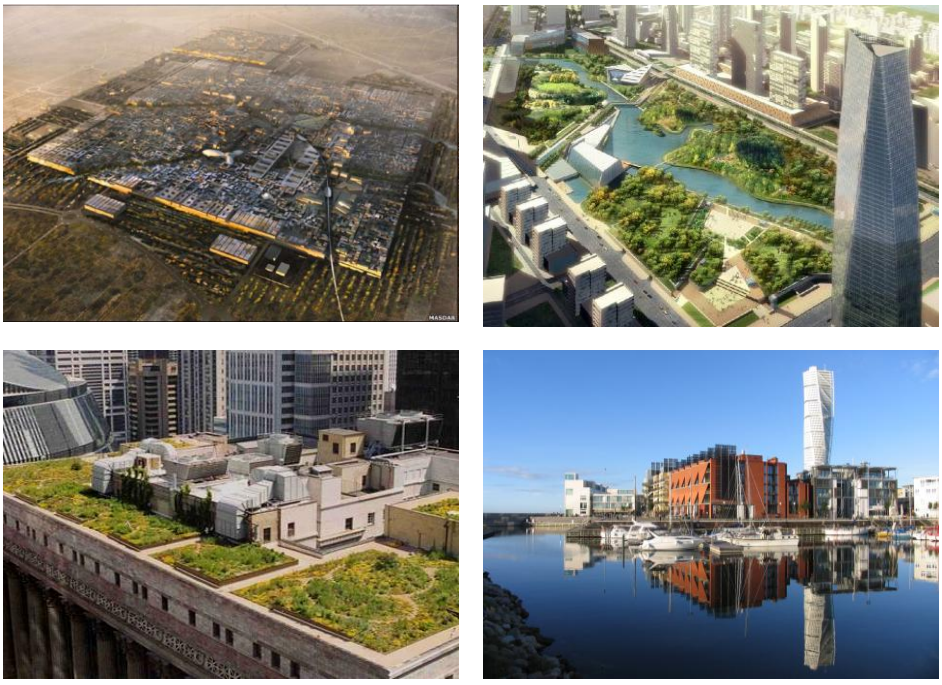
IDEALISTIC OR REALISTIC? :
A COMPARISON OF ECO-CITY TYPOLOGIES



CRP 3840: Green Cities
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Introduction

The rapidly increasing population and trends of urbanization in many world regions today call for a more sustainable form of development. Many city planners, politicians, and environmental groups seeking to create more sustainable cities have realized the challenges of changing existing community conditions. A city's location, buildings, and infrastructure strongly dictate its impacts on its environment, economy, and society over time, and these characteristics are difficult to significantly change after construction and inhabitation. To avoid these challenges, a trend for new, master-planned eco-cities has emerged. Proponents argue that these eco-cities can fully integrate sustainable building and urban planning principles to create more sustainable living environments than is possible by altering existing communities. Through analysis of several current eco-city developments and efforts to improve existing areas, stakeholders can evaluate the advantages and disadvantages of each approach. The examples of Masdar in Abu Dhabi, Songdo International Business District in South Korea, Chicago, Illinois, and Malmo, Sweden illustrate many considerations necessary to fully evaluate the sustainability and feasibility of development typologies. Analysis of resource inputs and the necessity of adaptability reveal the importance of prioritizing existing city development above ideal, master-planned eco-city construction for future development.

Eco-cities

Before exploring Masdar, Songdo IBD, Chicago, and Malmo, it is necessary to understand the definition of an eco-city. Philosopher and author Richard Register first coined the term. Register founded Eco-City Builders, a non-profit organization that promotes a holistic approach to the transformation and development of more sustainable cities. The term "eco-cities" first appeared in Register's 1987 book *Eco-City Berkeley*, in which he introduced the broad concept of eco-cities as well as a more detailed discussion of how Berkeley, California could become an eco-city. Register succinctly defined an eco-city as "an ecologically healthy city;" however, the Eco-City Builders have expanded upon this definition in their organization's mission statement, focusing on "reshaping cities for the long-term health of human and natural systems" (Register 1987; Ecocity Builders 2009).

The relatively broad definition of eco-cities has unsurprisingly lent itself to a wide range of applications, much as the terms "green" and "sustainable" are often used loosely. The term

eco-city can apply to the full spectrum of sustainable cities, ranging from model cities like Masdar and Songdo IBD that are built from the ground up, to existing cities, such as Chicago or Malmo, that were not originally planned as "eco-cities" but are making progress towards lessening their environmental impact. Register's position seems to affirm the broad application of the term when he explains that "*there are two ways to go about building eco-cities: changing existing towns or building new ones*" (Register 1987, emphasis added). New cities are often designed by an urban planning firm that attempts to incorporate all of the latest "green" technologies in order to create the most sustainable city possible. These cities serve the dual purpose of acting as large experiments for the various technologies that are incorporated into the cities while also serving as model cities for others to consider for future implementation. However, building completely new cities is undoubtedly expensive, and it is simply not a viable option to build all new cities when there is an abundance of already established cities and urban areas. While model eco-cities, such as Masdar and Songdo IBD, can be advantageous experiments, society ultimately needs to strive to improve existing cities, as illustrated in the examples of Chicago and Malmo.

Model City Case Studies

For our purposes, we will first examine the notion of model, master-planned eco-cities by discussing two relevant case studies before investigating ways that existing cities have begun to incorporate sustainable practices into their urban development.

Masdar

Masdar, meaning "the source" in Arabic, is a master-planned eco-city currently under construction in Abu Dhabi, United Arab Emirates, that aims to be the first city boasting zero carbon emissions (Palca 2008). One of the fundamental goals of the Masdar Initiative is "to [position] Abu Dhabi as a global leader and hub for the research and development of renewable energy and sustainable technology," or to position Masdar as the "silicon valley for green and alternative energy" (Masdar City 2009). Khaled Awad, one of the directors of the project, describes, "Abu Dhabi is an oil-exporting country, and we want to become an energy-exporting country" (Rosenthal 2009). The project can be characterized as a two-pronged approach: a *model eco-city* combined with a *rising research university*. While the city itself physically

manifests the sustainable vision for Masdar and serves as a large-scale testing ground for renewable energy, the research institute will facilitate the goal of positioning Abu Dhabi as a forerunner of renewable energy development in providing the resources for research and development. The Masdar Institute of Science and Technology (MIST), with the assistance of MIT, has been recruiting prestigious faculty to establish a research-intensive institution that can use the eco-city as an "open laboratory" for experimentation of the technologies that they develop (*Economist* 2008).

Despite criticisms of the project, several prominent stakeholders have contributed to the development of both the eco-city and the research institute. In addition to MIST's primary partnership with MIT, the university also has affiliations with numerous other world-renowned universities, including Cambridge, Oxford, Princeton, and Cornell. Furthermore, the British architecture firm Foster + Partners prepared the master plan for Masdar City, Swiss investment bank Credit Suisse invested over $100 million into the project, and the World Wildlife Fund (WWF) has backed the project as part of their One Planet Living initiative (*Economist* 2008). Considering this solid support from numerous credible organizations, Masdar presents many opportunities as a model eco-city. An analysis of Masdar's impact with regard to the environment, the economy, and equity will demonstrate these benefits.

