Low - Carbon Communities

An Analysis of the State of Low-Carbon Community Design

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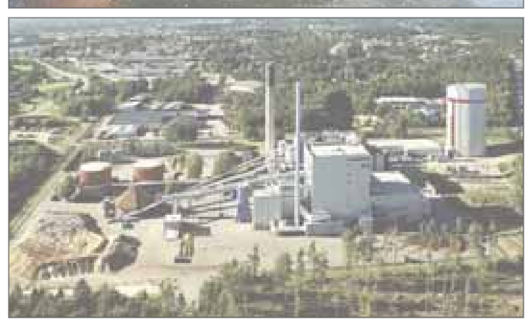

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Table of Contents

Low-Carbon on a Community Scale

While "green" or "sustainable" design has been gaining momentum in the architectural and environmental communities, the global focus has broadened, as have the players. Today, the focus of sustainable design encompasses entire cities, stakeholders include developers, lawyers, political leaders, business owners and citizens, and topping the list of concerns is the need to reduce carbon emissions. To explore this priority, this paper focuses on the current state of design (or retrofit) for "low carbon" communities.

By investigating a sampling of communities that have focused on reducing their carbon emissions, this research examines some of the most important aspects of designing, building and commissioning a low carbon community. Architects and planners should consider these key aspects in all planning phases of a low carbon community—from designing communities to reduce energy demand to providing the best options for renewable energy supply.

In tune with the American Institute of Architects 2011 National Convention and Design Exposition theme of "Regional Design REVOLUTION: Ecology Matters," the aim of this research paper is to identify the current standing of low carbon communities, the key objectives these communities are successfully meeting, and the sorts of setbacks the communities have encountered.

The aim of this research is not to rank communities but to highlight certain ones that demonstrate a deeper understanding of what a low carbon community is and how to achieve it. The particular mix of communities was chosen to highlight exemplary characteristics—for instance, a number of these communities not only promote sustainable building measures, but also educate their inhabitants about lifestyle choices that can reduce one's carbon footprint.

Some of the communities throughout the research are still in the design or pre-construction phases. For these communities, "assumed" data is taken from design goals or energy model projections in lieu of measured metrics. Data is also converted to achieve comparable units between projects. Notes accompany data to clarify sources, assumptions, and conversion processes.

Carbon's Role in Our Environment

Architecture 2030 states that "two events are converging to create one of the greatest threats in modern times"—the consumption of fossil fuels has far exceeded the earth's ability to regenerate their supply and the emissions from burning these fossil fuels are proving to be a catalyst for global warming.[1] Simple supply-demand economics demonstrates that excess demand is creating competitive prices for a dropping supply. Geological processes that created fossil fuels millions of years ago are not able to replenish the cycle without taking eons of time.[2]

Carbon, an essential building block of life, is exchanged and sequestered in the carbon cycle. The carbon cycle is made up of two interlinked exchanges of carbon: the biological and the ecological.[2] The exchange of carbon between plants and animals comprises the biological carbon cycle. In this cycle carbon dioxide exhaled from animals exchanges with plants, which in turn sequester the carbon along with water during photosynthesis leaving an oxygen by-product. Fossil fuels derive from the ecological carbon cycle. As plants and animals die, carbon is exchanged into the ground through ecological processes that slowly change the physical and chemical composition of the carbon into what we can use as fossil fuels.[2]

Burning fossil fuels to power our economy, which has escalated ever since the Industrial Revolution, has upset the natural balance of these cycles—excess carbon that was normally trapped within the earth's crust now exists in the atmosphere. Measures of atmospheric carbon concentrations have increased since the Industrial Revolution. Ice core samples from Antarctica provide a record of thousands of years of atmospheric concentrations of carbon dioxide. Comparisons of global temperatures and CO_2 concentrations lead to the conclusion that they are interlinked. This conclusion is further supported by a characteristic of carbon whereby its compounds absorb heat and pass it on to other molecules within the atmosphere.[3]

Ongoing research suggests that with the increase of these CO_2 levels in our atmosphere, the global average temperatures have been increasing as well. The convergence of these two events is placing a burden on our global society and has prompted the global effort to reduce carbon emissions through efficiency and low-carbon energy resources, with the goal of reducing or even preventing globally devastating climate change.[4]Studies of the arctic region indicate a rise in temperatures, decrease in sea-ice coverage, degradation and warming of permafrost, increase in carbon levels, and increase in vegetation.[5] The rising temperatures and impacts on the arctic climate affect the balance of the rest of the bio-regional climates. Samuel Fankhauser has classified the potential impacts of climate change into six categories: damage to property, ecosystems loss, primary sector damage, other sector damage, human-well being, and risk of disaster.[6] He demonstrates that climate change is not just an environmental problem but also a social and economic problem.

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1 "Problem: The Building Sector" 24 July 2010. <http://architecture2030.org/the_solution/solution_climage_change>

2 "Biochemical Problems: Carbon Cycle." 24 July 2010. <http://www.elmhurst.edu/~chm/vchembook/306carbon.html>

3 "The Discovery of Global Warming: The Carbon Dioxide Greenhouse Effect." 26 July 2010. <http://www.aip.org/history/climate/co2.htm>

4 "Problem: The Building Sector" 24 July 2010. <http://architecture2030.org/the_solution/solution_climage_change>

5 M. C. Serresze , J. E. Walsh , F. S. Chapin III, T. Osterkamp,, and V. Romanovsky M. Dyurgerovd, W. C. Oechel, J. Morison, T. Zhang and R. G. Barry. "Observational Evidence of Recent Change in the Northern High-Latitude Environment." *Climate Change* 46 (2000): 159-207.

6 Fankhauser, Samuel, Centre for Social and Economic Research on the Global Environment., and Economic and Social Research Council (Great Britain). *Valuing Climate Change: The Economics of the Greenhouse*. London: Earthscan, 1995

Why Low-Carbon Communities?

