



# **Sustainable Cities: Oxymoron or the Shape of the Future?**

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## **Sustainable Cities: Oxymoron or the Shape of the Future?**

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### **Abstract**

Two trends are likely to define the 21st century: threats to the sustainability of the natural environment and dramatic increases in urbanization. This paper reviews the goals, business models, and partnerships involved in eight early “ecocity” projects to begin to identify success factors in this emerging industry. Ecocities, for the most part, are viewed as a means of mitigating threats to the natural environment while creating urban living capacity, by combining low carbon and resource-efficient development with the use of information and communication technologies (ICT) to better manage complex urban systems.

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\* Authorship is alphabetical

## Introduction

Urbanization presents one of the most pressing and complex challenges of the 21<sup>st</sup> century. How cities are designed, managed and used is likely to shift substantially based on demands created by two powerful trends. One trend involves a growing awareness of a threat to the sustainability of the Earth's natural environment; the second is the rapid rise in the number of people moving into and living in cities. Combined, these trends call for massive development of new buildings and infrastructure, along with new social and cultural institutions, to accommodate vast numbers of city dwellers without irreparably harming the natural environment.

In particular, rapid population and economic growth in the developing world pose profound implications for the future of human society. About 90% of urban growth worldwide occurs in developing countries, which are projected to triple their existing base of urban areas between 2000 and 2030.<sup>1</sup> It is estimated that by 2025, China alone will add 350 million people to its urban population—more than the population of the entire United States today.<sup>2</sup>

The pathway taken by urban development over the next few decades will play a crucial role in the trajectory of worldwide greenhouse gas emissions and natural resource depletion. Cities consume 60% to 80% of the world's energy production, and with the urban population of the developing world projected to reach more than 5 billion people by 2050, ideas about how to combine urbanization and sustainability are of critical and immediate importance.<sup>3</sup>

In response, around the world, a few companies and government bodies have begun to explore the creation of “ecocities”—a term that overlaps and is sometimes used interchangeably with “smart cities” or “sustainable cities.” According to the declaration of the World Ecocity Summit 2008 in San Francisco, an ecocity:

...is an ecologically healthy city. Into the deep future, the cities in which we live must enable people to thrive in harmony with nature and achieve sustainable development. People oriented, ecocity development requires the comprehensive understanding of complex interactions between environmental, economic, political and socio-cultural factors based on ecological principles. Cities, towns and villages should be designed to enhance the health and quality of life of their inhabitants and maintain the ecosystems on which they depend.<sup>4</sup>

As this encompassing description implies, the term ecocity remains loosely defined.<sup>5</sup> A second, similar definition comes from the World Bank “Eco<sup>2</sup> Cities” report: “Ecological cities enhance the wellbeing of citizens and society through integrated urban planning and management that fully harnesses the benefit of ecological systems, and protects and nurtures these assets for future generations.”<sup>6</sup> Both definitions include environmental and social components and emphasize the importance of urban planning and management.<sup>7</sup>

Some observers have suggested that threats to the environment can be mitigated by ecocities, which might provide “needed structural change for transition into a post-carbon economy.”<sup>8</sup> To consider this possibility, we examined eight ecocity projects currently under development. We review both what these early efforts have in common and how they differ as a

first step in identifying factors that may affect the success of future ecocities. As elaborated below, ecocity projects typically include carbon emissions reduction and resource efficiency targets, economic development goals, and unique city designs to promote healthy, socially sustainable communities, as well as to gain recognition for sustainability. Whether or not these targets can be reached remains an open question. Is the juxtaposition of sustainability and urbanization an oxymoron, or the shape of things to come? The projects described below present evidence that a substantial number of thoughtful, deeply expert individuals and experienced organizations are betting on the latter.

### **Drivers and Components of Ecocity Initiatives**

The World Bank launched the Eco<sup>2</sup> Cities Program to “provide practical and scalable, analytical and operational support for cities in developing countries to achieve ecological and economic sustainability”<sup>9</sup> based on four key principles: (1) a city based approach; (2) an expanded platform for collaborative design and decision making; (3) a one system approach; and (4) an investment framework that values sustainability and resiliency. The program’s goals include assessing the economic viability of ecocities to explore the possibility that ecocities might attract global businesses and allow lower costs relative to traditional cities, while withstanding resource, climate, and economic shocks. The World Bank plans to partner with government, NGO and private sector organizations to help pilot Eco<sup>2</sup> Cities develop.

Attempts to define the attributes of ecocities include a joint initiative between the Clinton Climate Initiative and the U.S. Green Building Council that suggested the following: “100 per cent carbon-neutral energy production; an interconnected transport system and land-use pattern that shifts people from cars to walking, cycling and public transport; a zero-waste management system; resource conservation, including maximizing water and energy efficiency and preserving open land, wildlife and plant habitats; and using environmentally sound building materials, preferably locally sourced.”<sup>10</sup> Although these compelling attributes are not yet widely endorsed, there are two dominant themes associated with most ecocity projects: the use of green buildings to reduce greenhouse gas emissions, and the use of information and communication technology to better manage and operate the cities.

Green building has been the focus of much government attention over the past few years. In May 2010, the European Union (EU) announced a mandate for “nearly zero-energy buildings,” which will apply to all new public buildings in the European Union after 2018 and to all new homes and offices in 2020.<sup>11</sup> The European Commission, the executive branch of the EU, is responsible for designing specific regulations for “minimum energy” buildings. In the U.S., the General Services Administration, responsible for the federal government’s buildings and real estate, embraced sustainable design principles by mandating that all new construction and major renovations be compliant with LEED Gold standards.<sup>12</sup> While the EU is a step ahead of the U.S. in its requirements, governments in both regions are likely to continue to exert a major influence on the type of design and urban development that ecocities seek to achieve.

China’s Ministry of Construction established the China Green Building Council in 2008, to establish a LEED-like rating system as a step toward pursuing stricter environmental standards for construction and promoting clean-tech development.<sup>13</sup> The government’s goal is “to cut

energy use of buildings by 65 percent by 2020, using the average energy efficiency of Chinese buildings in 1980 as the base point.”<sup>14</sup> The four largest cities in China—Beijing, Shanghai, Tianjin and Chongqing—will work to cut building energy use by 65% before the end of 2010. As the World Bank estimates that 50% of new building construction globally will occur in China by 2015, this is a massive undertaking and could open up numerous “eco-friendly” development opportunities in China in the coming years.

Smart infrastructure, or the use of information and communication technologies (ICT) to better manage complex systems ranging from traffic patterns to the electric grid, is a related field that plays a central role in ecocity development. A key component is the integration of wireless sensors, which can collect and transmit information from almost any object, including utility lines, water pipes, roads, and buildings. Using sensors, advanced computer software interpret raw data to “monitor and optimize” these kinds of complex systems. In this way, computers will “become intelligent instruments of control, linking them to data-generating sensors throughout the planet’s infrastructure,”<sup>15</sup> resulting in enormous reductions in greenhouse gas emissions and wasted natural resources.