Environmental strategies. Masdar, a roughly six-square kilometer, 50,000-person city, is touted as being the first carbon-neutral, zero-waste, car-free city (Basantani 2008). One major advantage to building an entirely new city is the ability to selectively employ the latest technologies and materials in order to build a city that has as little impact on the natural environment as possible. In the case of Masdar, the environmental sustainability and impact of virtually every aspect of the city was carefully considered, from the initial planning and construction stages to the eventual daily functions of the city.

The construction process itself can be inherently unsustainable, due to the large amounts of carbon released and large quantities of water consumed. Considering that carbon neutrality is one of the fundamental goals of the Masdar project, measures need to be taken throughout the construction process to mitigate the carbon emissions produced as a result of construction. In order to offset these carbon emissions, trees are being planted for carbon sequestration. Another aspect of the construction process that can contribute to a lessened environmental impact is in the selection of building materials. In addition to making an effort to select sustainable materials

with recycled content and low embodied energy, measures are also being taken to ensure that scrap materials on the construction site are recycled rather than sent to landfills (Palca 2008).

Solar power will be the primary energy source for the construction process itself and eventually for the completed city, to utilize the abundant sunlight in Abu Dhabi's desert climate (Figure 1). Photovoltaic panels will be strategically placed on building roofs, canopies, and other available open spaces, often conveniently providing shade from the intense desert sun while simultaneously providing the city with energy. One of the primary advantages to building a solar-powered city in such a climate is the ability to test and experiment with the latest solar power technologies. Currently, forty-one different photovoltaic panels from thirty-one different manufacturers are being incorporated into the design for testing. Furthermore, the prolonged timeline for an urban project of this scale allows for additional experimentation. The design was intentionally left incomplete with the objective of incorporating the latest technologies as they are being developed. The experimental nature of the eco-city permits and promotes the development of new technologies, especially with the city's incorporation of a research institute and renewable energy company (*Economist* 2008).

Figure 1. Solar panels on rooftops and canopies serve the dual purpose of providing both energy and shade. (http://www.skyscrapercity.com/showthread.php?t=897392)

Figure 2. City walls block hot desert winds. (http://aedesign.wordpress.com/)

The design of the city itself incorporates many other building technologies that lessen the city's environmental impact once it is complete and fully functioning. The rationale behind creating a walled city was to block the area from the hot desert winds (Figure 2). In conjunction with energy-efficient buildings, shading from the intense desert sun and buildings designed for

heat to flow upwards and out of the buildings aim to decrease the need for energy-intensive air conditioning (Figure 3). The city green spaces will incorporate plants appropriate for the desert climate to reduce the water required for irrigation (*Economist* 2008). Roughly 80% of the city's water will come from greywater recycling systems; rainwater harvesting systems will also be used. Both types of water recycling aim to reduce the need for desalinization, which requires large energy inputs. Although the city will not be able to entirely eliminate the need for desalinization, the facilities will be solar-powered (Palca 2008). Perhaps the most impressive environmental impact reduction strategy is the complete elimination of cars from the city. The master plan outlines three primary means of transportation: walking, a light rail system, and an elevated personal rapid transit (PRT) system (Figure 4). This integrated system intends to provide a public transit stop within two-hundred meters of any given point in the city (Basantani 2008).

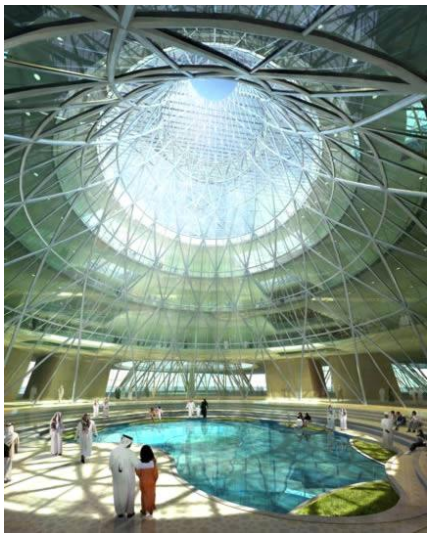

Figure 3. A building designed to allow rising heat to escape. (http://pepegrillo.com/2009/01/masdar-la-primera-ciudad-totalmente-ecologica-del-mundo/)

Figure 4. Elevated tracks for the personal rapid transit system. (http://www.treehugger.com/files/2008/01/ecocities_every.php)

Economic strategies. Despite the irony in the idea that wealth from the oil industry is now funding the development of this carbon-neutral eco-city, projects of this immense scale obviously require hefty investments that only organizations with large surpluses could fund. For such projects to be successful, stakeholders must possess the "willingness to invest in the seed capital" to initiate the development process (Rosenthal 2008). From an economic perspective, it is beneficial to the world economy for Abu Dhabi to front this initial "seed" investment for an eco-city that can

serve as testing grounds for renewable energy technologies in the experimental stages, as well as a research institute that theoretically will produce information that will benefit society as a whole.

Masdar's $22 billion budget serves as an incentive for additional innovation, which can also be considered a benefit to the economy (Todorova 2008). When large sums of money are allocated to a given cause, there is an incentive to be a part of that cause. For example, the city plans originally did not include aluminum as a primary building product because of the high carbon emissions associated with its production processes. However, aluminum companies responded by developing a more competitive product with significantly reduced carbon emissions to prevent their product from being excluded from the project (Rosenthal 2008). This example illustrates that market-driven incentives can spark innovation, which increases competition and variety in the economy. At the most basic level, the concept of Masdar as an eco-city itself was born out of an incentive-driven innovation; with oil prices as high as they have been in recent years, there has been an economic motivation to invest in alternative energy sources.

In a simpler and more obvious sense than both seed capital and incentive-driven innovation, the development of a master-planned eco-city like Masdar has job-creating potential that is especially attractive during an economic recession (Dilworth 2007). The Masdar project will create a wide array of jobs associated with the planning of an eco-city, including the design and planning phases, the construction process, the businesses that will eventually inhabit the city, and the faculty and staff working at MIST.

Equitable strategies. While a massive construction project is advantageous to stimulate the economy, the creation of "green collar" jobs for city planning, construction, and renewable energy research and development is also beneficial for social equity purposes. As part of the WWF's One Planet Living initiative, however, Masdar will have a broader focus on the equity aspect of sustainability than spans beyond the creation of jobs. According to Pooran Desai, one of the initiative's co-founders, "the vision of One Planet Living is a world where people everywhere can lead happy, healthy lives within their fair share of the Earth's resources" (World Wildlife Fund 2008). The initiative's ten founding principles include the categories of culture and heritage, equity and fair trade, and health and happiness. In the development of the city plan, the cultural and heritage aspect of equity refers to a respect for the local architecture and

cultural values. Throughout the construction process and beyond, the plan prioritizes fair wages and working conditions for all labor involved. The health and happiness aspect simply highlights that the city plan must include facilities catering to all demographics. Jean-Paul Jeanrenaud, director of the One Planet Living initiative summarizes this pursuit of equity in the development of Masdar: "We hope that Masdar will prove that sustainable living can be affordable and attractive in all aspects of human living" (World Wildlife Fund 2008).