According to US Energy Information Administration data, the building sector consumes nearly half (48%) of all the energy used in the US (globally the percentage is even greater). The operation of buildings within the US uses seventy-six percent (76%) of power plant-generated electricity. This means that in the United States, the building sector is the largest contributor to global carbon emissions.[7] Transportation, long a focus of concern due to its emissions, is also a key contributor. Community design may be the most critical way to reduce human-generated carbon, because it influences the commercial and residential building sectors and the transportation sector. Well planned and designed (or redesigned) communities are demonstrating that they can effectively provide the basic human needs—comfortable shelter, mobility, services, social interaction, etc- while reducing reliance on fossil fuels—and some communities have developed strategies for reaching a net-zero-carbon future. The widely accepted strategy is a design that starts by reducing the demands for energy, and then focuses on supplying the remaining demands with renewable resources. As architects, we are responsible for fostering vibrant community designs that reduce fossil fuel use as described above, while creating a sense of place and nurturing low carbon lifestyles.

With nearly 75% of the nation's building stock projected to be newly built or renovated within the next thirty years, architects' ability to create low-carbon building and community designs makes them a primary contender in society's race toward reducing excessive carbon emissions—and climate change—in order for future generations to prosper. [8]

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7 Battles, Stephanie J & Eugene M. Burns. "Trends in Building-Related Energy and Carbon Emissions: Actual and Alternate Scenarios." In *Summer Study on Energy Efficiency in Buildings, sponsored by the American Council for an Energy-Efficient Economy, August 21, 2000*.

8 "Solution: The Building Sector-A Historic Opportunity" 24 July 2010. <http://architecture2030.org/the_solution/solution_climage_change>

Low-Carbon Communities

An initial census of the state of low-carbon communities around the world was performed at the onset of the research project. This list (located in Appendix A), was narrowed down to nine communities that had sufficient information to develop summaries and examine the key features. Table 1 highlights these nine communities with a brief summary of each. Appendix A provides more detailed information on each of the communities.

These communities had a variety of goals and utilized a number of different techniques that align well with academic principles. The goals of low carbon communities align with broader "eco-friendly" and "livability" goals because the very nature of reducing carbon emissions favors designs that are compact, walk-able, resource-efficient and therefore affordable and inclusive. A low-carbon community should follow the principles for livable communities identified by the American Institute of Architects and highlighted in Dan William's book *Sustainable Design: Ecology, Architecture, and Planning:*

1. *Human scale*
2. *Provide choices*
3. *Encourage mixed-use development*
4. *Preserve urban centers*
5. *Vary transportation options*
6. *Build vibrant public spaces*
7. *Create a neighborhood identity*
8. *Protect environmental resources*
9. *Conserve landscapes*
10. *Design matters*

Likewise, a successful low-carbon community will provide all or most of the following benefits, as outlined in Hugh Barton's book, *Sustainable Communities: The Potential for Eco-Neighborhoods*:

1. *Cutting greenhouse emissions*
2. *Closing local resource loops*
3. *Enhancing local environmental quality*
4. *Creating a healthy environment*
5. *Increasing street safety*
6. *Increasing accessibility and freedom of choice*
7. *Equity and social inclusion*
8. *Local work opportunities*
9. *Value of local community*
10. *Increasing local self-determination*

Table 1. Low Carbon Communities

Arranged by approximate age, status

Ecolonia, Netherlands (1989)

Developed as a major EU-funded low energy housing demonstration, Ecolonia is organized to develop a wide range of new technologies and housing designs: each focused on different ecological aspects. The use of rainwater, passive and active solar energy, energy-saving design strategies, reduction in water consumption, and strict choices of construction materials and finished all highlight the importance of designing towards reducing the demand side of energy.

Photo courtesy Urban Design Compendium

Växjö, Sweden (1996)

The municipality unanimously voted in 1996 to stop consuming fossil fuels as the primary source of energy production. With a goal of reducing carbon emissions in the whole jurisdiction by 50% per capita by the year 2010 compared to 1993, Växjö is now finding actual reductions of 24% in 2005 with new targets of 70% reduction by 2025. A large biomass energy production plant supplies for energy needs as well as supplies 90% of the heating needs.

Photo courtesy municipality of Växjö

Greenwich Millennium Village - London, UK (2000)

Modern technological and green credentials were crucial during the design process despite no requirement to reach any sort of level of sustainable design. A Combined Heat and Power (CHP) system supplies heat through energy generation and reduces CO2 emissions. With goals of 80% energy reduction and water consumption by 30%, Greenwich Millennium Village is a sustainable, inclusive community that also promotes a sense of community through the provision of community facilities and a community website.

Photo courtesy Åke E: son Lindman

Bo01 (Vastra Hamnen) - Malmö, Sweden (2001)

A distorted street grid provides shelter from the sea winds. Various forms of vegetative planting strategies are used in green walls and roofs to reduce surface water runoff. An advanced sustainable urban drainage system creates an ecological, recreational and visual haven through the project. Wind turbines provide energy as the primary energy source in addition to the photovoltaic panels for other energy production needs. Aquifers store the summer's warm sea water for winter usage as district heating. Domestic waste is converted into biogas that feeds into Malmö's natural gas network.

Photo courtesy Henrik Andersson

Beddington Zero Energy Development - London, UK (2002)

BedZed is intended to use only energy from renewable energy sources generated on site. Solar panels are combined with tree waste fueling the cogeneration plant (not currently in use because of difficulties) to provide for district heating and electricity. A long southern exposure takes advantage of solar gain as well as triple-glazed windows paired with a high thermal envelope construction. Water efficiency, low-impact materials, as well as waste recycling are also heavily emphasized throughout the project.

Photo courtesy Bill Dunster

Hammarby Sjöstad Stockholm, Sweden (2004)

Built upon a former industrial brownfield site, Hammarby Sjöstad focuses on using energy and waste recycling to provide for the community's own needs. District heating is supplied partly by 34% from purified wastewater, 47% from combustible household waste, and 16% from biofuel. Approximately half of the land area has been developed with intentions to complete the project by 2015.