The Climate Group’s SMART 2020 plan identified ICT within cities as a resource that could cut global emissions by 15% by 2020, and the research firm IDC estimates that the smart infrastructure field will amount to \$122 billion over the next two years.<sup>16</sup> For example, IBM has been a leader in the digital infrastructure field and many of its advances apply to city-related technologies. IBM has undertaken projects across the globe under the umbrella of its “Smarter Planet” initiative, including smart grid software, working with cities on water management systems, and implementing “smart” traffic systems in major cities.<sup>17</sup>

Another example is technology giant Cisco’s interest in the ecocity realm. Executive Vice President, Cisco Services and Chief Globalization Officer, and head of Cisco’s “Smart+Connected Communities” initiative Wim Elfrink estimated that “at least \$500 billion will be earmarked for instant cities over the next decade, with \$10 billion to \$15 billion allotted for network plumbing alone.” CEO John Chambers predicted that the smart-grid market itself “may be bigger than the whole Internet.”<sup>18</sup> More broadly, Cisco sees its entire Smart+Connected Communities initiative as a potential \$30 billion opportunity, including revenues from installation of infrastructure—notably highways, bridges, railroads, airports, utilities, and dams—and “selling the consumer-facing hardware as well as the services layered on top of that hardware.”<sup>19</sup>

## **Ecocity Developments**

The development of eight ecocity initiatives provides early experiments from which we can learn. This section thus reviews Dongtan, Tianjin Eco-City, Nanjing, and Meixi Lake District in China; Masdar City in Abu Dhabi; New Songdo City in South Korea; Sitra Low2No in Finland; and PlanIT Valley in Portugal. While not exhaustive, the list presents a reasonable sample of early ecocity projects. Our aim is to assess these geographically diverse initiatives, beginning with the earliest ones, and to examine their aims, business models, and partnerships, so as to identify factors associated with the development of successful ecocities.

## New Songdo City

*Background and goals.* Plans for New Songdo City, located on a man-made island about 40 miles from Seoul, South Korea, began in 2000. The 1,500-acre city's anticipated population is 430,000 by 2014, and its overall development goal is "Compact, Smart and Green." Plans are to emit only one-third the greenhouse gases of a similar size city, with plans for green homes and commercial buildings developed by GE Korea. The city lies within the Incheon Free Economic Zone to attract businesses and foreign investment and aims to "position South Korea as the commercial epicenter of Northeast Asia."<sup>20</sup>

*Governance and financing.* In 2001, the City of Incheon gave development rights to a 70/30 partnership between developer Gale International and construction manager POSCO E&C, a Korean steelmaker.<sup>21</sup> The project has an estimated cost of \$35 billion and in 2006 Morgan Stanley became the first financial institution to make a direct cash investment, totalling \$350 million.<sup>22</sup> At that time, \$1.5 billion in construction had already been financed through a syndicated loan extended by a group of 26 financial institutions.

*Partnership network.* Kohn Pederson Fox was selected as the master architect for the New Songdo International Business District, but several architects, including KlingStubbins, HOK New York and Dong-II Architects, took charge of individual projects in the city.<sup>23</sup> Arup, an engineering and design consultancy with expertise in sustainability, was engaged to support engineering and design work on the downtown area of the city. Cisco emerged as the major technology player in the city, with plans to develop a "Cisco Global Center for Intelligent Urbanization" in New Songdo. Cisco plans to completely digitize the city by covering it in sensors so that it "runs on information"—meaning that Cisco's "control room" would act as the "brain" of the city.<sup>24</sup> New Songdo would be a key part of Cisco's Smart+Connected Communities initiative, which the company sees as a potential \$30 billion opportunity—including revenue from installing infrastructure and also selling consumer hardware and services.

New Songdo City features the Songdo International Business District (IBD), organized through a Memorandum of Understanding (MOU) between Gale International, United Technologies Corporation (UTC), and Hanjin Group.<sup>25</sup> The IBD was launched in August 2009 and is intended to fill the need for an international business hub in Northeast Asia due to the massive business growth in nearby cities such as Beijing, Shanghai, and Tokyo. Songdo IBD aims to attract multinational corporations by providing hotels, schools, technology infrastructure, and convention centers of the highest caliber, and by employing leading urban planning and sustainable design firms to create an "unparalleled quality of life."<sup>26</sup> Two other major technology companies, Microsoft and 3M, have agreed to partner to create a world-class health facility, Songdo International City Hospital, within the city. (See Figure 1, below, for a diagram of partnership networks for each city).

*Status.* As of 2009, 60,000 residents and 418 companies and research centers either had relocated to New Songdo or announced plans to do so, and by 2014 the second phase of development was targeted for completion.<sup>27</sup> The city plans to include 10 foreign universities, eight Korean universities, four international schools, and 17 theaters, at some point in the future.

## Dongtan

*Background and goals.* Dongtan City, China presents one of the earliest and most widely-publicized sustainable urbanization project. In 2005, the Shanghai Municipal government gave a tract of land on Chongming Island to the Shanghai Industrial Investment Company (SIIC), China's state-run investment arm. Chongming Island is situated about nine miles from Shanghai's financial district and covers nearly 33 square miles—an area about three-quarters the size of Manhattan.<sup>28</sup> The government instructed SIIC to develop a plan for the land, thus beginning the project of Dongtan City.

The city's original stated goal was to be a “renewably powered, car-free, water-recycling” city which could serve as a sustainable city model for the world, housing 25,000 residents by the 2010 Shanghai World Expo and 500,000 by 2050.<sup>29</sup> According to SIIC, the broader idea was “to skip traditional industrialization in favor of ecological modernism.”<sup>30</sup>

*Governance and financing.* In 2010, SIIC was the second-largest real estate holder in China and, as the developer of the Dongtan City project, was solely responsible for appointing companies to the project. SIIC first hired consulting firm McKinsey & Company to be involved in its process of considering different design and engineering firms to take on the project. Eventually, with the recommendation of McKinsey, SIIC offered the lead design role to Arup. Finally, SIIC and Arup signed partnership agreements with HSBC and U.K. investment bank Sustainable Development Capital LLP for financing.

*Partnership network.* Arup oversaw the key design and sustainability aspects of the Dongtan project: “urban design, planning, sustainable energy management, waste management, renewable energy process implementation, economic and business planning, sustainable building design, architecture, infrastructure and even the planning of communities and social structures.”<sup>31</sup> The intended collaboration between SIIC and Arup received significant political support and publicity. On November 9, 2005, in a ceremony in London at Number 10 Downing Street in the presence of Prime Minister Tony Blair and visiting Chinese President Hu Jintao, the two companies signed a contractual agreement to develop the world's first “ecocity” and also collaborate on sustainable development projects in the future.

Over time, SIIC spent over \$1 billion building a bridge and tunnel connection between Chongming Island and Shanghai, connecting the site to one of the most rapidly growing megacities on the planet. The partners grappled with complex issues, including who would live in Dongtan, what sort of jobs would be created, how to make the city commercially viable, and how to make it replicable.<sup>32</sup>

The project planned to focus on education, including building a Dongtan Institute for Sustainability. Dongtan's educational initiatives received support and assistance from the Engineering and Physical Sciences Research Council (EPSRC), the primary U.K. funding body for engineering and physical sciences. EPSRC, Arup, and SIIC agreed to form research networks to study the process of developing a sustainable city and collaborate to address the associated challenges.<sup>33</sup> Arup and SIIC also signed a MOU with the University of East Anglia

carbon reduction team in the U.K. to collaborate on the Dongtan Sustainable Technologies and Renewables (STAR) Project, which would include a renewable energy station in the city.<sup>34</sup>

*Status.* Despite the partnerships and planning, delays pushed the construction start date back from 2006 to 2009. As of 2010, implementation of Arup's masterplan seemed stalled. Peter Head, a key project leader from Arup, said in an interview that to his knowledge the plans were indefinitely on hold and that SIIC had not informed Arup of the reasons for this. Chen Lianglu, a Communist Party leader in Shanghai, who played a large role in procuring the Chongming Island land for development by SIIC, was arrested for fraud in 2006, perhaps creating political tension that helped derail the project timeline. There has also been speculation about funding and environmental challenges. Chongming Island is home to important wetlands, making development less environmentally friendly than developers would have liked.<sup>35</sup>

## **Masdar City**

*Background and goals.* The government of Abu Dhabi began one of the most famous - and most widely criticized - ecocity projects to date. The 2.7 square-mile Masdar City, located in a desert 10.5 miles from downtown Abu Dhabi, was designed to house 40,000 residents, along with hundreds of businesses and a research university, and to serve as a clean-tech city cluster. Masdar City officials stated that the city's goal "is to serve as a model for other sustainable urban development, assist the wider Abu Dhabi in lowering its eco footprint, contribute to Abu Dhabi's economic diversification and establish the emirate as a global hub for renewable energy and clean technology."<sup>36</sup> Initially, Masdar City had a \$22 billion price tag and a projected completion date of 2016.