Critical analysis. Although Masdar has much to offer as an eco-city that can serve as testing grounds for experimental technologies and as an example for other cities to lessen urban environmental impacts, the development of an entirely new city provokes criticism and raises irony. First, Masdar, as an eco-city, does not contribute to increasing the sustainability of the United Arab Emirates as a whole, considering that the U.A.E. is one of the most unsustainable and largest carbon-emitting areas in the world. Masdar's claims of producing zero carbon emissions even within the city itself are misleading. Until energy storage technologies for solar power are developed, the city will have to export its excess energy to the city of Abu Dhabi during the day, while using energy from the city's grid at night when sunlight is not available (*Economist* 2008). Furthermore, the walled-in, six-square kilometer city intentionally did not allow energy-intensive industries inside in order to keep its energy consumption lower.

The practice of selecting the types of businesses to allow in the city plan raises the larger issue of determining the actual scope of sustainable city development; the environmental impact of the city is highly dependent on where its boundaries lie. For example, when considering Masdar's carbon-neutrality, does one include the countless flights from Europe to the U.A.E. required by the design team in the planning stages of the project? Such an example demonstrates how in the case of any eco-city, it is possible to frame a project favorably by purposefully excluding factors such as international flights or by careful drawing city limits to exclude harmful factors (Palca 2008).

Especially in an area like Abu Dhabi, skeptics fear that Masdar may be a case of greenwashing on an urban planning level. As Professor Peter Droege, chair of the World Council for Renewable Energy, believes, Masdar could be viewed as "an oil producer buying a bit of insurance" (Fox 2008). The spectacle of developing a zero-emissions city may, in fact, be an attempt to transition to renewable technologies before their oil supply runs out. However, despite the possibility of Masdar being a large case of greenwashing, Register believes there is

the possibility that Masdar will have a beneficial impact. "If Masdar stands alone as an isolated green jewel while the rest of the UAE proceeds along its current bigfoot path, you could call it greenwashing. If instead it serves as an active laboratory that inspires the UAE and other regions…then it could make a real contribution" (Fox 2008). If nothing else, at least the wealth generated by the oil industry, in this case, is being put towards the cause of developing renewable energy technologies.

Songdo International Business District

Songdo International Business District (IBD) is another master-planned eco-city gaining media attention for its environmental contributions. The project began in 2001 with the innovative design from Kohn Pedersen Fox (Figure 5). The development's strategic location 7 miles from Incheon Airport and 40 miles from Seoul incited a main goal to become a thriving business hub. Songdo IBD is currently the largest private real estate project in the world today, totaling $35 billion in costs, 100 million square feet in area, and 350 new buildings. The project is also the largest private LEED development in the world; all new buildings are required to meet LEED for New Construction or LEED for Core and Shell certification, and Songdo IBD is also participating in LEED for Neighborhood Development and the Korean Green Building Certification System (KGBCS). Its developer, Gale International, is confident in its "sustainable design principles and combination of the best practices in urban planning" to create an ideal model for a current city and for future development (Gale 2009).

Figure 5. Overhead view of Songdo IBD (Gale 2009)

Songdo IBD attempts to address the environmental, economic, and equity issues that encompass sustainable development. A key strength of Songdo IBD is its relatively holistic viewpoint to integrate the interests of many stakeholders, creating a balance to sustain a long-term community.

Environmental strategies. To achieve LEED certification in all buildings, the planners must employ a variety of environmental strategies uniformly throughout the community. The LEED categories include Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials

and Resources, Indoor Environmental Quality, and Innovation and Design Process. By gaining credits in these various categories, LEED buildings address sustainable practices on many levels and stages of the building process (U.S. Green Building Council 2005). Songdo IBD focuses its environmental efforts on water use reduction, decreased automobile use, waste reduction, energy conservation, and sustainable materials.

Songdo IBD plans to implement many strategies to increase water conservation and efficiency. Building sites are prepared to collect greywater and rainwater for irrigation and cooling towers. Water collection for these purposes conserves potable water, and, in conjunction with green roofs, reduces runoff. The city plan also designates 40% of land area as open or green space, totaling 1,500 acres, to support storm water retention. Native vegetation in open spaces reduces the need for irrigation and supports natural ecosystems (Meinhold 2009). Green spaces and underground parking also help to reduce the heat island effect due to less pavement area, keeping the city cool with less air conditioning. In addition, the use of low-flow plumbing fixtures within buildings will decrease water consumption greatly over long-term occupancy (Gale 2009).

An extensive public transportation system aims to reduce resident reliance on private automobiles (Figure 6). A range of choices, including water taxi, subway, citywide bike rentals, car-share, and fuel-cell buses, will connect all areas of the city (Woyke 2009). In accordance with LEED's credit for alternative transportation, new buildings will be located within ¼ mile of multiple bus stops or ½ mile of a subway station. An abundance of open spaces, a 25 km network of bike lanes, and pedestrian walkways spread through mixed-use development promote short trips outside of automobiles, benefiting the environment and support community interaction and resident well-being (Gale 2009).

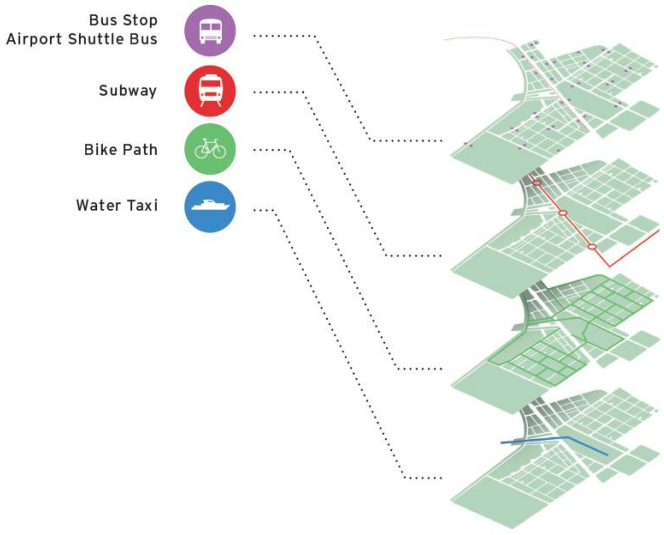

Figure 6. Public transportation networks (Gale 2009)

To reduce the impacts of new construction, 75% of construction waste will be recycled, returning this embodied energy to production cycles for further use. The city has also developed a waste management plan, in which buildings access an underground pneumatic pipe system to remove solid wastes without garbage trucks (Woyke 2009). Compressed air powers the streamlined garbage disposal to reduce the fossil fuel emissions and manual labor associated with vehicular garbage collection. In addition, Songdo IBD buildings must provide areas for recycling collection as a LEED prerequisite, reducing total wastes from occupancy (U.S. Green Building Council 2005).

Strategies to conserve energy incorporate building lighting, orientation, and glazing. Sunlight and LED lighting will provide quality lighting to occupants at low energy costs. Lighting controls will also be easily accessible to occupants to promote visual comfort and avoid energy waste from over-lighting. Carefully oriented buildings aim to maximize passive solar gain and prevent overheating with shading devices. Green roofs will also reduce buildings' heat gain by absorbing radiation, reducing the need for energy-intensive air conditioning (Meinhold 2009). Similarly, the use of high performance glazing and double facades will insulate buildings from excess heat, creating thermal comfort naturally with visual access to the outdoors. When cooling is needed, passive cooling with natural ventilation will be employed when feasible. In other circumstances, buildings will use energy efficient, variable air volume HVAC systems to maintain thermal comfort (Whitman et al. 2008).