Photo courtesy Flickr

Drake Landing Solar Community - Alberta, Canada (2007)

This 52-house subdivision seeks to approach renewable energy production by providing for the energy source closer to the consumer. A combination of seasonal and short-term thermal storage (STTS) facilitates collection and storage of solar energy in the summer for use in space heating in the winter. Borehole thermal energy storage (BTES) utilizes an in-ground heat- sink for seasonal energy storage much like a geothermal heating system. A district look moves heat from the thermal storage to the houses.

Photo courtesy Edmonton Journal

Sonoma Mountain Village - Sonoma County, CA (2008- partially built)

Situated as a 200-acre mixed-use development, Sonoma Mountain Village is a solar-powered, zero-waste community that promotes a five-minute lifestyle. Parks, shops, residences, and businesses are all within manageable walking distances from each other. With goals of producing 100% renewable energy, the goal is to have zero green house gasses coming from building energy. The community also strives to provide sustainable transportation options as well as provide for local goods, materials, and services. Park spaces will provide for natural habitats as well as create a sense of identity and place within the project.

Photo courtesy MBH Architects

Twinbrook Metro Station - Rockville, MD (2009- partially built)

This development will transform 26 acres of existing parking lots at the Twinbrook Metro Station outside of Washington, DC into a transit- and pedestrian-oriented mixed-use community. Multifamily residential space with ground floor retail and a new community park will reestablish a much needed connection to the transit line. Energy and water- efficient designs have influenced the overall impact of reducing carbon emissions by simply placing people closer to public transportation lines.

Photo courtesy JBG Construction Management

Working Artists Ventura (WAV) - Ventura, CA (2009)

Seeking to provide for affordable and low-income housing project, the city of Ventura sought after PLACE to create a sustainable development that successfully incorporates mixed-income housing as well as an artist's community. The project takes advantage of 4 direct mass transit lines that converge on the site . The overall goal was to create a sense of community that reduces one's needs to commute to work and to then commute again to get groceries.

Photo courtesy Stephen Schafer

Emeryville Market Place - Emeryville, CA (2008- not built)

This 14-acre development seeks to transform an aging commercial district into a high density pedestrian, transit-oriented community. This former brownfield site will incorporate landscape as an essential design integral from the ground to the roofs. Twenty percent of the units are allocated to be affordable, low income housing with a subsidized car-share program that will serve as a test area for future markets. The program also incorporates a comprehensive program to establish greener business models for restaurants and retail businesses within the development.

Photo courtesy Heller Manus Architects

Geos - Arvada, CO (2008- not built)

This development incorporates passive solar design as an essential tool that places the buildings onto a checkerboard-like layout to maximize solar access. Rather than having a single district energy source, the energy production is distributed to each unit as to reduce transmission losses as well as remove a need for a separate power plant for energy production. Narrower street designs as well as passive solar design strategies are vital in establishing efficient design strategies for future communities. A car share program will be established for those the occasional need for a truck or van along with an emphasis on the existing cycle path that runs through the site.

Photo courtesy Geos

Dockside Green - Victoria, Canada (2009- partially built)

This project involves a sweeping waterfront master plan that incorporates a holistic, closed-loop system of sustainability. A biomass gasification system provides district energy along with reclaimed heat from on-site sewage treatment and municipal sewage lines. Excess heat is sold to nearby businesses. Currently under construction, the final plans involve room for over 2500 residents and over 1.3 million square feet of development.

Photo courtesy Enrico Dagostini

Strategies for Reducing Carbon

The communities studied vary in their individualized low-carbon strategies, but they demonstrate common trends and approaches that serve as a guideline for establishing successful results. The first step is to foster effective, efficient community planning and building design to provide quality of life while dramatically reducing the demand for energy. This is generally the most economically viable approach to reducing community carbon emissions. Low-carbon supply-side approaches can then effectively and economically meet community needs. This hierarchy, demand reduction first, then low-carbon supply, applies to both communities being designed from the ground up and to existing communities in a retrofit phase. Education and incentive structures are also important for fostering effective low carbon communities (including behaviors of inhabitants). Figure 1 outlines the low-carbon strategies exemplified by the communities studied.

Figure 1 - Summary of Tactics

1. Community planning (compact, mixed-use, parks, etc.)
2. Transportation (multi-modal services)
3. Building efficiency (reduce built-in demand)
4. Education (reduce behavior-based demand)
5. Policy (incentives for efficiency & renewables)
6. Financing (incentives for efficiency & renewables)
7.Renewable energy

Low Carbon Community Planning

Communities that are planned to be high density and mixed use reduce the need for residents to travel by car between home, work and shopping, while creating a better sense of community. Chris Ventura, President of Projects Linking Art, Community & Environment (PLACE), summed up the community planning approach to lowering carbon emissions, stating, "Be where you already want to be." Rather than designing for the automobile, why not place everything within walk-able or bike-able distance? Key design criteria for *any* community include maintaining affordability, providing longevity, and creating a sense of identity. Low-carbon communities often do all three, while also reducing carbon emissions associated with excessive building space and transportation, by using designs that are high-density and mixed use. Not only should the layout and arrangement of the community reduce commuting needs, it should also foster good solar orientation and access.

New developments such as WAV and Dockside Green in Victoria, British Columbia have plans that promote multi-use facilities as well as high density planning in order to foster community job creation as well as the idea of the "third-place," neither work nor home but an in-between place for inhabitants to gather or recreate. WAV utilizes a small development footprint that provides residential units above retail on the ground floor. Dockside Green varies in its approach due to the scope of the project by having multiple buildings located within a district of the city compared to just a development the size of a city block, but it still maintains the idea of mixed-use planning, including over 1.3 million square feet of retail, office, and residential space, currently under construction in the first of five phases.

