassing, city and state standards pertaining to environmental health and safety. This means that several action items are achieved by improved public transportation services via ecodistrict implementation, including water conservation, reduced waste, renewable energy, and the reduction of greenhouse gas emissions (Vinnitskaya, 2013). While the Central SoMa area is a generally well-connected region of San Francisco, with 82% of trips made by walking, biking, or transit, a more robust neighborhood center by public transit systems can reduce greenhouse gas emissions produced by residents driving single occupancy vehicles (City and County of SF, The Central SoMa Plan, 2014)(Central SoMa Ecodistrict, 2013).

Proponents of ecodistricts state that major metropolitan cities can improve upon resiliency by providing more social services and working collaboratively to ensure equity amongst the people living in that specific district through the establishment of ecodistricts (Finley, 2014). For example, the localized production of renewable energy will help to increase resiliency for the area by lowering greenhouse gas emissions and providing local jobs that then support immediate economic development. Also, the creation of ecodistricts drives linkages between city government, not-for-profit organizations, developers, and residents to instate new opportunities for economic advancement, social well-being, and ecological health (Schmiechen, 2013). This joining of entities for a communal cause builds resilience in a neighborhood, since sustainability efforts are discussed and delegated without unnecessary repetition or conflict.

Legal and Institutional Barriers to Ecodistrict Adoption

While ecodistricts can help to improve environmental, social, and economic consciousness, they come with many challenges. The most immediate issue with any regional planning initiative is the large initial capital investment that every shareholder must consider in the assessment process. As there is not yet a cost benefit analysis performed on the potential outcome of the Central SoMa ecodistrict, there is no way to forecast the future value of the investment to rationalize its worth the residents and businesses in the area. The majority of existing shareholders are in support of this redevelopment, but without a financial study performed to analyze the added value of the community, these shareholders will be reluctant to pay additional taxes or contribute voluntarily (Tam, 2015).

Likewise, it is difficult to incentivize the public to accept infrastructural changes that may or may not lead to increased efficiency for personal resource usage when studies have not yet been conducted on their effectiveness. In order to install advanced technology that monitors water and energy systems and helps them function optimally, old infrastructure in San Francisco must be replaced, thus causing temporary displacement of services and delays in renewed services (San Francisco Planning, 2015). These services are also more expensive, and stakeholders will not buy into an approach toward a more sustainable lifestyle if they have to pay a lot more for that way of life. The concept is readily adopted, but it may be more complex and riskier to accomplish once construction begins in the area (Tam, 2015).

Old infrastructure will need to be updated for use in the new ecodistricts to meet sustainability goals, and this replacement or upgrade process may deliver new complications for the city. Infrastructural enhancement is very cost prohibitive, and therefore stalls sustainable service additions (Swae, 2015). Technical challenges may arise as a result of mass construction, and since any amendments to San Francisco infrastructure or building scape takes years to complete, there is the possibility that civic action may not be quick enough to accommodate population growth and environmental challenges in the city. The implementation of shared infrastructure would be necessary for the ecodistrict to run efficiently, but the installation and agreement process would require many years of planning and may not improve the speed by which services are obtained (Tam, 2015).

At this time, transboundary agreements, legal documents designating which water sources belong to a certain area, prevent water-sharing across multiple cities and jurisdictions. In order to prepare for the impending ailments of climate change that include droughts and urban heat islands, new treaties will need to emerge in order to make resource sharing possible. These treaties must also include a very clear agenda on how to manage conflicts that may begin as a result of reduced water availability (Curran, 2014). Similar agreements conduct the sharing of energy sources, both in terms of electrical infrastructure and fuel. This struggle to overcome regulatory barriers will need to be addressed in order to distribute water, electricity, and steam across ecodistricts and cities (Grace, 2012). Property and development rights are difficult subjects in the discussion for increased efficiency and community improvement. Local funding and collaborative efforts are hurdles in the path toward localized sustainability, and additional support from government entities is needed in order to manage these ecodistricts in the future (Hanscom, 2011).