The government originally announced that the city would aim to be zero-carbon, powered entirely by renewable energy, car-free, and produce net-zero waste. Plans for the city were later revised to achieve more modest, if still ambitious, sustainability performance indicators. These include reducing overall energy demand by 50%, embodied carbon (emissions caused by building materials and products) by 30% and operational carbon (emissions caused by the city's day-to-day operations) by 50%, compared to what Masdar City officials describe as "business as usual" in Abu Dhabi.<sup>37</sup> Aside from energy, Masdar City's planners hope to reduce water and landfill waste by 30% and 50% respectively. Also, Abu Dhabi won the right to host the headquarters of the International Renewable Energy Agency (IRENA), an organization with a mandate to "promote the widespread and increased adoption and sustainable use of all forms of renewable energy," within Masdar City.<sup>38</sup>

*Governance and financing.* The plan for Masdar City was conceived by the government of Abu Dhabi and administered by Masdar, a wholly owned subsidiary of the Mubadala Development Company, a government-owned investment vehicle that manages a multi-billion dollar portfolio of projects to support the growth and economic diversification of Abu Dhabi. Masdar is comprised of five integrated units, including Masdar City, Masdar Carbon, Masdar Capital, Masdar Power, and Masdar Institute of Science and Technology. Masdar describes itself as "a commercially driven enterprise that operates to reach the broad boundaries of the renewable energy and sustainable technologies industry" and "seeks to become a leader in



making renewable energy a real, viable business and Abu Dhabi a global centre of excellence in the renewable energy and clean technology category.<sup>39</sup>

The Abu Dhabi government set aside \$15 billion for Masdar, about \$4 billion of which was allocated to Masdar City. Other forms of financing will presumably provide the remainder of approximately \$19 to \$20 billion anticipated total price tag.<sup>40</sup> The city is designated as a special economic zone that allows 100% foreign ownership and zero taxes in an effort to encourage economic investment and to attract international companies.<sup>41</sup>

*Partnership network.* In 2006, Masdar selected London-based Foster + Partners to design the city, help set sustainability standards, and design the Masdar Institute campus. Design of the Masdar Headquarters building was awarded to Adrian Smith + Gordon Gill Architecture; Atkins took on the infrastructure design concept, while Mott McDonald handled infrastructure consulting. CH2M Hill was selected as the program managers, with the Al Jaber Group managing infrastructure construction.<sup>42</sup>

Several technology companies are participating in the city's development, particularly on demand-side energy solutions. Masdar City and Siemens signed a strategic partnership agreement, and are working on an innovative power grid and advanced building technologies development agreement for the first phase of Masdar City. Siemens plans also to locate its Middle East headquarters in the city. General Electric (GE) works with Masdar's shareholder, Mubadala, across a range of fields. GE and Masdar City are investigating ways to reduce peak power demand through the use of GE smart home appliances agreed to design the appliances and networks for Masdar City; GE stated it has "developed a line of 'smart' appliances that automatically react to pricing signals from the utility and delay or reduce wattage of high-consumption tasks until lower-cost, off-peak periods."<sup>43</sup> GE plans to build its first Ecomagination Center, which "will develop the innovative technologies and services to help ensure the sustainability of our planet" in Masdar City.<sup>44</sup> Masdar City also partnered with Al Falah Ready Mix, which is manufacturing low-carbon concrete required for the City's first phase. Finally, BASF, an international industrial giant, was named Masdar City's "preferred supplier" of construction materials and system solutions, and also plans to open an office in Masdar City.<sup>45</sup>

Masdar developed Masdar Institute (MI), the Middle East's first graduate research institution dedicated to renewable energy and environmental technologies, in partnership with the Massachusetts Institute of Technology (MIT). Located in Masdar City, MI is supported by MIT's Technology and Development Program. A second class of graduate students, for whom tuition is free of cost, entered MI in the fall of 2010.

*Status.* The city's original timeline included six development phases, beginning with the development of MI, the Masdar Headquarters, and the initial residential, office and community infrastructure in the first phase. The first buildings of MI were set to open in 2009, with full build out expected by 2016.

Masdar project leaders scaled back some ambitions and adjusted their original timelines, facing financial challenges in 2010.<sup>46</sup> They pushed the construction finish date back from 2016

to 2021-2025. *The New York Times* reported that Masdar was reconsidering its plan to generate all power on-site, and that computer-driven “personal transit pods” intended to connect the entire city might be rolled out at a more limited scope.<sup>47</sup> Several directors of various aspects of Masdar left the organization.<sup>48</sup> In July 2010, Masdar’s CEO Dr. Sultan Ahmed Al Jaber announced that, although delivery dates and some of the city’s sustainability performance benchmarks would not be achieved immediately, the vision of Masdar City remains the same. Masdar officials attributed these changes to the global economic crisis and a weakened Middle East property market,<sup>49</sup> coupled with lessons learned in building the first phase of the Masdar Institute Campus, noting that the crisis suggested “it made no sense, either commercially or from an eco-sustainability perspective, to insist on the original zero-carbon, zero-waste goals in the short term, when current technology would make achieving such targets enormously expensive and thus largely irrelevant to any other sustainable urban development project.”<sup>50</sup>

Masdar City officials have stated that Phase 1 of the city should be completed in stages through 2015.<sup>51</sup> This should include doubling the size of Masdar Institute’s current campus, and constructing the Masdar Headquarters building (which will house IRENA), an office building, and several residential and commercial buildings. Masdar expects that Phase I will accommodate 7,000 residents and 15,000 commuters; at full build out in 2021 - 2025, they expect around 40,000 residents and 50,000 commuters.<sup>52</sup>

## **Sino-Singapore Tianjin Eco-City**

*Background and goals.* In 2007, only a few years after announcing the Dongtan project, the Chinese government made plans for another ecocity, Sino-Singapore Tianjin Eco-City on a site about 25 miles from the Tianjin city center, 95 miles southeast from Beijing, and less than a ten-minute drive to the Tianjin Economic-Technological Development Area (TEDA). The city’s mission revolves around “Three Abilities” (Practicability, Scalability, and Replicability) and “Three Harmonies” (harmony with economic development, harmony with the environment, and harmony with society). The city’s plans for sustainable development include six dimensions: intelligent city, clean water, ecology, clean environment, clean energy, and green building.

*Governance and financing.* The structure of Tianjin Eco-City differs from Dongtan— hinting that the Chinese government learned from its first highly-publicized and unsuccessful ecocity experience. Tianjin Eco-City is a joint collaboration between the Chinese and Singaporean governments, agreed to by Singapore Prime Minister Lee Hsien Loong and Chinese Premier Wen Jiabao in November 2007. The groundbreaking ceremony occurred just 10 months later. The project is structured as a 50/50 joint venture between a Chinese consortium and a Singaporean consortium, called Sino-Singapore Tianjin Eco-City (SSTEC).