Hammarby Sjöstad and Twinbrook Station are larger-scale re-development projects that are converting brownfield sites to mixed-use high-density developments. Much like purely new developments these projects are addressing the multiple needs of the residents within the community in hopes of reducing commuting to nearby communities for shopping, work, or school.

Ecolonia is one of the oldest communities on the list. Established as an EU-funded low energy housing demonstration, it was developed with a wide range of housing designs and technologies for its time in the late 1980s to early 1990s. The design facilitates walking and cycling as means of transportation because of the compactness while still providing for a sense of being within the landscape. The design incorporates a public park amenity with wetlands that also help filter stormwater runoff from nearby roadways. The compactness of the community fosters community interaction, while making public transit more feasible, lowering infrastructure costs, and reducing life-cycle costs by conserving energy, materials, and maintenance.

One of the lifestyle studies conducted at BedZed concluded that on average residents know twenty percent of their neighbors' names (compared to eight percent, in the nearby community of Hackbridge).[9] Bioregional, the developer of the project, attributes the cohesiveness of the community to a successfully planned, dense, mixed-use design and rich activity program.

With respect to creating a sense of identity, Sonoma Mountain Village supports the idea of a five-minute lifestyle: parks, shopping, services, and a town square are all within walking distances of homes and businesses. This five-minute lifestyle reduces one's need to drive and supports the idea of working near where you live. While low carbon communities support a lifestyle that itself fosters community identity and culture, physical communal structures and open spaces are also important for social gathering, local commerce to provide economic vitality as well as community identity. In Sonoma Mountain Village, these parks and town centers support farmer's markets and festivals.

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9 Data found under 2007 Monitoring Results Summary: Quality of Life. 12 October 2010. <http://www.bioregional.com/what-we-do/our-work/bedzed/>

Transportation Options

The Environmental Protection Agency states that nearly a third of US carbon emissions come from the transportation sector. Reliance on the personal vehicle is not only prevalent in the United States, but also in many developed countries across the world. Seeking to reduce personal vehicular travel is a step towards reaching low carbon status. It can be achieved by an ongoing process of increasing the convenient alternative public transportation options, reducing the need to travel by car to do a variety of activities by creating densely populated, mixed-use communities, and by discouraging personal vehicular usage by limiting the number of—and/or charging true market value for—parking spaces.

Mixed-use, high-density developments reduce the need to rely on the individual car by providing for retail, living, education and work opportunities within walking distances. Eliminating personal vehicular travel, and possibly car ownership altogether, saves inhabitants significant costs, thereby enhancing the affordability of the community. While dense, mixed-use community planning allows for walk-ability and bike-ability, public transportation is essential for longer trips and for less mobile people.

In new communities such as Emeryville Market Place, the pedestrian is emphasized while the car is de-emphasized in the design. Various transportation opportunities allow for flexibility in planning trips to destinations ranging from the grocery store to the nearby city of San Francisco. Access to an Amtrak station, bike paths, walking paths, and a regional shuttle connection via Bay Area Rapid Transit all provide for pedestrian-oriented modes of travel rather than catering to personal vehicular traffic. In some cases personal vehicle use is still necessary and Emeryville is implementing a car-share program to facilitate those needs. The community is considering adding a bike-share program as well.

Similar to Emeryville Market Place, Twinbrook Metro Station emphasizes public transportation as a primary means of reducing carbon emissions. Tony Greenberg, JBG Properties Project Manager for Twinbrook Metro Station, notes that "Proximity to mass transit, especially Metro, has the greatest impact on reducing carbon emissions and is essential to creating an effective low carbon community." A potential drawback of the design of the transit line is that it hinders pedestrian traffic from one side of the development to the other, with limited bridge access across the tracks. To mitigate this, considerable time and energy were put into studies throughout the design and planning phases in order to ensure that the project develops as a whole, rather than a community divided by the Metro line.

In some existing communities, such as those in Europe, walking has always been the primary mode of transport but communities such as Beddington Zero Energy Development (BedZed) emphasize alternative transportation (biking, walking, transit) even more, by limiting the number of parking spaces on the site. At the Västra Hamnen (Bo01) development of Malmö, Sweden there is no distinction in the travel corridors for specific users—bikes, cars, etc.—but rather an overall understanding that all are to be aware of each other while traveling. While this can cause some parking problems sometimes evident today in Bo01, the pedestrian still has the right of way according to the current plans, which de-emphasize the use of the personal car and emphasize other means of transport.

Looking at *Table 2 - Transportation Options per Community*, a majority of the low carbon communities studied demonstrate a transit-oriented typology. Some of these communities utilize existing transit stops and redevelop parking lots into high-density neighborhoods while others foster car-share and bike-share programs. Below is listed a variety of transportation options available at each of the communities. Notably, many emphasize the pedestrian and the cyclist as an important means to reducing carbon. Many of the communities also incorporate bus and rail transit that connects the community to a larger municipality in the region.

Table 2 - Transportation Options per Community

Low Carbon Communities	Walking	Cycling	Car-share	Bike-Share	Bus	Rail Transit	Shuttle/Ferry
Ecolonia (Netherlands)	✔	✔				✔	
Greenwich Millennium Village	✔	✔			✔	✔	
Beddington Zero Energy Development (BedZED)	✔	✔	✔		✔	✔	✔
Bo01(Västra Hamnen) in Malmö, Sweden	✔	✔			✔		
Drake Landing, Alberta, Canada	✔	✔					
Sonoma Mountain Village, Sonoma County, CA*	✔	✔	✔	✔		✔ (gray)	
Växjö, Sweden	✔	✔	✔	✔	✔		
Hammarby Sjöstad, Stockholm, Sweden	✔	✔			✔	✔	✔
Dockside Green Victoria, British Columbia, Canada	✔	✔			✔		✔
Emeryville Market Place - Emeryville, CA*	✔	✔	✔	✔	✔	✔	
Twinbrook Metro Station- Rockville, MD*	✔	✔				✔	
Geos - Arvada, Colorado	✔	✔	✔ (gray)				✔ (gray)
Working Artsists Ventura (WAV) by PLACE (200 residents)	✔	✔	✔ (gray)	✔ (gray)	✔	✔	