Lastly, scaling up successful sustainable efforts from an ecodistrict level to a city-wide level has never been completed before, and therefore may lessen the value of the investment.

Changes in Governance Structure

Ecodistricts require the thought process behind city planning to transcend scales, therefore amassing planning processes between block, neighborhood, city, and regional areas. This means that governance concerning ecodistrict development will be altered to accommodate new agreements in the area. These agreements will comprise shared utilities, land use policy, building materials, and more (Eger, 2013). Therefore, all governing bodies who support the ecodistrict will need to communicate effectively with one another and adhere to and jurisdictional changes or multi-governance structure responsibilities that may be addressed to improve sustainable conditions in San Francisco.

The ecodistrict movement derives the grassroots or neighborhood-bred development of initiatives, signifying a bottom-up approach to city planning. This means that while projects are generated on a neighborhood basis, their implementation is still processed through city governance (Maaoui, 2015). This is true in the case of new zoning laws which may prolong civic action to develop the new neighborhood. Laws that prevent water and energy sharing would need to be changed in order to enable district functionality. As zoning in San Francisco is very complex, the additional utility contracts and infrastructure development would make the rezoning of certain areas in San Francisco a very strenuous process. In locations where building heights are less political, development rights could be transferred to change zoning in that way. Zoning can also be altered to allow for improved ecological function in areas that would not normally allow for zoning changes (Tam, 2015).

Chapter 6: Recommendations

Residents and businesses in a community typically frame themselves, their successes, and their challenges within the area that they can walk to and travel through. They are financially and socially committed to the neighborhood because it defines the way they view themselves (by work and recreation) and the city in which they live (Grace, 2012). In this way, it is practical for neighborhoods to work collaboratively through ecodistricts to instate new sustainability programs that will impact the residential and professional communities that frequent an area.

Ecodistricts have the ability to achieve success on certain economies of scale that can be attained by a neighborhood instead of city-wide. For example, ecological preservation and habitat building is one of the essential components of a city that should be addressed via an ecodistrict project as each area in a city can differ drastically in terms of climate, topography, and building density (OECD, 2013). This is evident in San Francisco when comparing the suburban Sunset District to the metropolitan Financial District. In coming years, increased population in these areas will consume more natural resources, inhabit more space, and require more social services. Therefore special attention to environmental health and open space should be paid (Central SoMa Ecodistrict, 2013).

In coastal urban centers there is the immediate need to prepare for the inclement effects of climate change, most notably sea level rise. San Francisco, especially along the Bay-facing coastline, is preparing for this change, as the city boasts an extensive mitigation process headed by an organization named SF Adapt (SF Environment, Adaptation). This city will greatly benefit from the implementation of ecodistricts now that efforts to combat climate change are underway, and sustainability efforts can go much farther on a neighborhood scale. San Francisco intends to place capital aside in the city budget in order to protect infrastructure and provide services as climate change continues to progress. This tactic will ensure that measures taken toward environmental protection are not hindered by lack of funding. As always, extensive environmental impact reports will be conducted in the process of ecodistrict creation in order to measure the impact that development will have on surrounding ecological resources or wildlife (City and County of SF, Sustainable Development, 2014).

City planners, government organizations, and environmental stewards will have to work together to alter regulations and reiterate land use laws to conserve open space, preserve historical elements, and reshape accessibility through transportation enhancement, among other tasks. Therefore, the city is moving toward innovating the standard neighborhood structure by implementing ecodistricts that could improve environmental health as they encourage stable community living on a micro-scale.

The success of innovative sustainability systems will be the indication to investors that ecodistricts are a safe path for future sustainable development. The key to implementing ecodistrict designs with regard to environmental resilience is to ensure that partnerships between public and private entities provide effective means of funding and feasibility studies to find the highest priority sustainability projects. Once it is evident that ecodistricts can guide consciously green development, the active scaling-up of the operation will be easier to facilitate. In order to reach this goal, San Francisco will need to engage timely and aggressive policy planning that enables ecodistricts to form rapidly and efficiently.