The Chinese are led by the state-run Tianjin TEDA Investment Holding Co., Ltd. (Tianjin TEDA), and other partners include China Development Bank, Tianjin Real Estate Development and Management Group Ltd., Tianjin Tanggu Urban Construction Investment Company, Tianjin Hanbin Investment Co. Ltd, and Tsingli Group (Tianjin) Assets Management Co., Ltd. The Singaporean consortium is led by an entity called the Singapore Tianjin Eco-City Investment Holdings Pte. Ltd, in turn led by its majority stakeholder, the Keppel Group. The Keppel Group

is a Singaporean company involved in property, infrastructure, and investments, and is partially owned by state investor Temasek.

While Tianjin TEDA originally owned the land, the SSTECH joint venture is the official master developer for the ecocity. The progress of Tianjin Eco-City indicates that developers are managing the project by land parcels, which are controlled by different private developers—and it seems that SSTECH is trying to involve many major corporations. Financing is being handled primarily by the China Development Bank, and by May 2010 the project had about \$1.5 billion of registered capital.<sup>53</sup> SSTECH plans to develop several economic incentives to attract residents and companies to the city, including tax incentives, housing rebates, R&D funding, and subsidies for businesses.

*Partnership network.* In 2009, several real estate-focused companies formed partnerships with SSTECH through a MOU. One of these was Ascendas, Singapore's primary business space solutions provider, with plans to develop and market an Eco-Business Park in the city. The park plans provide space and resources for the offices or headquarters of world-class companies, particularly those focused on energy and other environmental issues. Other partners include Shimao Property Holdings, China's leading foreign-funded property developer, Mitsui Fudosan Co., Ltd, Japan's largest real estate developer, and Shanghai Broadway Packaging & Insulation Material Co., Ltd which plans to develop a green technology center. Additionally, Taiwan's largest property developer, Farglory Land Development Group Shanghai, proposed to create a "live, work and play" center, intended as the city's primary space for leisure activities.

Additionally, SSTECH formed partnerships to study and work on reducing the city's energy usage with energy and technology companies, including PV World (a Singapore-based manufacturer of wafer-based photovoltaic solar modules), First DCS Pte. Ltd. (a Singaporean company that plans to develop heating and cooling systems for the Eco-Business Park), Sembawang Engineers & Constructors Pte Ltd (to study feasibility of a planned billion dollar solar polysilicon production plant), and Envision (a Chinese company working on energy efficient glazing systems). Other technology companies involved through "strategic partnerships" and/or MOUs are Philips (test-bedding and application of energy-efficient lighting and consumer lifestyle solutions for sustainability), Hitachi (eco-solutions for homes, electric vehicle charging, building energy management, smart grid, and water), Samsung C&T Corporation (developing an eco-residential project), (Singapore Technologies Electronics Limited (intelligent building/transport systems), and STSE Engineering Services Pte Ltd (overseeing pneumatic waste collection systems). The Land Transport Authority of Singapore plans to advise on transportation for the ecocity, including a public transport system and hybrid/electric vehicles for both public and private usage. A primary focus of the ecocity is on education, with plans for a new university that will offer doctoral and master's degree programs in sustainable design.

*Status.* The Tianjin Eco-City project is continuing to sign tenants and expects its first wave of residents in 2011. Completion of the initial phase of the project, about three square miles, is expected within the next three to five years, and the entire 11.5 square miles is planned for completion within 10 to 15 years. According to Wang Bao, a Chinese environmental activist, the Tianjin ecocity has realistic design schemes and expectations, making it China's most

promising ecocity project to date. Furthermore, Bao believes that the project developers “have scientific methods of ensuring that the development is in line with their green targets—and the Singapore leaders frequently come to check the progress.”<sup>54</sup>

### **Sino-Singapore Nanjing Eco High-Tech Island**

*Background and goals.* Nanjing Eco High-Tech Island (Nanjing Ecocity) is another Chinese ecocity being developed by a joint partnership with Singapore. It is about two square miles in size and four miles from Nanjing, the capital of southern Jiangsu province. This ecocity’s goal is “to establish a platform for the sustainable development of high-tech, smart industries under an ecologically conscious environment;” however, information about its projected dates and size is limited.

*Governance and financing.* In November 2007, a bilateral platform—the Singapore-Jiangsu Cooperation Council—was launched to promote collaboration between Singapore and Jiangsu on the project. International Enterprise (IE) Singapore signed a MOU with the Nanjing Municipal People’s Government agreeing to jointly undertake a feasibility study of the Eco High-Tech Island. The final agreement was formed in 2009, and the city is slated for completion in three phases by 2020. Three Chinese banks—Bank of China, Industrial and Commercial Bank of China, and Bank of Shanghai— extended an RMB 7.2 billion credit line to the Singapore-Nanjing Eco High-Tech Island Joint Venture company.

*Partnership network.* The Nanjing municipal government procured the land, and the real estate developers are Singapore Intelligent Eco Island Development and Nanjing Jiangdao Investment & Development Company.<sup>55</sup> Singapore Intelligent Eco Island Development is a private joint venture company formed by Yanlord Land Group (real estate developer), Sembcorp Industrial Parks (industrial development and engineering), and Surbana Land (design/architecture of the city). Other companies involved include G-energy Global, ST Engineering, Etonhouse International, AVI Tech Electronics, and Ivy Group (a Hong Kong-based firm that plans to develop educational systems for the city).<sup>56</sup>

*Status.* In October 2010, the Singapore-Jiangsu Cooperation Council was renewed for three years, to promote further “economic collaboration in urban planning and development, environmental services, logistics, commercial tourism/hospitality projects.”<sup>57</sup> The council also announced in October 2010 that the official launch of housing construction for Nanjing Eco High-Tech Island had recently taken place.

### **PlanIT Valley**

*Background and goals.* PlanIT Valley is a prototype smart city being planned for a site in the municipality of Paredes, about ten miles from the center of Porto, Portugal, by a start-up high technology company called Living PlanIT. In 2008, the company acquired the right to purchase 4,200 acres from the municipal government of Paredes as the site for PlanIT Valley. The anticipated completion date is 2015, by which time the city plans to accommodate around 150,000 residents.<sup>58</sup>

PlanIT Valley was designed as a research-focused city in which Living PlanIT and its partner companies would base research and development operations to test new technologies and services for sustainable urban development. According to Living PlanIT, the city was designed to be the world's first "living laboratory of sustainability."<sup>59</sup> Company founders, Steve Lewis and Malcolm Hutchinson are former software executives who bring a technology perspective to the business of developing cities, and are focusing on the development of what they call an "Urban Operating System" (UOS). The UOS is intended to function as the city's central "brain" by collecting information from all urban systems, storing it in the UOS data center, and efficiently managing the systems through a software platform.

*Governance and financing.* Living PlanIT is running the project, which received special investment status from the Portuguese government as a "Project of National Interest," with strong support from all levels of the Portuguese government including the Municipality of Paredes and various national agencies in Lisbon.<sup>60</sup> The city aims to be green and has extensive plans for alternative energy usage and water/energy efficiency, as well as a goal of diverting 80% of trash to energy production or recycling (in comparison to the current average of 5% per city).<sup>61</sup> Living PlanIT plans to build pre-made smart infrastructure technology and sensors into all the city's facets—from concrete foundations blocks to the energy supply to transportation systems.<sup>62</sup> The total expected cost of this venture is \$8 billion to \$10 billion.