*gray mark indicate plans for transportation options but not implemented in first stage

Building Efficiency within the Infrastructure

The following *Table 3 - Community and Building Efficiency Measures* highlights some of the building efficiency strategies that each of the communities utilize in order to reduce carbon emissions. Design and material choices should foster energy efficiency and durability, and should flexibly address the changing needs of the inhabitants for generations to come, as well as potential future technological advancements. Many of the communities boost energy efficiency with higher insulation values to increase envelope tightness. Many communities also incorporate high efficiency appliances and lighting choices. Material selection is important in the design process because it can also have an impact on the carbon footprint of a project due to the embodied energy and sourcing of materials, as well as the energy associated with their use and recycling or disposal, although this study does not go into an in-depth analysis on these issues. Water management is also critical— some of the communities even incorporate efficiency measures that store, treat, and reuse water on site, reducing the energy and carbon associated with traditional water supply and treatment systems. Finally, the table summarizes the key energy efficiency innovations particular to each community.

Table 3 - Community and Building Efficiency Measures

Low Carbon Communities	Insulation	Envelope Tightness	Appliances	Lighting	Materials	Water Management	Innovation
Ecolonia (Netherlands)	✔	✔	✔	✔	✔	✔	Solar orientation in coordination with window areas, increased insulation and efficient heating systems in combination with heat recovery units.
Greenwich Millennium Village	✔	✔	✔	✔	✔		Recycled and locally produced materials are being used whenever possible. Proposed standard for Greenwich Millennium Village was to have walls areas satisfying 0.35 W/m2K (building standard at the time 0.45 W/m2K) while windows 1.8 W/m2K (building standard at 2 the time 2.8 W/m K).
Beddington Zero Energy Development (BedZED)			✔	✔	✔	✔	Community groups and events provide education and awareness of transportation options.
Bo01(Västra Hamnen) in Malmö, Sweden			✔	✔		✔	Municipal waste handled by pressurized under-ground waste handling systems and waste grinders reduce need for waste transportation.
Drake Landing, Alberta, Canada	✔	✔	✔	✔	✔	✔	Upgraded insulation and vapor barrier systems,lumber certified and produced by sustainable harvested sources,engineered joist and load bearing components that are stronger, more structurally stable. A SIP panel system at joist header areas ensures consistent insulation and vapor barrier in this traditionally hard to finish space. Recycled materials in the drywall, upgraded windows.
Sonoma Mountain Village, Sonoma County, CA	✔	✔	✔	✔	✔	✔	Follows One-Planet Communities Program including emphasis on local and sustainable food choices, material choices, transportation options. Use of panelized light guage steel framing systems.
Växjö, Sweden	✔	✔			✔		Portvakten Söder project is a development within Växjö 5-8 stories tall in accordance with passive house technology: completely sealing the building from external environment utilizing heat from appliances and lighting to maintain temperatures. Ventilation allowed by efficient heat exchangers.
Hammarby Sjöstad, Stockholm, Sweden	✔	✔	✔	✔	✔		Thick insulation, improved window technology available on the market (U-value of 1,0 W/m2 K), heat recovery, controlled ventilation and the selection of energy efficient appliances
Dockside Green Victoria, British Columbia, Canada	✔	✔	✔	✔	✔		Buildings to surpass Model National Energy Code by 50% with double-glazed, low-emittance windows, higher insulation ratings and external shading devices.
Emeryville Market Place - Emeryville, CA	✔	✔	✔		✔	✔	A remodel the existing buildings with an eye on sustainability; the company certified the food court as a green business, began composting and recycling onsite waste, and diverted restaurant grease to biodiesel. Over the next 25 years, parking at the Marketplace will be reduced and over 1.2 million square feet of rehabbed and new office, retail, residential and open space will create a dense, mixed-use community.
Twinbrook Metro Station- Rockville, MD	✔	✔			✔	✔	Throughout the project, green operations and cleaning plans will be put in place, as well as organic gardening practices. New buildings will feature energy- and water-efficient design strategies, projected to use 30% less water than comparable conventional projects. Waste management and recycling programs throughout the development will further lower its environmental impact.
Geos - Arvada, Colorado	✔	✔	✔	✔		✔	All buildings will have envelopes that are tight and well-insulated.The natural ACH (air changes per hour) during the winter will be 0.15 or 1 complete air change every 6 hours. Perhaps the most innovative feature for the building enclosure will be the automated interior insulated shades.
Working Artsists Ventura (WAV) by PLACE	✔	✔	✔	✔	✔		Utilizing LEED as a means of intiating sustainable design standards, PLACE utilizes the system as a starting point and goes beyond the standards to provide for low-income housing as well as an artist housing community.

Enabling Low Carbon Lifestyle: Education and Awareness

Communication and education are important to help foster an aware and supportive culture. For example, the general population often is not aware of the amount of energy required to sustain bedroom communities that rely highly on a commuter lifestyle or of what factors are most important with regard to building energy efficiency (for both new construction and retrofits). Many low-carbon communities have fostered a cultural shift by educating their residents about effectively living a low carbon lifestyle. This can also include establishing incentives to track progress. Tactics that educate occupants include providing programmable thermostats and educating the building occupants about using them, providing information and incentives for efficiency upgrades and efficient appliances, facilitating alternative transportation options, illuminating the importance of buying local goods and featuring ways to do so through farmers/local crafts markets or community-supported agriculture—these are just some of the many educational avenues. Programs provided at BedZED to foster a low-carbon lifestyle include a cycling club, educational workshops, and a car share program. BedZED developer Bioregional even incorporated a Green Lifestyles Officer to educate and train residents in living a low-carbon lifestyle.