Policy Propositions

Mandatory Green/Cool Roof Ordinance

Central SoMa should follow in the footsteps of Toronto, Canada, and the entirety of France by instituting a by-law that requires a certain percentage of all newly constructed building's roofs to be covered in either vegetation or solar panels. The construction of mandatory green spaces should also be extended to outside walls on commercial, residential, and institutional buildings to minimize the impacts of the urban heat island effect and maximize biodiversity potential. Though the policy in France is limited to commercial buildings, Toronto has adopted a rigid set of system requirements for all buildings 2,000 m^2 or larger (Aljazeera America, 2015). As the buildings get larger, so does the requirement for green roof coverage. The coverage ranges from 20% coverage for buildings 2,000-4,999 m^2 up to 60% coverage for buildings 20,000 m^2 or greater. The exception to this requirement are residential buildings 6 stories or smaller (Toronto, 2015).

These sustainable improvements are often much more expensive for building owners to implement. Therefore, by making the measure mandatory, ecodistrict professionals can work alongside local government to create additional funding sources and tax incentives that make green and cool roof installation a more attainable and extensive sustainability project. The ecodistrict planning format can also easily work to adopt the current policies in place that can help to initiate this mandate.

For example, the GreenFinanceSF Program can help to develop green and cool roofs as part of the Property Assessed Clean Energy program that will grant building owners specialized loans for the purpose of energy efficiency and general sustainability. The Stormwater Management Ordinance of 2010 currently governs the construction of new buildings to control future stormwater with such means as channels, infrastructure, green roofs, and permeable pavement (Tam, 2013). Ecodistrict design can help to streamline this effort by obtaining authorization for all buildings in a district, including existing buildings, to develop these stormwater management tactics, instead of just one building at a time. San Francisco should be enabled to institute a mandatory green or cool roof policy in the next 2-5 years, and can manage to obtain additional public and private entity support through the implementation of ecodistricts.

Re-zoning for Open Space

The Central SoMa Corridor is composed of several zoning categories including service and light industrial, downtown general, downtown retail, and commercial and arts zones (City and County of San Francisco, 2013). Traditionally, re-zoning would allow for additional housing to be built in an area with low housing availability, but the Central SoMa area should take advantage of the opportunity to re-zone in favor of natural habitat and parkland. Ecodistrict implementation could manage the task of re-zoning the area to supplement open spaces, and gather shareholder support from surrounding businesses and residents to ensure that this plan is more readily adopted by city government.

A transfer of development rights can be put into place to transfer a portion of land costs from an area in the ecodistrict where density and development will occur to an area in the ecodistrict where development will be minimized and open space planning will be optimized. This way, new construction can remain active while open space corridors are preserved in the midst of an urban setting (Rutgers, 2015). An example project that can emerge from this arrangement would be to prohibit new development in a vacant lot, transfer the development rights to the proper entities, and then to convert the original lot into public parkland and an urban garden with the help of public and private funding.

However, this open space would not be limited to street level lots. Every building has rights to the air space above their plot of land. This air space can be purchased and sold to developers who wish to build very tall complexes and are not zoned to accommodate the new desired height (The Examiner, 2010). The willing lots in the Central SoMa region can sell or donate their air rights to ecodistrict planners who can use this extended building ability to reinforce the roofs of existing commercial, residential, and industrial buildings in the area to implement green or cool roofing. This new height zoning can accommodate the growth of green surfaces and the renovation of older buildings toward efficient infill. This is also one of the ways ecodistricts can ensure updated energy and water infrastructure, since although the buildings will be taller, they will amass more opportunity for green space.

Projects that help to convert vacant lots or parking structures to farmers markets, or use air rights to implement urban green areas will help to minimize driving outside of the city for open space access and thus reduce the amount of greenhouse gases emitted by travel and automobile operation.