A final environmental consideration in planning was the use of building materials. Low-VOC materials were chosen to reduce negative health effects from chemical exposure and earn LEED credits. These materials included adhesives, sealants, paints, coatings, carpet systems, and composite wood. Attention was also given to selecting local materials with recycled and rapidly renewable content, despite the lack of choices for these materials in Korea's market (Whitman et al. 2008).

Economic strategies. In accordance with its goal to become a business hub for Southeast Asia, Songdo IBD will encourage economic activity through its structure and policies. Fifty million square feet of commercial area and office space, including internationally-designed Class A business towers, will attract new businesses to the area. Highlights of the area include the 68-story Northeast Asia Trade Tower, which will be Korea's tallest building, and the Songdo Convensia as Incheon's convention center. The commercial district is located as a central band

through the city, directly adjacent to residential neighborhoods and open spaces for convenient access (Figure 7). A variety of stores, boutiques, and department stores are also expected to stimulate the area's economy (Gale 2009).

With new construction as a foundation, Songdo IBD will use policy to draw global activity. Beyond the attractiveness of LEED certified buildings to attract environmentally-conscious firms and its ideal location for both local and international transportation, Songdo IBD will provide financial incentives for international firms. A primary feature is a cap on personal and corporate income tax at 17%, attracting large corporations who would be subject to increasingly higher taxes in higher tax brackets. Light regulations within the Incheon Free Economic Zone (IFEZ) will also create opportunities for job growth (Curlik 2009).

Figure 7. Zoning map (Gale 2009)

The city's use of advanced technologies and communications fosters a strong economy. Video networking and energy management software will connect all sectors in the city into one common inclusive network. The system will facilitate coordinated activities between municipalities, including education, health care, transportation, and hospitality, to deliver optimal service to consumers (Woyke 2009). Increased efficiency of business processes decreases operating costs and makes the location more attractive to prospective businesses. The city also plans to enact programs to increase the English skills of officials and residents to facilitate interactions with the United States and follow a modern Westernized city image (Je-hae 2009).

Equitable strategies. Social indicators, such as equitable inclusion and access, cultural amenities, health, and safety, are equally important factors in city sustainability. According to Songdo IBD's master plan, all residential neighborhoods are spread evenly around the central

business hub and are well connected by various modes of public transportation. All residential zones are mixed-use to provide convenient access to basic services for all citizens. A variety of quality housing options will meet differing price points, including affordable garden residences to sleek high-rise apartments (Gale 2009).

Figure 8. Rendering of canal walk (Gale 2009)

The wide range of amenities available to residents is a key strength of Songdo IBD. Public and private schools, hospitals, parks, an arts center, a golf club, an ecotarium, a mall, and a canal walk all add value to residents and increase their quality of life (Figure 8). The master plan borrows popular features from world-renown cities, such as New York's Central Park, Venice's canal system, London's Soho, and Paris's Champs-Elyees, to create excitement for the new development (Gale 2009). By imitating landmarks known for beauty and community, Songdo IBD hopes to become an ideal aesthetic and cultural center.

Songdo IBD's architecture and technology will also enhance the lives of residents. Building materials without VOCs, increased daylight, and natural ventilation will contribute to improved health, performance, and well-being of inhabitants. Apartments connected to the city video network will be able to teleconference with medical providers and teachers to obtain necessary information quickly and conveniently (Woyke 2009). The incorporation of these elements into all new construction communicates the city's commitment to providing a positive, equitable lifestyle for all residents.

Critical analysis. Songdo IBD's environmental, economic, and equitable strengths are apparent in its described features. The wide variety of retail, service, and office industries creates employment for a diverse skill set and opportunities for businesses, and strategies to achieve LEED credits show promise in reducing the city's environmental impacts. However, many features of the new development have contradicting impacts that require consideration.

Songdo IBD's site is ideal for business development and claims environmental benefits by using reclaimed land. However, the land was previously a muddy tidal-flat and habitat for near-threatened and endangered bird populations (Birds Korea 2009). The tidal-flat reclamation not only contributed to losses in biodiversity but also required 500 million tons of sand to

transform the land into a buildable state (Curlik 2009). The changes resulted in further damage to nature with fossil fuel emission for sand transportation.

The location also created additional challenges in obtaining LEED materials. Green products, such as low-flow plumbing fixtures, green refrigerants, and recycled, rapidly renewable, and low-VOC materials, are rare in the Korean market, and the area lacks natural resources for other conventional building materials. To obtain necessary materials, buildings could not meet the LEED credit of installing materials extracted, processed, and manufactured within 500 miles of the building site (Whitman et al. 2008). The energy and emissions required to transport these materials should be considered in the footprint of the new construction. Nonetheless, the demand the Songdo IBD project has created for sustainable materials in Korea may lead to the development of these products in their local market, having a positive benefit for future projects.

The Jack Nicklaus Golf Club Korea poses environmental concerns for maintenance. The golf club is over twice the size of the expansive Central Park and occupies valuable waterfront property (Gale 2009). Its land area shows the city's commitment to the upper-class, business clientele, and tourism, possibly indicating an inequitable target market. The golf club is also excluded from the environmental strategies and is likely to consume a disproportionate share of water in the city. The focus on the golf club appears to conflict with Songdo IBD's equitable and environmental goals. Similarly, Songdo IBD's high-class international schools and international hospital restrict lower income families and individuals from use. While public schools will be available, the renowned private schools' tuition is $20,500 USD per year, restricting private school to the elite. South Korea's per capita income was measured at $27,700 USD in 2008, making private school unaffordable to the average citizen (Central Intelligence Agency 2008). The international hospital is also likely to incur large fees because it will be free from the regulations of the National Health Insurance System, which enforces price control requirements. Without the availability of affordable health care, lower income individuals will experience a lower quality of life (Baek 2006). These income barriers create further stratification of society by separating income levels into different social institutions.

Songdo IBD has also been criticized for not addressing renewable energy sources, such as solar, wind, or small scale hydropower. The city will create energy through natural gas combustion with cogeneration to utilize generated heat (Gale 2009). Natural gas is the cleanest

of all the fossil fuels but still releases significant carbon dioxide when burned (Naturalgas.org 2004). Although cogeneration increases the efficiency of conventional power plants by 50 to 70%, this method does not address the unstable supply of fossil fuels and the need to convert to renewable sources of energy (Editors 2008). As a model for an ideal city, it is contradictory that Songdo IBD does not incorporate renewable energy into its design, considering the argument that cities are difficult to alter after construction.

The consequences of other strategies must be determined after implementation. Songdo IBD's pneumatic waste management system will require great amounts of energy to continually move solid wastes through its pipes, and initial monetary and energy costs for underground drilling and construction will be exorbitant. As a new concept for development, monitoring will be required to determine whether the savings from reduced automobile use and human labor offset the system's costs.

Lastly, a community's success is dependent on people's willingness to participate. Songdo IBD's attention to landscaping, open space, and the harbor are likely to create a beautiful environment, but social programs and institutions are necessary to attract permanent residents. It takes time to build a thriving community, and Gale International is not expecting to see a return on investment until two or three years after construction is complete (Woyke 2009). The immense input of funds, resources, and labor are dependent on the public's reception of the development. A primary concern for public acceptance is the rising income of Koreans and Asians as a whole. With rising income, Koreans may wish to obtain status symbols, such as automobiles, that would conflict with Songdo's sustainable mission. City leaders must monitor social trends closely to address potential challenges and promote the success of the community.