In an interview with Norbert Klebl from the Geos development, he stressed the importance of educating existing communities that are going to be impacted by a newer low carbon community. He mentioned that one key rule is to communicate openly throughout the whole process. Providing education is key for both future inhabitants and for their neighbors. The input from the surrounding communities provides feedback to designers on how the new community will interact with the social, and economic culture currently in existence. A new low-carbon community can have a drastic impact on the infrastructure of the surrounding areas and can prove to be a catalyst for change if the new development fosters education and communication.

Chris Velasco of PLACE noted that communication and education are essential tools within the design of the WAV project in Ventura, California. PLACE works by invitation only so there is already an inherent understanding that the community and its government are more receptive to changing their current standards in order to promote low carbon community development in the area. Velasco noted that nevertheless, some doubt persisted in the community about whether it should be a mixed-income project. The public tended to believe that such projects are solely funded by public taxes. Being transparent about the actual funding mix of the project allowed a public attitude shift. Velasco stressed the importance of educating the public that tax money was not the primary funding source for the projects.

Not only are education and communication important aspects of new low-carbon communities, they are also critical for existing communities planning to retrofit to achieve low carbon standards. Even if a community is producing enough renewable energy to achieve low carbon standards, it must also educate its inhabitants about living a low carbon lifestyle in order to continually progress toward reducing carbon emissions. One example is the large community of Växjö, Sweden, which is retrofitting existing infrastructure on a municipal level. The city council voted to reduce carbon emissions in 1996 by 50% per capita by the year 2010. While this goal is still not met, the rolling reduction in emissions has proven the city's commitment to lowering carbon and now the city has plans reduce emissions by 70% by the year 2025. With a long history of community planning in Sweden, the city of Växjö is an exemplar source of information for planning low carbon communities. With a strong commitment to environmentally related work since the 1970s, Växjö established cooperation with the Swedish Society for Nature Conservation, an entity raising public and political awareness for sustainable development. The city of Växjö organizes technical visits to local businesses to promote sustainability and also provides low-cost energy audit consultations to an average of 2000 residents a year. Without support from the citizens, this would not be as feasible.

A Shift in Government Policy

Government policies such as planning guidelines and zoning ordinances that vary from jurisdiction to jurisdiction can greatly influence any sort of development. As previously mentioned mixed-use, high density zoning plans allow for the greatest flexibility and can help promote development of low carbon communities. But some policies can actually *hinder* progressive design measures. . For example zoning regulations that mandate low density or prohibit stores and office buildings to be located nearby residences, encourage the use of a vehicle for everyday needs. Minimum parking requirements *hinder* design efforts to replace reliance on cars and parking lots, with convenient public transit, walking and biking. As Robin Chase, founder of ZipCar, has pointed out, alternative transportation needs to be *more* convenient than driving, if personal automobile travel is to be reduced.[10]

Chris Velasco said that despite PLACE being invited by the city of Ventura to develop there, some changes were still necessary in order for the project to fully succeed. PLACE works by invitation only, and the city of Ventura challenged them to address the need for an artists' community by providing housing that would be affordable, not only in upfront costs, but also through energy efficient designs to ensure low utility costs. Velasco noted that one of the largest barriers for implementing Working Artists Ventura (WAV) was working with various government agencies that lacked communication between them. In order to gain broad support for the mixed-use project, PLACE worked to break down the barriers between the departments of the city government such as marketing, policy, and economic development. By establishing communication between departmental "silos," Velasco was able to get support for an integrated, whole-system design with cross-departmental benefits and synergies. His approach to creating transparency between all parties was to include a member of each agency within every meeting throughout the entire process. Without the receptiveness of the government, the project would not have been successful. Velasco credits the city manager for rethinking the city as a modern entity that encompasses an ecologically friendly attitude.

One of the major hurdles for the Sonoma Mountain Village community was the integration of greywater reuse into the design. As with many municipalities, the Sonoma County regulation "PUC Rule 16" proved to be a barrier. Ryan Sakata, from Codding Enterprises in charge of Sonoma Mountain Village, noted that PUC Rule 16 hinders developments that want to use re-claimed water (including greywater and rainwater) for irrigation, cooling tower makeup water or to flush toilets. Existing policy in many jurisdictions needs to be reviewed to address the use of greywater within sustainably designed projects.

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[10] Radio interview with Robin Chase on 26 June 2009 via Treehugger <http://www.treehugger.com/files/2009/06/robin-chase-zipcar-goloco-car-sharing-1.php> Accessed 10 January 2011.

Financing

A combination of private and government financing can provide a good financial balance for establishing a low carbon community, including the provision of affordable housing to ensure economic health, vitality and diversity, and to provide the benefits of energy efficiency to those who are most in need of low long-term operational costs.

The financing of a low carbon community can have a major influence on the success of the project. A low carbon community may seek tax breaks or credits for commercial development within the project. Some of the communities described here enjoyed full government involvement, including municipal changes in how energy is produced. But for the smaller communities, private and corporate funding combined with government incentives were the best financing methods.

Norbert Klebl is funding his Geos development with personal finances and funds from investment firms. Although the cost of each home includes a $45,000 premium for energy-saving technologies (including high performance windows, better insulation, ground source heat pump, energy recovery ventilator and 5 kW roof-mounted photovoltaic array), the monthly utility savings and tax savings more than offset the additional monthly mortgage amount resulting in positive monthly cash flow for the homeowners. Klebl calculates that a Geos home will have a 5.7% annual return on the investment in energy-saving measures.[11]

WAV is a mixture of public and private investments, including corporate tax credits. These tax credits along with energy tax credits and new market tax credits were primary catalysts for allowing financing of the project to proceed without nearly as much public cost burden.