Wave and Tidal Energy Supplementation

Of all renewable energy sources that could positively impact San Francisco as a whole, energy production through wave or tidal technology would be the most practical method to guarantee a consistent and observable stream of energy to the city. This locally produced, entirely renewable energy source can feed into the existing electricity infrastructure for the city with some necessary adjustments, and the Central SoMa Ecodistrict can be one of the first locations to raise funding for and benefit from this initiative.

In 2009, San Francisco performed its preliminary analysis of the wave energy potential in the ocean and bay surrounding the city. It found that approximately 100 GWh of power can be generated at a location about 8 miles off the western coast of the city at an annual cost of 17 to 22 cents per kWh. This amount of energy could provide for 10% of all homes in San Francisco, and this price is comparable to energy produced by solar photovoltaic cells (SF Environment, Wave Energy).

This technology should be further investigated for implementation due to impending rising tides, and should be funded through federal, state, and district measures toward renewable energy production. The Central SoMa ecodistrict can then become a pilot project within which to test the applicability of this energy source through their independent neighborhood-scale energy grid.

Environmental Education Services

Environmental programs and educational opportunities that would serve to improve environmental conditions are integral as a component of ecodistrict functionality. To encourage public support of sustainability protocol, it is necessary to promote and educate as extensively as possible on the methods and means of new projects. Residents and businesses of an ecodistrict will be the primary proponents of sustainable change, and will act as campaigners, funders, and conservationists for natural and historic sites.

Education surrounding environmental action and projects pursued by the ecodistrict should therefore be prominently featured as platforms for sharing opinions and forming plans toward publically supported goals. Forming an ecodistrict will require non-government and government organizational backing to meet community ecodistrict standards efficiently and effectively. Therefore, the act of disseminating project details and progress, along with general knowledge about sustainable behaviors, can create a consolidated public effort toward environmental and civic management in a specific area. This community effort can help to improve public health and well-being conditions in the area, thus enhancing the ease of living and the sense of place that exists in that neighborhood. The more involved the community is in shaping its future, the more committed it will be in the projects that lead to obtaining that end goal. Specifically in San Francisco, the promotion of environmental education as a means to involvement is an innovative method of collaborative city planning in preparation for increased metropolitan density.

Future Ecodistrict Proposals

Chinatown (In Progress)

The Ecodistricts framework has influenced the Chinatown Community Development Center in their plans to revitalize the highly populated Chinatown district. Therefore, the Sustainable Chinatown Initiative, along with assistance from several San Francisco not-for-profit agencies, is prepared to adopt the ecodistrict format to help alleviate the strain on this unique area. The primary goals of this project are to protect the neighborhood's vital cultural identity, reinforce resilience to changing climate conditions by increasing water and energy efficiency, strengthening existing buildings and infrastructure, and maintaining the available housing present in the area (The San Francisco Foundation, 2014).

Noriega and 25th (Sunset District)

While the Sunset District of San Francisco has traditionally remained suburban and residential for several generations, the stretch of roadway along Noriega on either side of 25th Ave. would be optimal for the integration of an ecodistrict. This area already exists as a bustling center of activity with local restaurants, shops, bars, and banks, and is only a few short blocks away from one of the busiest streets in San Francisco, 19th Ave. While this area sees many patrons and business owners, it is accessed by only two public transit routes, both busses (SFMTA, 2015). This means that the primary mode of transportation to the area is by single occupancy vehicle. Thus, this area is congested and limiting to those who live nearby. Also, there are unused, vacant lots along this stretch that can provide opportunity for future sustainability projects.

Through the implementation of an ecodistrict in this region, older buildings can be retrofitted to accommodate upgraded neighborhood-serving energy and water infrastructure. Vacant lots can be filled with mixed-use, technologically advanced properties that bring new life into the community, and transportation opportunities will follow as a result of the densified population.