Existing City Case Studies

With rising concerns about the future of the natural, economic, and social environment, existing cities around the world are recognizing the need to adopt sustainable strategies to be global leaders. Some cities lag in their efforts while others are implementing large-scale initiatives and emerging as internationally-recognized "green cities." The move toward sustainability in cities is critically important because cities have an extremely large environmental impact, countless businesses are based out of cities, and cities are home to millions of people. These three factors relate directly to the three E's of sustainability:

environment, economy, and equity. Chicago, Illinois and Malmo, Sweden are two leading existing eco-cities with various city-wide and community-specific programs that strive to make each city more sustainable.

Chicago

Environmental strategies. Chicago is most well known as a green city due to Mayor Daley's Green Roofs program. To date, over 200 green roofs cover over 4.5 million square feet in Chicago, which is the highest coverage of any American city (Sustain Lane 2008). Daley has created a grant program to make constructing green roofs more affordable for small businesses and homeowners. The eco-friendly health foods store True Nature Foods was awarded a green roof grant in 2005. They currently use their roof garden to grow vegetables and herbs for the store, which thereby also promotes local foods (Pilloton 2006).

Another successful project implemented by Mayor Daley is the Green Alley Program. There are over 1,900 miles of alleyways covering 3,500 acres throughout the city of Chicago, which is also the greatest alleyway length of all American cities. These alleys are covered with impermeable surfaces and lack proper sewage connections, creating flooding problems and ineffective rainwater management. The Green Alleys Program presents "a more comprehensive strategy [than the current DOT program] to implement environmentally friendly solutions to the city's infrastructure problems" (Kriscenski 2007). The improvements outlined in The Chicago Green Alley Handbook "showcase innovative, environmental technologies to help manage stormwater, reduce heat in urban areas, promote recycling and conserve energy" (Chicago Department of Transportation). The alley improvement guidelines are aimed at all applications, which include commercial, residential and industrial areas.

Additionally, there are many proposed designs by local architecture firms to make Chicago more environmentally-friendly. Some of these designs remain mere ideas while others are headed for implementation. Inspired by New York City's High Line, Gensler and 4240 Architecture designed Chicago's Bloomingdale Rail Line to transform the abandoned elevated rail line into a greenhouse and

Figure 9. Rendering of Bloomingdale Rail Line Greenhouse (Meinhold 2009).

hydrogen generation facility. The greenhouse, built on the three-mile rail line, would create 10 acres of farmland and would provide local and organic food for the community (Figure 9). The hydrogen generation facility would use the aqueduct below the rail line and provide a fuel source for Chicago schools and revenue from surplus energy sales (Meinhold 2009).

While Chicago's original master plan was not founded on the principles of sustainability, one such design from the 1909 Burnham Plan of Chicago may soon come to fruition. Burnham's plan for the Eco-Bridge is now being designed by Adrian Smith + Gordon Gill Architecture (Figure 10). The plan features a two-mile bridge connecting opposite ends of the city center (Meinhold 2008). The bridge would serve as a breakwater in the harbor, creating a safe environment for marine life and recreational space. Plans include wind turbines, an eco-observation tower with solar panels, pedestrian walkways, bike paths, and an electric or solar trolley system (Adrian Smith + Gordon Gill Architecture).

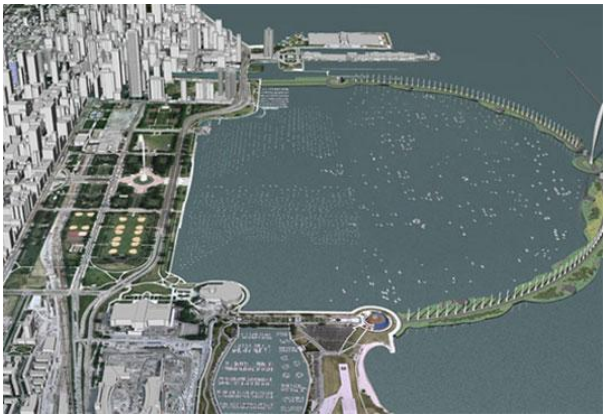

Figure 10. AS+GG Architecture design for Eco-Bridge (Meinhold 2008).

A final proposed environmental project is the West Loop Green Space. The plan, designed by Perkins + Will, aims to create a pedestrian gateway across the Kennedy Expressway, eliminating the barrier between downtown and neighborhoods in the West Loop. Also included in the plans is the construction of high-rises with green facades, plants and trees throughout the green space, and wind scoops; together these design features would ameliorate the problem of carbon emissions and noise from the highway and improve air quality (Chen 2009).

Economic strategies. Many non-profit and grassroots organizations have arisen in Chicago in the past few decades, and their rate of growth has increased further in recent years to promote economic sustainability. One such non-profit of note is Foresight Design Initiative. Foresight Design Initiative is a Chicago-based organization working towards sustainability in an urban setting through smart design. Engaging all sectors and industries, "Foresight collaborates to develop and empower initiatives, build community support and engender a positive human evolution" (Foresight Design Initiative). While Foresight is not a project of the Chicago city government, it is affiliated with the City of Chicago Department of the Environment and the

Illinois Environmental Council. Foresight has over a dozen current and upcoming projects and programs. Their educational programs include Eco Launch, a leadership program for high school students, and Sustainovate Immersion, an intensive summer design studio program for college graduates. They also operate a consulting and design studio and coordinate multiple education, outreach and networking opportunities, such as the Chicago Sustainable Business Alliance and Chicago Green Drinks, a monthly gathering with a panel. Aligned with their efforts to provide service to the community, they have also compiled a Chicago Sustainability Action Guide and a Chicago Green Business Directory (ibid).

Equitable strategies. The City of Chicago passed a Living Wage Act in 2006 and operates the Chicago Housing Authority to provide and manage low-income housing. However, similar to the economic sustainability strategies, many equitable strategies are being promoted with non-profit and grassroots organizations. There are various minority organizations working towards environmental justice, such as Climate Justice Chicago and Little Village Environmental Justice Organization, both of which provide resources and participate in activism. Another organization is Growing Home, "a South Side Chicago-based nonprofit offering job training to homeless and low-income individuals through urban-farming" (Tigay 2008). The organization's goals are "a good job, a living wage and healthy food on the table," to work against the health problems created by food deserts and create green jobs, education, and job-readiness training (ibid). The nature of the work also gives workers a sense of responsibility, as they must care for the plants, building self-esteem and a connection to nature (Figure 11).

Figure 11. Poor South Side residents working in greenhouse (Tigay 2008).

Critical analysis. Chicago employs many green strategies that are beneficial but primarily environmental, rather than holistic, in focus. This singular focus is not surprising because when negative impacts of cities are considered en bloc, the environment is generally seen as the most violated. With high concentrations of activity, cities produce enormous carbon emissions, pollution, waste generation, and widespread destruction of natural environments.

While there are numerous economic and equitable sustainability efforts in Chicago, the majority of these efforts are promoted through non-governmental organizations. Citizen involvement and activism is clearly important and vital to support and sustain the movement; however, these issues must also be addressed by an authoritative body. Issues of economy and equity in regards to sustainability are less visible to the general public and are, consequently, not given as much attention by the government, whereas Mayor Daley's Green Roof Program received excellent citizen support. The City of Chicago must become more involved to represent disadvantaged citizens and create and enforce regulations that mandate the principles of corporate social responsibility.