Living PlanIT and its partner eco-system plan to develop several revenue streams to fund the Valley. Living PlanIT estimates the revenue produced from real estate leases in PlanIT Valley will represent less than 5% of total revenues.<sup>63</sup> Revenue streams, such as partner fees, participation fees and equity sharing, are planned to be supplemented with small amounts of debt capital from banks. The conversion of \$8 million worth of salaries to employees to equity means that venture capital funding has not been needed to date.

*Partnership network.* PlanIT Valley's business model depends on "creating an ecosystem of large and small company partners that will focus on creating products and services for sustainable urbanization."<sup>64</sup> It has already established partnerships with companies, including Cisco, Accenture, U.K. engineering firm Buro Happold, and McLaren Electronic Systems, which manufactures sensors. The goal is for these companies to work together in PlanIT Valley to develop city-solution technologies and the UOS platform, and to tackle similar city-building projects elsewhere.

As Lewis said, "You create a platform, you license it to partners, they augment it, they drive it, and we pick up a royalty . . . we provide a software model to the entire industry."<sup>65</sup> He aims to sign 14,000 partners eventually, to participate in the company's plan to "code cities like software—in which buildings, sensors, and traffic applications alike are connected through the cloud."

*Status.* PlanIT Valley received the Project of National Interest designation in September 2009, an asset valued at €8 million on the company's balance sheet.<sup>66</sup> Land acquisition and zoning for the commencement of construction were underway in 2010. PlanIT Valley has been divided into 25 "Waves," with the first Wave involving the purchase of 90 acres of land and the building of R&D centers, schools, and retail, residential and entertainment facilities, expected to

be completed by the first quarter of 2012. The project's target goal was to have the majority of PlanIT Valley completed by the end of 2015.

## **Meixi Lake District**

*Background and goals.* In February 2009, Changsha Municipal People's Government of Hunan Province and real estate developer Gale International signed an agreement to develop an ecocity called Meixi Lake District in Changsha, the capital of Hunan province in south-central China. Meixi Lake District expected to eventually house 180,000 residents in 1,675 acres.

According to Kohn Pedersen Fox, the city's designer, Meixi Lake proposes to offer "a new model for the future of the Chinese city."<sup>67</sup> It plans to focus on combining the features of a metropolis and a natural setting, and plans to feature innovative transport networks, a smart grid, urban agriculture, and waste energy recovery.<sup>68</sup> Furthermore, Changsha is a booming city of over 65 million residents, so the project planners see major opportunities for the economic development of the Meixi Lake District.

*Governance and financing.* Gale International signed an agreement with Changsha Municipal People's Government of Hunan Province to "plan, develop and operate" Meixi Lake, which Gale called "an ecological city."<sup>69</sup> China Merchants Bank (CMB) promised to extend RMB 10 billion in new credit to key projects and enterprises in Meixi Lake over the next five years.<sup>70</sup>

*Partnership network.* Kohn Pedersen Fox and engineering firm Arup plan to work together on the city's design. Cisco envisages extending its New Songdo City partnership with Gale into the Meixi Lake project. Here, Cisco plans to "deploy video networking technology and energy management software tools city-wide and meld municipal systems, such as education, health care, transportation and hospitality into a common network."<sup>71</sup> Wim Elfrink of Cisco's Smart + Connected Communities initiative reported that Cisco plans to begin by focusing on six to seven of the 20 services the company believes can be linked. UTC plans to provide energy-saving elevators and water-cooled air conditioning, which can reportedly cut energy use by 20%; 3M is developing digital signs and "stick-on film" for use in both Meixi Lake and New Songdo City.

*Status.* The project, in early planning stages, is expected to be completed in 2020.

## **Sitra Low2No**

*Background and goals.* Low2No plans to be a mixed-use eco-development in Helsinki, Finland about the size of a large city block. In 2006, a master plan for the redevelopment of Jätkäsaari, an industrial port area, was approved, and the Low2No site lies within this region. Low2No's goal is to create a successful prototype of a low- to no-carbon district. The project intends to "spur innovation in the field of energy efficiency and sustainable development."<sup>72</sup> The project does not expect to make a profit; its primary goal is to catalyze sustainable development in Finland by learning from the project and enacting new financial policies to make low carbon

ventures economically viable. The development's leaders hope this will encourage other developers to tackle similar projects in the future.

*Governance and financing.* Unique because of its innovative financing model and partnerships, Low2No was initiated by Sitra, Finland's government-run venture capital fund and investment firm. Sitra is supervised by the Finnish Parliament, and its projects are funded by endowment capital and returns from capital investments. Sitra's tasks are to promote the welfare of Finnish society through stable and balanced development in the growth of the country's economy. Sitra has identified energy and low-carbon development as a major area of interest. A team led by international design and engineering firm Arup won a competition in 2009 to design the Low2No carbon neutral district.

*Partnership network.* Other members of the winning team included international sustainable finance consultancy Galley Eco Capital, architecture firm Sauerbruch Hutton, and design consultancy Experientia. Sitra partnered with SRV, one of the biggest real estate developer in Finland, and VVO, the Finland's largest provider of rental buildings, to develop the project. SRV and VVO are traditional companies focused on the bottom line of building sellable developments while Sitra is focused on transforming Finnish industry and spurring clean tech and economic development.<sup>73</sup> SRV and VVO do, however, aim to become leaders in sustainable construction and residential development. Executive Director of Sitra's Energy Programme, Jukka Noponen, stated, "With this project Sitra encourages cities and the real estate and building industry to tackle these ambitious goals in their projects."<sup>74</sup>

The creation of new financial policies to support green development is a crucial desired outcome of the project, and Galley Eco Capital started this process by developing "ways to create a reliable pipeline of green mortgage, environmental, energy and carbon finance capital for Jätkäsaari."<sup>75</sup> All decisions for Low2No have input from multiple project partners and are made through a five-frame "lens" which includes Inspired Design, Social Innovation, Environmental Responsibility, Economic Viability, and Replicability/Diffusion.

*Status.* After the design competition, Sitra moved on to planning and scoping phases focused on the project proposal and general project guidelines such as sustainability frameworks and carbon protocols. The government hopes to see the completion of ten successful low or zero-carbon developments similar to Low2No in the five years after Low2No is complete. Sitra plans to use the number of these developments as one metric of the project's success.<sup>76</sup>

Insert Figure 1 about here

## **Discussion**

The government agencies, developers, urban planners, designers, builders, technologists, and financiers involved in the projects discussed above have launched urban development efforts that are unprecedented in kind, if not in scale. Although the deliberate creation of cities from scratch has notable precedents in the form of new towns, company towns, capital cities, and other planned communities, the idea of building full-scale "smart" and "sustainable" cities is still new and the viability of such efforts remains unproven. If projects such as those reviewed here

and summarized in Table 1 prove successful, they may give rise to a new industry of ecocity development, the success of which will surely depend upon novel, complex collaborations between public and private sector organizations. Integrating knowledge in fields as disparate as computing, sensor technology, architecture, engineering, real estate development, materials, energy, finance, and management, such collaborations will require innovative business models to design, develop, and manage cities that are economically, socially, and environmentally sustainable. Many challenges related to governance and civic engagement will have to be addressed.

Insert Table 1 about here

The emergent industry created by “sustainable urbanization” activities is likely to function more like a natural ecosystem than a traditional marketplace.<sup>77</sup> This has implications for how companies and other organizations succeed over the long term. Yet, today, companies and other entities working to create this new industry must operate without the kind of knowledge players in established industries take for granted, such as accepted best practices and recognized performance standards.<sup>78</sup> As a result, the entities responsible for the development of each project have made notably different choices about the ways to define, organize, deliver, finance, and administer their initiatives.