Judah at 48th (Sunset District)

The beach-adjacent region of Judah and 48th is an area that would serve its residents and businesses more sustainably if it were to be reinvented as an ecodistrict. This community is already ecologically minded in that the Other Avenues Co-op is operated by solar photovoltaic electricity, and there is a prominent community garden located between 43rd and 44th avenues. If an ecodistrict was erected in this location, renewable energy would be made more easily available to the residents and businesses that exist in the neighborhood, especially if wave energy were to be funded and operational in the coming years. Also, N-Judah is the most heavily-ridden Muni light rail line in San Francisco, and therefore brings many people to the turnaround junction at Judah and 48th (Reisman, 2013).

Recommended Spearhead Organizations

To effectively manage the implementation of ecodistricts in San Francisco, prominent organizations which contain the capacity for the all-encompassing knowledge and operation of the city should be placed in charge of ecodistrict management. Once the ecodistrict is established, a not-for-profit organization devoted to creating and reiterating sustainability projects should be designated as an overarching organization that manages incoming funding and guides the ecodistrict in the best interests of the community.

The three existing agencies most appropriate to take charge of planning, financing, and maintaining an ecodistrict are the San Francisco Public Utilities Commission, the San Francisco Department of Public Works, and the San Francisco Department of the Environment. These agencies work for the public sector, and as such, can coordinate public-private partnerships as needed by the ecodistricts. Also, these entities are well established and are therefore more likely to obtain funding from federal, state, and grant sources, along with other financial venues. While these agencies all specialize in differing fields, their paths intersect in nearly every part of the city. The SF Public Utilities Commission will readily handle water, energy, and waste management to prepare the basic needs of a neighborhood. The SF Department of Public Works will manage shared infrastructure such as roads, tunnels, bridges, and corridors to ensure safe and efficient passage through the district. The SF Department of the Environment will be able to survey all projects implemented by the other two agencies with respect to ecological longevity and environmental sustainability. While these three bodies will help the ecodistrict to form, a not-for-profit agency will allow for focused development and iteration of ecodistrict projects and civic relationships (Central SoMa Ecodistrict, 2013).

A newly formed ecodistricts-centered not-for-profit in San Francisco can help to connect to residents and businesses in a neighborhood on a more community-centered level than a city government agency may be able to achieve. This agency would be able to solicit support from neighbors and draw attention from sustainability-focused developers in their mission to help the ecodistrict thrive. Because a new not-for-profit would not be as well-connected in terms of civic partnerships or funding sources, it would need to work closely with developed public and private agencies in the area to develop alliances and secure financial backers for new projects. However, a not-for-profit formed around ecodistrict potential can be well-received by the public and make changes that a busy public agency would not have the time of bandwidth to accomplish (Central SoMa Ecodistrict, 2013).

Together, these three government organizations and single not-for-profit would be able to facilitate the growth of ecodistricts and their respective projects within San Francisco.

In Conclusion

Ecodistrict implementation is a fresh topic in the scope of urban and regional planning that has not yet been assessed for longevity or enduring success. In addition, ecodistrict planning may not be a practical course for neighborhood sustainable development in all cities of the world since cities are all managed on different civic platforms and may not have the money, time, or agencies available to commit to a new design. As such, future research on the topic of ecodistrict integration in city planning in recommended to verify its value in terms of sustainable development and environmental resilience. This research will likely populate and diversify in the next 10-15 years as ecodistricts begin to see the impact of their planning and commitments.

Despite having limited previous research availability with which to perform an analysis, the case studies provided in this paper and the sustainability projects discussed provide at least preliminary evidence as to the positive outcome of ecodistrict implementation. Going forward, the retrofits and redevelopment of residences and commercial buildings will expand to increase efficiency and reduce the impact of imminent global climate issues including the urban heat island effect, sea level rise, flooding, and drought. The integration of ecodistricts is currently on course to help instill all-encompassing improvements to community water, air, safety, and health quality, and thusly enhance environmental resilience for the cities in which they are located (Triple Bottom Line Hub, 2014). San Francisco and the Central SoMa Ecodistrict will be only one of many pilot projects to guide the path toward improvement and provide a model of sustainability for future generations.

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