The City of Växjö is notably a larger scale community with a very bold goal of freeing the entire municipality from dependence on fossil fuels and corresponding carbon emissions by 2030. The city began its push to reduce carbon emissions in 1980 with biomass-fueled district heating and added combined heat and power generation in 1983. Federal government subsidies aided this transition from oil to biomass fuel. Växjö's collaboration with national agencies as well as with the European Union helped to garner financial assistance that includes over 18 million Euro (over $23.7 in 2010 US dollars) from the former Swedish Ministry of Environment. Government subsidies have also aided investment in green technologies, including fuel-efficient cars for private citizens and taxi operators. Nevertheless, most of the funding was from local sources, as described by city representatives:

> "In order to start some new investments and try new ideas, financial contribution from the Government, national authorities and the European Union have been important . . . but most activities have been financed by the municipality, the companies and the citizens [of Växjö]."[12]

Hammarby Sjöstad in Stockholm, Sweden is funded primarily by large financial investments through the Local Investment Programme for ecological sustainability (LIP). The estimated project costs for Hammarby Sjöstad are 693 million Euro (or about $913.1 in 2010 US dollars). Political shifts over the course of the project compromised its original social equity goals and the resulting demographics of the project show higher-than-average income. The right-green coalition maintained power throughout the early phases of the project and established the housing mix to be 18% public-ownership and 82% private-ownership. The left-green coalition came into power in the later phases and changed the mix to be 30% public, 20% private-rental, and 50% private-ownership.[13] The increase of public usage does not indicate public housing but it indicates that percentage must be available to

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11 From Powerpoint received 24 July 2010 from Klebl, Norbert. 2010. "NZE at GEOS Feb 2010.ppt"

12 See Appendix C for more detailed interview transcripts

13 Dastur, Arish. "How Should Planning Engage the Issue of Sustainable Development? The Case of Hamarby Sjostad, Stockholm" NewYork. May 2005. http://www.cabe.org.uk/default.aspx?contentitemid=1318&field=sectionsearchterm&term=hammarby&type=1. Accessed October 2010.

the public primarily as parks and open space; under Swedish law developers are not required to provide for low-income housing. These shifts have left the demographics of the area to lean toward higher-than-average income residents. The gentrification of Hammarby Sjöstad shows how political shifts can effect project financing because of the conflicting aims of whichever party is in power at the time. Some political parties are more concerned about environmental conservation, but neglect to address low-income housing within a project. Although not fully achieved, Hammarby Sjöstad was begun with the intention that a project should achieve a balance of incomes through various government subsidies and various housing types in order to provide the opportunity for all to live in low-carbon communities.

Renewable Energy Supply

Perhaps the step with the highest up-front costs for lowering carbon emissions is to replace carbon-intensive energy production methods with low-carbon, renewable energy methods. While this step is necessary to achieve an ultimate goal of net-carbon neutrality, communities can still reduce carbon through solutions that do not have to significantly increase up-front costs, but involve energy efficient and ecological design, construction, and inhabitation of a community. Significantly reducing the demand for energy, through techniques described above such as compact, transit-oriented city planning and highly energy-efficient building design, is the first step in low-carbon community design. Efficiency will deliver the most carbon reduction for the least capital outlay—compact development, for instance is less expensive than its sprawling alternative. After communities and buildings within them are designed as effectively as possible, much less renewable energy production (which tends to be expensive, compared to efficiency) is required to meet low- or zero-net-carbon design goals. The communities studied here have invested in a range of renewable energy supply, including passive solar space heating and solar photovoltaics (PV), wind, biomass, and geothermal (ground-source heat pumps and energy storage). *Table 4 - Renewable Energy Sources Per Community* is a list of the types of renewable energy sources that each of the communities utilizes.

Table 4 presents some interesting trends. Consistent with the “energy demand reduction before renewable supply” mantra, all of the communities are using passive solar design strategies. After passive solar, all but two communities use some form of active renewable energy as well, with active solar being the most popular [However, if you separate active solar thermal and solar PV, neither may be more popular than biomass]. Active solar energy encompasses solar collectors to provide heat or hot water, and photovoltaic panels to provide electricity. Some of the communities integrate the solar collector system onto the buildings, which places the energy source closer to the consumers, reducing transmission losses. At Drake Landing Solar Community, solar thermal collectors supply excess summer heat to a seasonal heat storage system (located in vertical underground boreholes) to provide winter heating via a district heating loop. This solar energy system is predicted to provide 80-90% of the community’s heating needs, once the ground is fully charged with heat (in 2009 the system provided 60% of heating needs)[14]. Rather than independent solar heating systems for each household, a district heating approach can work more efficiently and cost effectively.

Rather than storing collected solar heat in the earth, Geos will have horizontal ground loops that rely on the constant temperature of the earth as a source and sink for a geothermal heat pump system, which will provide both winter heating and summer cooling. Solar photovoltaics will provide electricity for the ground source heat pumps and for other residential electrical loads. Geos developer Norbert Klebl sees a need for a residential shift to producing surplus energy to the electrical system[15]. The system at Geos incorporates a solar power system distributed among all the residences rather than having an off-site solar array that provides energy to the community with higher transmission losses.

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14 Drake Landing Solar Community Annual Report for 2008-2009, prepared by SAIC, February 3, 2010