Variations across the eight ecocity projects suggest both opportunities and challenges in such initiatives. We identified differences in financing, in extent of public-private sector collaboration, in relative emphases on technology versus real estate development, and in replicability. The projects also have interesting features in common: most notably, all are located close to major urban centers. Yet, their differences may be more informative in our search for the key factors that will explain success. With these early reflections, our aim is to provide a foundation for future research to evaluate ecocity success.

## **Financing**

Financing remains one of the greatest challenges facing ecocity initiatives. Although benefits of ecocity developments may be realized over the long-term, the staggering capital requirements of such projects—estimated between \$10 billion for PlanIT Valley and \$35 billion for New Songdo City—typically require both public and private sector involvement. The projects we reviewed have approached this challenge in different ways. In some models— notably Masdar City, Nanjing, Meixi Lake, and Tianjin Eco-City—governments provide a significant portion of the funding through state-owned banks or direct public sector financing. Although Masdar City is currently funded by the government, those involved anticipate private developers and third parties will provide most development capital after the completion of Phase I, when Masdar City will revert to the role of master developer responsible for infrastructure and other city-wide services.<sup>79</sup> New Songdo and PlanIT Valley, on the other hand, rely upon investments and capital from international companies, although the South Korean and Portuguese governments have provided incentives through various forms of indirect support and tax relief. Low2No also has support from its own state-based venture capital funds. All eight initiatives anticipate some revenues from real estate sales, long-term leases, and office rentals, while some include technology-based royalties to offset the capital requirements. Whether these



projects will secure financing in an appropriate time-frame remains uncertain; moreover, the optimal capital structure cannot be determined from these data.

### **Partnerships: Integrating Public and Private Sectors**

The complexity and scale of an ecocity initiative necessitate cooperation among multiple entities, including companies of varying types, sizes, and nationalities, and government entities at the city, regional, and national levels. In most of the ecocity projects we studied, public-private partnerships (PPPs) were initiated by governments working with companies ranging from real estate developers, architects, technology experts, financial institutions, and other service providers. The balance between the private and public sectors varies across projects. Dongtan, Masdar City, and Low2No are primarily government initiatives. Besides providing much or all of the financing, governmental entities are responsible for administering the project and selecting the other parties. Nanjing and Tianjin are led by joint ventures between consortia in China and Singapore. Although these consortia include private-sector corporations, each is led and managed by a state-owned company. Finally, New Songdo and PlanIT Valley are supported by the Korean and Portuguese governments, respectively, but spearheaded by private companies driving financing and development, and working to recruit other partners.

Each of these three models—projects led by single government, dual-government joint ventures, and private-sector companies—present distinct challenges. According to Asanga Gunawansa of the National University of Singapore, the standard PPP models common in traditional infrastructure projects, where the government recruits private companies that contribute to project development, may not work well for ecocities.<sup>80</sup> Gunawansa offered reasons, including: ecocity projects require a unique type of public acceptance to entice residents and businesses in the long-term; a completed city will require high levels of maintenance; and it is difficult to bind developers and end-users to the desired regulations for sustainability features and standards. Government-led projects may be ill-equipped to face these challenges. Such initiatives are also threatened by mismatched expectations, poor communication, and misunderstandings between the private and public entities. Peter Head, an Arup Director, reflected on his experience working with the Chinese government in Dongtan: “China does everything by the rules handed down from the top. There is a rule for everything. The width of roads, everything... We wanted to change the rules in Dongtan, to do everything different. But when it comes to it, China cannot deliver that.”<sup>81</sup>

Initiatives developed through joint ventures between governments face similar issues. Coordination between private and public entities from two different countries can result in a lack of coordination and cooperation. While the innovative partnership structure behind Tianjin Ecocity, for example, appears to be working relatively well, there have been reports of “disharmony” between the Singaporean and Chinese consortia, possibly caused by friction from different work cultures and differing opinions on how fast the project should develop.<sup>82</sup>

Finally, initiatives led by the private sector face a separate set of challenges. Coordinating a network of private companies without the institutional authority of a governmental entity at the center, and garnering sufficient financial support without the backing of a government-owned bank might prove challenging. Partnership models where value is delivered through a network of

collaborating companies are rare in any industry, and, to succeed, ecocity initiatives spearheaded by private companies will have to develop new governance structures and frameworks for coordination.

### **Real Estate Development Emphasis**

Most of the ecocity projects discussed here are based on a real estate development model. Although many promise social and economic benefits to separate them from pure property development projects—including Masdar City’s focus on becoming a global clean-tech cluster and New Songdo’s free economic zone – six of the eight projects (Dongtan, Tianjin, Nanjing, Masdar City, New Songdo, and Meixi Lake) rely on real estate sales and rentals as the means for eventually repaying banks and other capital providers. Several initiatives, including Masdar City, New Songdo and PlanIT Valley, also intend to offer government-based economic and tax incentives to encourage corporations to locate offices there, driving demand for both office space and residential real estate.

Two projects do not rely on real estate as the primary driver. The Low2No project instead develops an economically viable low-carbon model, albeit with a real estate component. Sitra partnered with SRV to deliver a well-designed and professionally developed project, and to encourage other developers to follow a sustainability-oriented approach. However, the Low2No development does not expect profit on real estate sales. Real estate is envisioned as a means to foster Sitra’s end of testing methods of sustainable development for others’ learning.

Similarly, while Living PlanIT intends to work with developers to lease and sell real estate in PlanIT Valley, property development is not the major driver of its business model. Living PlanIT’s leaders believe PlanIT Valley will become economically self-sustaining through a business model based largely on the software industry, comprised of revenue sharing arrangements, royalties for the use of intellectual property (IP) developed by Living PlanIT and its partners, annual partner fees, and PlanIT Valley participation fees. Living PlanIT’s model for PlanIT Valley is an interesting alternative for ecocity development.

### **Technology Emphasis**

A study by Booz Allen and The World Wildlife Foundation found that an up-front investment of \$22 trillion dollars in green urban transportation and residential technology would save \$55 trillion in future infrastructure spending.<sup>83</sup> Most ecocity projects aim to realize these kinds of savings through the development of city-based technologies. However, the level of emphasis on technology R&D, in particular on the application of new “clean” and “green” technologies, varies across these eight projects. Dongtan is at one end of the technology spectrum. Despite expressed dedication to R&D programs and technology initiatives, the initiative has not yet recruited technology companies, involving only real estate developers, designers, and engineers.

The Masdar City, Nanjing, Tianjin Eco-City, New Songdo and Meixi Lake projects, in contrast, engaged technology companies early to develop innovative technological solutions and R&D centers. Although technological solutions, from smart buildings to renewable power-

plants, are planned features of the completed cities, these are not intended to be a primary driver of Nanjing and Tianjin Eco-City's business models. There is greater emphasis on technology in New Songdo and Meixi Lake which tout the application and development of connected urban technologies as central to their visions. New Songdo and Meixi Lake are key players in Cisco's Smart + Connected Communities initiative, designed to be part of Cisco's common infrastructure in order to allow for the coordination, control, and optimization of a wide range of urban services. Masdar City officials stated that "Masdar City specifically seeks to be a test-bed for new technologies," including the use and application of smart sensors and city-wide power and utility management systems.<sup>84</sup>

Finally, technology is the very foundation of Living PlanIT's business model and thus at the core of the PlanIT Valley project. While New Songdo and Meixi Lake will make extensive use of new technologies, PlanIT Valley is a research city that will showcase existing new and to-be-developed technologies of Living PlanIT and its partners, including Cisco's networking technologies, McLaren Electronics' sensor technologies, and Living PlanIT's UOS, intended to optimize resource allocation within the city. IP licensing fees and revenue sharing arrangements from the application of these technologies are intended to form the foundation of the company's revenues.