Additionally, access to many of these sustainability programs in Chicago is limited to wealthy residents. Despite the grant program for green roofs, the expense continues to exceed the budget of poorer residents. Green alleys and renewable energy are also prohibitive to low-income individuals due to cost. Beyond income, Chicago also faces the universal problem of segregation by class and race. Marginalization plagues all cities; issues of inclusion and mixed neighborhoods are difficult to overcome and require government aid. While Chicago will never be a utopia, these equity concerns demand attention. The success of Chicago's established environmental programs and the plans for future environmental efforts call for Mayor Daley to refocus his initiatives to create a more holistic view of sustainability.

Malmö

Environmental strategies. Ekostaden Augustenborg was launched in 1998 to make the existing Augustenborg neighborhood more socially, economically and environmentally sustainable. The program is financially supported by a government investment program, the city of Malmö, and an independent housing company. Many environmental projects have been undertaken over the past decade, such as insulating the post-WWII apartment buildings to increase energy efficiency, constructing an eco-friendly modular school, building a large solar energy project and a wind power plant, developing a regional carpool with vehicles fueled by ethanol or biogas, renewing gardens, building green roofs and open stormwater channels, and improving recycling and composting facilities (City of Malmö).

Another major environmental project is the Bo01 ("City of Tomorrow") in Western Harbor. The name Bo01 comes from the Swedish word "bo" meaning "to dwell" and 01

signifying the year 2001 when it was built (Guardian 2005). It is an entirely new district with 600 dwellings and commercial spaces built within Western Harbor, the former industrial park. The development is meant to be "an internationally leading example of environmental adaptation of a densely built urban environment" (City of Malmö). An innovative design strategy implemented in Bo01 is the location of tall buildings around the edges of the development to shield the smaller buildings and green spaces within from the wind. All buildings were required to meet established program standards for quality and sustainability. Other environmental aspects of this development include an efficient waste collection system, energy supply from 100% locally renewable sources (Figure 12), using city parks and canals to manage and clean rainwater, extensive bike paths, and priority lanes for fuel-efficient buses (ibid).

Figure 12. Uniquely designed residences in Bo01 with solar collectors on roofs (City of Malmö).

There are many other environmental initiatives within Malmö at differing stages of development and completion. Lillgrund Wind Park in Öresund is the third largest off-shore wind park in the world (Figure 13), and Sege Park is Sweden's largest photovoltaic plant. The city also generates biogas from collected organic waste, which is used to generate electricity. Currently, more than half of all school meals are organic with a goal of reaching 100% organic school meals by 2012. There is also a green event planning organization, an organic produce market, and 410 kilometers of bike paths, which is the most extensive city biking network in Sweden. An educational campaign, a green newspaper, a partnership with Copenhagen to further environmental efforts, and research partnerships with universities and institutes in Malmö further support environmentalism in Malmö (City of Malmö).

Figure 13. Lillgrund Wind Park (http://www.talentfactory.dk/composite-1216.htm)

Economic strategies. In the past, Malmö was a thriving industrial city dominated by shipyards. Its booming economy supported its growth into the third largest city in Sweden. However, a recession in the 1980's devastated the industry. Malmö "has had to think, and build, itself out of a crippling industrial decline" (Guardian 2005) and has since "been on a mission to regenerate its urban landscape," becoming a "leader in modern architecture and environmental design" (Wong 2009). Today, Malmö is still Sweden's third largest city, demonstrating how creativity, innovation, and drive can create a sustainable economy. Ekostaden Augustenborg, specifically, is an exemplar for creating a sustainable economy. The program has created many local jobs, and it represents a successful revitalization project. It transformed an existing development built in the 1950's into a modern, sustainable, well-functioning community.

Equitable strategies. "The key word in Bo01's strategy was 'diversity'" (Guardian 2005). The community built itself from this tenet. Literally, each of the housing units is unique, differently colored, and designed with various accommodations inside (Figure 12). These distinct units create one cohesive neighborhood, with one resident noting, "I get a larger sense of community here than anywhere else I've lived in Malmö" (ibid). Ekostaden Augustenborg also addressed issues of inclusion in its development. Resident participation was a major aspect in the design process for the neighborhood. New construction in Augustenborg included a "communal house for the elderly," an addition to an existing building for mobility-impaired persons, and "a new house with flats for the elderly" (Miljökarta över Skåne).

Another equity-based initiative in Malmö is a focus on fair-trade. Malmö was named Sweden's first Fairtrade City in 2006 by the Swedish national Fairtrade initiative, Rättvisemärkt. This award followed the opening of a local World Shop and information campaigns run by the Red Cross Youth (Hannah). Now, Malmö has a Fairtrade City campaign comprised of various stakeholders, whose efforts have received much media attention.

Another factor contributing to equity in Malmö is its thriving cultural background, which strongly emphasizes music (Wong 2009). Additionally, while the Scandinavian countries are generally thought to be a homogeneous population, thousands of immigrants, primarily from Iran, Iraq, Yugoslavia, and East Africa,

Figure 14. Farmers' Market in Mollevangen, an ethnic neighborhood (Wong 2009).

speak over 100 different languages in total and reside in Malmö (Figure 14) (Guardian 2005).

Critical analysis. Despite its surprising diversity, Malmö faces ubiquitous segregation problems. This issue is particularly apparent in Bo01. While Bo01 was founded on the idea of a diverse community, that diversity is limited to the built environment. "One thing that's not so diverse about Bo01 is the people. Judging by the healthy, affluent, almost entirely white residents, you'd never guess that 40% of Malmö's population is foreign-born" (Guardian 2005). These foreign-born residents live in "grubby housing blocks on the other side of the city" to whom Bo01 is an "unattainable paradise" (ibid).

Another problem within Bo01 is energy use. While the project was meant to be "a shining example of low-energy living," it is inhabited primarily by upper-class residents who generally consume far more energy than poorer residents (Guardian 2005). These residents were also less willing to abandon driving private automobiles than the plans had projected. Nonetheless, Bo01 was a pilot program and meant to provide insight into sustainable development. It is a single development within the expansive Western Harbor, which inevitably will be further developed in the future. "We learned a lot from Bo01. It was a very good start for the Western Harbor and very important for integrating the area with the rest of the city" (Guardian 2005). Now that the area has established itself with the extravagant Bo01, it can develop more modestly. "The next phase of building… will be less spectacular but more egalitarian – as much as 70% will be affordable housing… and, it's hoped, just as sustainable" (ibid).

Comparison of existing city developments

Chicago and Malmö are exemplars of the common environmental focus of existing eco-city developments. These cities will face challenges to modify existing infrastructure, buildings, and general city problems, such as poverty, crime and waste management. However, Malmö has shown that successful sustainable solutions can be implemented to both old and new developments. Although Bo01 is not as sustainable in terms of equity and economy, it has provided concepts and strategies for future development in the Western Harbor. Subsequent communities will include more affordable housing, and, once it is complete, perhaps the Western Harbor will have a diverse mix of races and income levels. The development of an existing city creates feasible changes that can be easily transferred and implemented in new locations, while

transference is often more difficult for master-planned cities. Addressing issues on a community scale, rather than individually, is an important aspect of holistic thinking and gives Malmö an advantage over Chicago's current initiatives. However, both Malmö and Chicago have implemented sustainability strategies for existing development and new spaces with varying success. Chicago and many other American cities are likely to face more obstacles to becoming eco-cities than most European cities, due to American's consumption habits and European's broader acceptance and understanding of sustainability.