While the success of these models and technology initiatives remains uncertain, observers have noted that interconnected systems raise serious security issues.<sup>85</sup> The integration of sensors into all aspects of a city—everything from traffic signals to windows to vehicles to people—raises concerns about privacy, government surveillance, and disastrous security breaches.<sup>86</sup> Even Sam Palmisano, CEO of IBM, acknowledged, "Some citizens have expressed discomfort at living in not a safer society but a 'surveillance society.'"<sup>87</sup> While companies such as IBM and Cisco hope to resolve these issues, how citizens will react to living and working in entirely connected communities remains unknown.

## **Replicability**

These initiatives differ greatly with regard to replicability. Certain projects are intended to create a unique ecocity. Masdar City officials hope the city will provide a "model for sustainable urban development regionally and globally," and that its business model and technology will demonstrate the commercial viability of eco-cities.<sup>88</sup> Although they are offering consulting services to developers, they lack plans to pursue similar projects elsewhere. On the other hand, Chinese government's involvement in over a third of the initiatives reviewed here reflects industry estimates that China needs to build 500 new cities over the next several decades—100 with populations over one million.<sup>89</sup> Although each Chinese ecocity is conceived as a one-off, the Chinese government appears to be learning from each venture—moving, for example, to a collaborative model with Singapore perhaps as a result of the problems it experienced in Dongtan. Although each Chinese ecocity may not be replicated exactly, the government's experience with them might lead to a greater understanding of the appropriate strategies for sustainable urbanization.

The governments and businesses involved in Low2No, New Songdo, and PlanIT Valley, on the other hand, are less interested in building a single ecocity than in developing strategies

and business models for building new ecocities and making existing cities more sustainable. The projects vary in the extent to which their keystone partners—Sitra, Gale International, Cisco, and Living PlanIT—intend to be involved in these future ventures. Sitra does not intend to build any cities other than Low2No. It has been clear, however, about its hopes that Low2No can serve as an economic model or a showcase for future initiatives spearheaded by independent developers. One of Sitra’s stated goals is to encourage similar initiatives; indeed, the project’s founders explain that they will measure its success partially on whether its model of sustainable development spreads to other developers and other countries.<sup>90</sup> Gale International and Cisco, the primary drivers behind New Songdo, are explicit about their intent to develop similar ecocities in the future: “We’re trying to replicate cities,” Elfrink at Cisco stated.<sup>91</sup> Indeed, Meixi Lake is seen as the first of many anticipated New Songdo-like cities. Living PlanIT also hopes PlanIT Valley can serve as a “showcase” for sustainable urbanization, and that its business model and technologies will be replicated around the world. While Living PlanIT hopes to be involved in some of these ventures, it also hopes its partners will eventually build cities on their own—utilizing (and paying for) the IP developed through PlanIT Valley.

There are many challenges to developing replicable business models for sustainable urbanization. We identify four that are particularly important. One is getting access to enough land in the right location at the right price—a necessary but not sufficient condition. A second is the great variation in how development occurs under different political systems. Lessons learned in Portugal won’t translate directly to China, for example. Third, lessons from new ecocities will need to be adjusted for projects done in existing cities or the urban retrofit market. Each setting provides its own opportunities and constraints. Fourth, and in our view the biggest challenge of all, is establishing a new economic model for ecocities. Every new city needs an economic foundation based on jobs. Not every new ecocity can be a research city whose purpose is the development of new technologies for building other ecocities. To thrive, a city requires a range of jobs, spanning multiple sectors, such as technology, financial services, retail, entertainment, education, and health care. And every ecocity similarly needs a clear economic model, as well as features that attract both businesses and residents. Sectors likely to play crucial roles in new ecocities include health care (and related industries like biotechnology and pharmaceuticals), light or heavy manufacturing, natural resources, and tourism. Yet, too many ecocity projects are implicitly or explicitly based on a real estate development model—a kind of “if we build it they will come” approach that often lacks serious consideration of who will come and why.

## **Limitations and Future Research**

This paper reviewed the goals, business models, and partnerships involved in eight ecocity projects to identify common features of initiatives in this emerging industry. In brief, these projects were conceived as a means of creating urban living capacity while mitigating threats to the natural environment – by combining principles of low carbon and resource-efficient development with the use of information and communication technologies to better manage complex urban systems.

The tentative nature of the ideas we have put forward reflects the embryonic state of the ecocity industry.<sup>92</sup> We lack crucial knowledge about these initiatives. How will they be governed? How will residents’ security be protected? Will they achieve their goals of social,

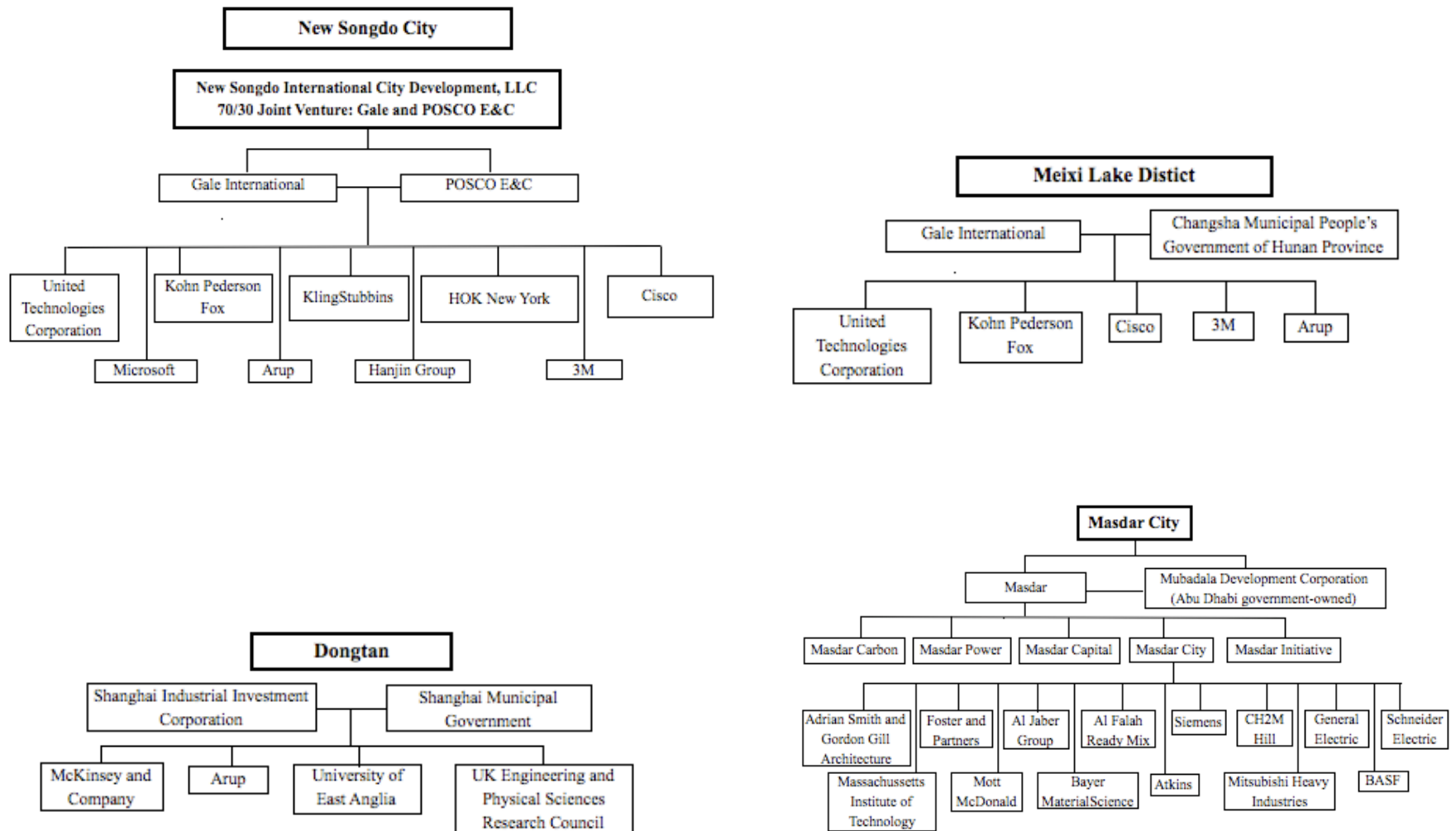
economic, and environmental sustainability? How will residents respond to living in heavily planned communities? What governance structures and financing schemes will lead to success? What business models are most replicable? We hope that scholars will pursue these important questions as ecocities continue to develop and take shape.