Analysis

Comparing Eco-City Typologies

Due to the vast differences between master-planned eco-cities and existing eco-cities, eco-city typologies are difficult to compare and to declare one city as more sustainable than another. One cannot easily compare sustainability as a whole between these cities because of their differences in scope and time frame. For example, Songdo IBD may contain 350 LEED certified buildings and be deemed more sustainable than other cities that lack such widespread use of environmentally-sustainable strategies. However, existing cities develop more slowly and incorporate strategies into the existing city landscape that may support their populations more fully. Existing cities are not rebuilt to imitate master-planned construction, so their changes do not hold the same expectations. Different issues also arise in each situation. An analysis of master-planned cities must consider the value of the previously undeveloped land for habitat or farming and focus on provisions of equitable amenities and actions against income disparities. These tenets are not main concerns in existing city developments; rather, small-scale interventions should be measured by relative improvements over past conditions and consider the resources consumed to create such changes. In addition, existing cities must be examined in their entirety to holistically analyze the fit of sustainable plans into the city conditions, while new eco-cities are already considered as a complete master plan. Despite these challenges, eco-city typologies should be judged to consider the feasibility of each development for future use and resource allocation. Evaluating cities in terms of resource usage, attained benefits, and consequences in regards to the three E's of sustainability can create a useful point of comparison.

Eco-city merits and weaknesses. As common in the current image of master-planned eco-cities, both Masdar and Songdo IBD use international best practices to convey an idealistic

image of sustainable development. Masdar publicizes impressive catchphrases, such as "carbon-neutral", "zero-waste", and "car-free" to create excitement for its efforts, while Songdo IBD uses complete LEED certification to gain credibility in green design. Interestingly, each city earns different merits in sustainable urban planning due to highly divergent strategies. In terms of energy, Masdar focuses on a strength of solar energy and shading, combining active and passive strategies to optimize energy use with a sustainable source. Songdo IBD, however, chooses to disregard renewable sources of energy, creating an efficient fossil-fuel process instead. Due to its climate, Songdo IBD is able to focus on quality of life with connection to nature, creating aesthetic and functional public spaces that Masdar lacks due to its desert environment. Both cities take similar approaches to attract new industries and provide lifestyles for different income levels but take the risk of failing to attract a required minimum population to sustain the large area constructed.

One common weakness of Masdar, Songdo IBD, and master-planned cities in general is the tendency to underrepresent the equity issues due to overemphasis on economic growth. The completely new city must attract businesses in order to succeed and often attempts to sustain rapid growth to earn returns on massive capital investments. In order to attract industry, policies naturally favor the wealthy and increase income disparities. For example, Songdo's aforementioned cap on income tax allows the wealthy to earn higher profits while the poor continue to pay standard taxes on their income (Curlik 2009). Alternatively, existing cities are established and commonly not pursuing rapid growth; their economy and population is more stable and has programs and regulations to support low-income individuals. Chicago's Living Wage Act of 2006 attests to existing city efforts to support the poor that generally develop over time in active communities.

However, the primary weaknesses of master-planned eco-cities do not concern the individual strategies they employ but the dramatic, energy-intensive process required for their creation. The large inputs of energy required to construct an entire, functional city in one continuous project must be regarded when considering the true sustainability of a community. Beyond the initial inputs, it is unlikely that all buildings will function exactly according to users' needs, causing the need for redesign, adaptation, and consequently, additional capital. A key advantage of improving existing cities with sustainable strategies is the ability to modify environments that already perform well for their inhabitants. The lack of user input in the

construction of a master-planned city creates a contradiction with its goal of creating an ideal community for humans and the natural environment. Similar to natural processes, true sustainable processes are developed over a long period of evolution and adaptation; change is considered a necessity for survival. While model eco-cities claim to overcome the challenges of modifying existing developments, master-planned eco-cities too must be able to adapt with their populations and incorporate advances in technology to remain current and advantageous. Due to this fact, model eco-cities, such as Masdar and Songdo IBD, may serve as beneficial experiments to optimize strategies for further incorporation, but the general focus for true sustainable communities should center on how to incorporate these strategies into existing global communities.

Existing development advantages. While modifying existing cities does not produce the sweeping changes and exciting "harm-free" catchphrases that eco-cities produce, their changes are more feasible for large-scale implementation. One important consideration is the availability of capital for global cities. Most states and nations do not have expansive monetary surpluses to invest in creating master-planned eco-cities; incremental changes with smaller investments are more practical and likely to pass approval for implementation. Existing cities are able to retain existing embodied energy and amenities, which reduces costs; improving cities continues the use of all of the energy and resources already invested into parks, buildings, roads, and other infrastructure, rather than constructing new systems.

In addition, the sustainability of new construction with greenfield development is an equal concern. Building on undeveloped land permanently removes these areas from farming capabilities and damages natural ecosystems. Even in Songdo IBD, which claims to be reclaimed, infill development, excessive energy and resource inputs were required to modify the land into a usable state, and habitat for endangered avian species was destroyed. Brownfield redevelopment within existing cities has proven to be an excellent strategy to transform unusable or damaged land into functional and profitable area, as shown in the Western Harbor in Malmö. Additionally, current American cities are considered to have low densities that reduce their green qualities; focus should be given to increasing the densities of existing cities, not drawing people to fill new cities. While existing cities may not be as ideal to integrate new strategies as a blank template, their challenges often yield more creative solutions to develop unique strategies specifically suited to a given locale. The economic and societal base of existing cities provides a

stable, supportive foundation for future sustainable development that master-planned eco-cities lack. By evolving strategies over the life of the city, the resulting processes can be more holistic and sustainable than developing all strategies in one short-term project due to fewer risks and uncertainties in investment, development, and popular response.

Conclusion

Master-planned eco-cities and existing city developments each have advantages and disadvantages for sustainable strategies. Existing cities avoid the struggles of establishing economic and equitable features that new eco-cities face, and new, master-planned eco-cities are better suited to fully integrate environmental strategies for optimal use. Current model eco-cities have great value in research potential and the ability to develop sustainably in a holistic manner. However, while the end results may be initially impressive, the concept of constructing an entire city as one project is counter to basic tenets of sustainability. Sustainability involves adaptation, maintenance, innovation, and responsibility. New eco-cities employ the latest innovations, but these four sustainable concepts fit more aptly with modifying existing cities that have experienced a history of trials, failures, and successes. The energy, innovation, and capital required to build new eco-cities would be better invested in improving existing developments in terms of environmental, economic, and equitable strategies. While retrofitting existing cities is time-intensive due to the implementation, education, and adoption processes, these steps are essential to create sustainable results. Existing cities with a willing population provide opportunities for great improvement, and growing support of sustainable efforts will aid the process of transforming global cities into eco-cities.

Works Cited

Adrian Smith + Gordon Gill Architecture. “Chicago Eco-Bridge.” Adrian Smith + Gordon Gill Architecture. http://www.smithgill.com/#/work/chicago_eco_bridge.

Baek, Yong Chun. "Attraction of High Value Added Businesses." Planning Office of Free Economic Zone, Ministry of Finance and Economy, Republic of Korea. May 2006. http://info.worldbank.org/etools/docs/library/235393/baek-eng.pdf.

Basantani, Mahesh. "Plans for Foster's Masdar Carbon Neutral City Debut." Inhabitat. February 6, 2008. http://www.inhabitat.com/2008/02/06/plans-unveiled-for-worlds-first-zero-carbon-zero-waste-city-masdar-city/.

Birds Korea. “Reducing Rates of Biodiversity Loss: The Challenge Ahead.” Birds Korea. June 2009. http://www.birdskorea.org/Our_Work/Publications/Homepage-articles/BK-HP-Homepage-article-06.2009.shtml.

Central Intelligence Agency. "World Factbook." Central Intelligence Agency. 2008. https://www.cia.gov/library/publications/the-world-factbook/fields/2004.html

Chen, Olivia. “West Loop Park Infuses Chicago With Green Urban Space.” Inhabitat. August 31, 2009. http://www.inhabitat.com/2009/08/31/west-loop-park-an-urban-plan-for-chicago/.

Chicago Department of Transportation. “The Chicago Green Alley Handbook.” Chicago Department of Transportation. http://www.resourcesaver.org/file/toolmanager/CustomO16C45F95080.pdf.

City of Chicago. “Department of Environment.” City of Chicago. http://egov.cityofchicago.org/city/webportal/portalEntityHomeAction.do?entityName=Environment&entityNameEnumValue=13.

City of Malmö. “Sustainable City Development.” City of Malmö. http://malmo.se/English/Sustainable-City-Development.html.

Curlik, Larissa. “Cities of the Future.” *Worth*, October-November 2009, 49.

Dilworth, Dianna. "Zero Carbon; Zero Waste in Abu Dhabi." Business Week. August 1, 2007. http://www.businessweek.com/innovate/content/aug2007/id2007081_901739.htm.

Ecocity Builders. "About Ecocity Builders" Ecocity Builders. 2009. http://www.ecocitybuilders.org/about.html.

Economist. "Masdar Plan." *Economist.* December 4, 2008. http://www.economist.com/search/displaystory.cfm?story_id=E1_TNGSPQPP.

Editors of E/The Environmental Magazine. “Boosting Energy Efficiency with Cogeneration.” The Daily Green. June 22, 2008. http://www.thedailygreen.com/environmental-news/latest/cogeneration-460608.

Foresight Design Initiative. “Programs.” Foresight Design Initiative. http://www.foresightdesign.org/programs/.

Fox, Jesse. "Ecocities of Tomorrow: Can Foster + Partners' Masdar City in the U.A.E. be Truly Sustainable?". Treehugger. March 4, 2008. http://www.treehugger.com/files/2008/03/masdar-roundtable.php.

Gale International, LLC. “Songdo IBD.” Gale International, LLC. 2009. http://www.songdo.com/.

Guardian. “Swede Dreams.” Guardian. August 29, 2005. http://www.guardian.co.uk/artanddesign/2005/aug/29/architecture.

Hannah. “Malmö - Sweden’s first Fairtrade City.” Fairtrade Towns. http://www.fairtradetowns.org/resources/malmo-swedens-first-fairtrade-city/.

Je-hae, Do. “Incheon to House 200,000 Foreigners by 2020.” *Korean Times,* June 15, 2009. http://www.songdo.com/songdo-international-business-district/news/in-the-news.aspx/d=59/title=Incheon_to_House_200000_Foreigners_by_2020.

Kriscenski, Ali. “Chicago’s Next Lead: The Green Alley Project.” Inhabitat. December 22, 2007. http://www.inhabitat.com/2007/12/22/chicagos-next-lead-the-green-alley-project/.

Masdar City. "Masdar City: All About Us." Masdar City. 2009. http://www.masdarcity.ae/en/index.aspx.

Meinhold, Bridgette. “Chicago’s Bloomingdale Rail Line to Be a Park in the Sky.” Inhabitat. October 30, 2009. http://www.inhabitat.com/2009/10/30/chicago%E2%80%99s-high-line-park-in-the-sky/.

Meinhold, Bridgette. “Eco-Bridge: Chicago’s New Harborside Green Space.” Inhabitat. June 11, 2008. http://www.inhabitat.com/2008/06/11/chicagos-eco-bridge/.

Meinhold, Bridgette. “Songdo IBD: South Korea’s New Eco-City.” Inhabitat. September 4, 2009. http://www.inhabitat.com/2009/09/04/songdo-ibd-south-koreas-new-eco-city/#.

Miljökarta över Skåne. “Ekostaden Augustenborg.” Miljökarta över Skåne. http://www.eco-guide.net/skane/Ekostaden_Augustenborg_project.php?db_id=.

NaturalGas.org. “Natural Gas and the Environment.” NaturalGas.org. 2004. http://www.naturalgas.org/environment/naturalgas.asp.

Palca, Joe. "Abu Dhabi Aims to Build First Carbon-Neutral City." NPR. May 6, 2008. http://www.npr.org/templates/story/story.php?storyId=90042092.

Pilloton, Emily. "Chicago Green Roof Program." Inhabitat. August 1, 2006. http://www.inhabitat.com/2006/08/01/chicago-green-roof-program/.

Register, Richard. *Ecocity Berkeley: Building Cities for a Healthy Future.* Berkeley, CA: North Atlantic Books, 1987.

Rosenthal, Elisabeth. "Gulf Oil States Seeking a Lead in Clean Energy." The New York Times. January 12, 2009. http://www.nytimes.com/2009/01/13/world/middleeast/13greengulf.html?_r=4&scp=1&sq=dubai%20gulf&st=cse.

Sustain Lane. "Chicago, IL: The Wind at its Back." Sustain Lane. 2008. http://www.sustainlane.com/us-city-rankings/cities/chicago.

Tigay, Chanan. "Watering Chicago's Food Deserts." Sustain Lane. September 2008. http://www.sustainlane.com/us-city-rankings/articles/watering-chicagos-food-deserts/ZT9H4OJK4C4VYDOUAUNJQF9IDLRU.

Todorova, Vesela. "Progress is 'On Track' at Masdar City." The National. August 28, 2008. http://www.thenational.ae/apps/pbcs.dll/article?AID=/20080828/NATIONAL/734829586/1010.

U.S. Green Building Council. *LEED for new construction & major renovations version 2.2*. Washington, DC: U.S. Green Building Council, 2005.

Whitman, Christine Todd, Charles Reid, James von Klemperer, Josh Radoff, and Anthony Roy. "New Songdo City- The Making of a New Green City." CTBUH 8th World Congress. 2008. http://www.ctbuh.org/Portals/0/Repository/T11_WhitmanVonKlemperer.cf720bde-f92c-4231-94ad-c44207ee53e6.pdf.

Wong, Grace. "Malmo: Sweden's Most Eco-Friendly City." CNN.com. February 5, 2009. http://edition.cnn.com/2009/TRAVEL/01/07/malmo.overview/index.html.

World Wildlife Fund. "WWF, Abu Dhabi Unveil Plan for World's First Carbon-Neutral, Waste-Free, Car-Free City." World Wildlife Fund. http://www.panda.org/wwf_news/press_releases/?121320/WWF-Abu-Dhabi-unveil-plan-for-worlds-first-carbon-neutral-waste-free-car-free-city.

Woyke, Elizabeth. "Very Smart Cities- Asia's Smart Metropolis." *Forbes*, September 3, 2009.