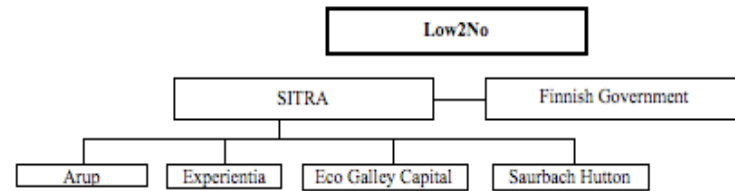
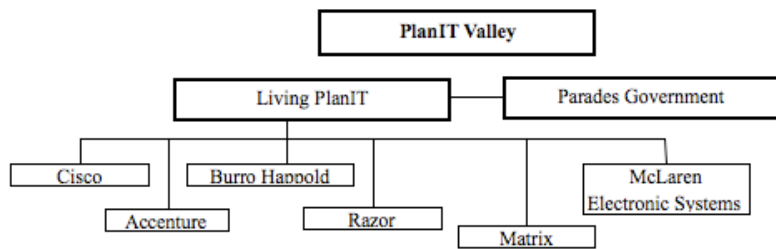
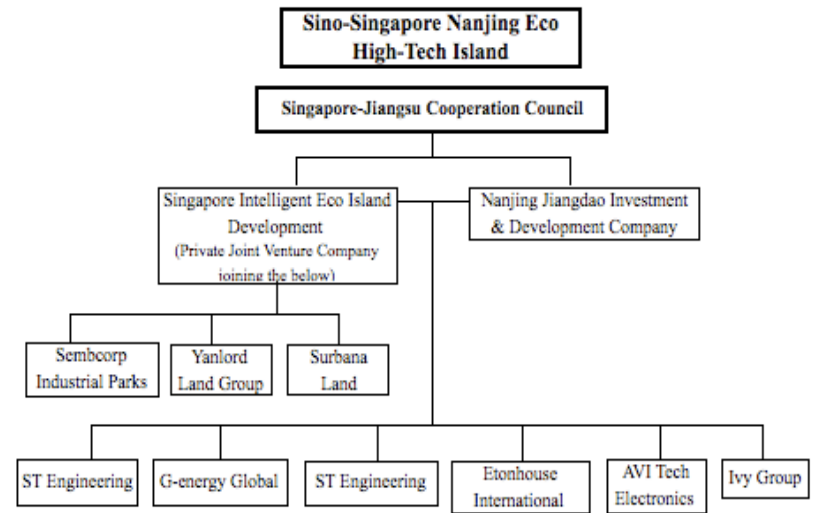
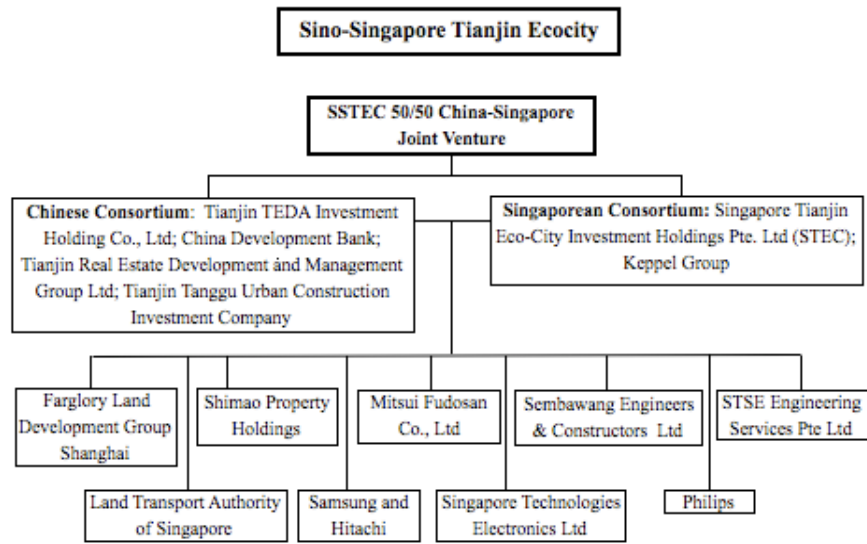
We believe that ecocities provide fertile territory for future collaborative research by urban planners, designers, engineers, public policy experts, sociologists, and management researchers. Through our review of eight early and still unfolding projects, we have sought to identify factors that characterize and differentiate ecocities as a small contribution to understanding the challenges and opportunities of sustainable urbanization.

**Table 1. Key Statistics**

<b>Ecocity (Start Date)</b>	<b>Nearest Major City (Distance)</b>	<b>Land size</b>	<b>Project leader</b>	<b>Estimated cost</b>	<b>Anticipated residents</b>	<b>Premise</b>	<b>Completion date &amp; status</b>
New Songdo City (2001)	Seoul (40 miles)	1,500 acres	Gale International	\$35 billion	430,000	International business district	2014; under construction
Dongtan (2005)	Shanghai (16 miles)	21,250 acres	Shanghai Industrial Investment Corporation	N/A	25,000 by 2010, 500,000 by 2050	Model sustainable city	Stalled
Masdar (2007)	Abu Dhabi (10.5 miles)	1,730 acres	Masdar	\$19 billion	40,000	Clean-tech cluster in model sustainable city	2025; six buildings operational, with residents; continuing 2018-2023; continuing
Tianjin Eco-City (2007)	Tianjin (25 miles)	7,360 acres	SSTEC	N/A	350,000	Education	2020
Nanjing Ecocity (2008)	Nanjing (4 miles)	1,280 acres	Singapore- Jiangsu Cooperation Council	N/A	N/A	High-tech, smart industries in an ecologically-aware environment	2015; planning
PlanIT Valley (2008)	Porto (20 miles)	1,670 acres	Living PlanIT	\$10 billion	150,000	Research	2020; early planning
Meixi Lake District (2009)	Changsha (within city limits)	4,200 acres	Gale International	N/A	180,000	Model future Chinese city	2012; in design
Low2No (2009)	Helsinki (within city limits)	5.4 acres	Sitra	TBD during design process	60% of space designated residential	Low or no carbon district	

**Figure 1. Ecocity Project Partnership Networks**







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