15 Phone interview with Norbert Klebl, August 17, 2010

Table 4 - Renewable Energy Sources Per Community

Low Carbon Communities	Passive Solar	Active Solar-Thermal	Active Solar-PV	Wind	Boimass	Geo-thermal Heat Pump	CHP	Innovation
Ecolonia (Netherlands)	✔	✔	✔		✔		Biomass	Combined Heat and Power along with energy conservation through the design of highly insulated windows and walls, active and passive solar design , and raw material selections that can either contribute towards a renewable life cycle or are already recycled.
Greenwich Millennium Village	✔	✔	✔		✔		Natural Gas	To generate its own power locally, the village uses a combined heat and power (CHP) system, which provides central heating, hot water, and electricity. Greenwich Millennium Village is the first UK private housing development to incorporate CHP.
Beddington Zero Energy Development (BedZED)	✔	✔	~88,000 kWh/yr		✔		Biomass	The project is designed to use only energy from renewable sources generated on site. There are 777 m² of solar panels. Tree waste fuels the development's cogeneration plant (downdraft gasifier) to provide district heating and electricity. The gasifier is not being used, because of technical implementation problems, though the technology has been and is being used successfully at other sites.
Bo01(Västra Hamnen) in Malmö, Sweden	✔			✔	✔	✔		Aquifers are used to store the summer's warm sea water in the bedrock to use in the winter as district heating for residential housing. In the winter cool sea water is stored to be used as district cooling in the summer. Wind is the backbone of the renewable energy source.
Drake Landing, Alberta, Canada	✔	✔	✔			✔		Combination of seasonal and short-term thermal storage (STTS) facilitate collection and storage of solar energy in the summer for use in space heating in winter.This system uses borehole thermal energy storage (BTES) is an in-ground heat sink for seasonal energy storage, where short-term thermal storage (STTS) tanks are the central hub for heat movement between collectors, district loop to houses, and the borehle thermal energy storage.
Sonoma Mountain Village, Sonoma County, CA*	✔		1.14MW solar					GOAL:Zero use of fossil fuels for building energy with 100% of power coming from renewable energy by 2020. Zero green house gasses from building energy.
Växjö, Sweden	✔	✔	✔	✔	✔		Biomass	District heating with biomass from the waste products of the local forestry industry with over 90% of heating supplied by district energy sources
Hammarby Sjöstad, Stockholm, Sweden	✔	✔	✔		✔		Mixed	District heating with 34% from purified waste water, 47% from combustible houshold waste and 16% from biofuel
Dockside Green Victoria, British Columbia, Canada	✔	✔	✔	✔	✔		Mixed	Installation of biomass gasification system to provide district energy source (heat to convert any carbon-containing fuel into a clean-burning gas using 20-30% of air needed for full combustion) Only a small portion of fuel burns completely where the "starved air" combustion process provides sufficient heat to pyrolize the balance of fuel into syngas which is then burned in a boiler. The hot water from the boiler is then distributed to supple heat and hot water for the community. Reclaimed heat from on-site sewage treament and municipal sewage trunk lines
Emeryville Market Place - Emeryville, CA*	✔							A former brownfield site transformed with landscaping integral from ground to green roofs. Implementation of a comprehensive program to establish greener business models for restaurants within development. Working to have a subsidized car-share program to spur more growth in the market for car-share businesses with planning of a bike-share program.
Twinbrook Metro Station- Rockville, MD*	✔							A transit- and pedestrian-oriented mixed-use development with sustainable operations and cleaning methods will be established on site. Energy- and water-efficient designs within buildings to be projected to have 3-% reduction in water consumption compared to projects of similar scale. A waste management and recycling programs established throughout construction process into occupany phases.
Geos - Arvada, Colorado	✔	✔	3.5 kW solar panels			✔		3.5 kW solar panels with 1 kW for Ground Source Heat Pump (GSHP) and other 2.5 for electrical loads of each unit
Working Artsists Ventura (WAV) by PLACE (200 residents)	✔	✔	✔					PLACE works by invitation (government already has a better idea of sustainable initiatives and should be more open to changing zoning, code issues). LEED-driven project but with principles taken much further. A large investment into solar panels as an integrated design option.

Another common approach for low carbon communities is biomass energy production, with over half of the projects studied here incorporating some form of it. Biomass fuels include wood and agricultural waste products, which are rapidly renewable energy resources and considered carbon neutral when burned because the net carbon produced from burning is equivalent to the amount of carbon produced if the biomass were to decay. Most of the projects that involve biomass also incorporate a combined heat and power energy production system (CHP, also called cogeneration). While a typical thermal power plant loses two thirds of the energy of the primary fuel source to heat that goes up the stack, CHP systems utilize both the heat and electricity produced, thereby dramatically increasing fuel efficiency. Thus, even communities, such as Greenwich Millennium Village, that use fossil fuels instead of biomass for their CHP system, increase their primary fuel efficiency and therefore have a lower carbon footprint than conventional communities.

The City of Växjö was an existing town that initially reduced its carbon footprint by implementing a biomass-based district heating system. The municipality is continuing to reduce emissions further by implementing efficiency measures in the building sector, including, but not limited to, material choices and energy efficient construction methods.

The Västra Hamnen community is one of the few to incorporate wind power. While solar and biomass tend to be more universally available resources and easier to implement in small-scale communities, wind made sense for Västra Hamnen. The wind turbines were placed far enough from the community to have little to no visual impact but close enough to provide small transmission losses.

Dockside Green is another community that uses wind power, but rather than placing the wind turbines out of sight, smaller-scale turbines are incorporated onto some of the rooftops, placing value on design as a teaching tool. In addition to wind Dockside Green utilizes an innovative biomass gasification system where a small portion of fuel is completely burned and the remaining fuel is starved of air in a combustion process that creates a "syngas" that is pyrolyzed and burned in a boiler that supplies heat to the community.

Chris Velasco of PLACE likens the presence of renewable energy production to the introduction of Toyota's Prius whose radically changed body style stirred interest and became a successful marketing strategy. Rather than discreetly tucking it away, the placement of a renewable energy system, whether it consists of biomass, wind, or solar, can be an architectural statement that stirs interest and creates a sense of identity in the community.

Performance

Once low-carbon communities are developed, the first question asked is: How do these communities fare when it comes to the amount of carbon emitted? For purposes of this research, given the available data, the communities were only compared based on their residential utility-purchased electricity and gas. This accounts for reduced carbon-intensity due to housing energy efficiency and on-site renewables, but it is not a perfect proxy for actual carbon intensity, most notably in the case of Vaxjo, whose local grid itself is highly decarbonized, being 60% biomass-based. The carbon intensity of residents' transportation behavior is not evaluated due to lack of information from most communities.

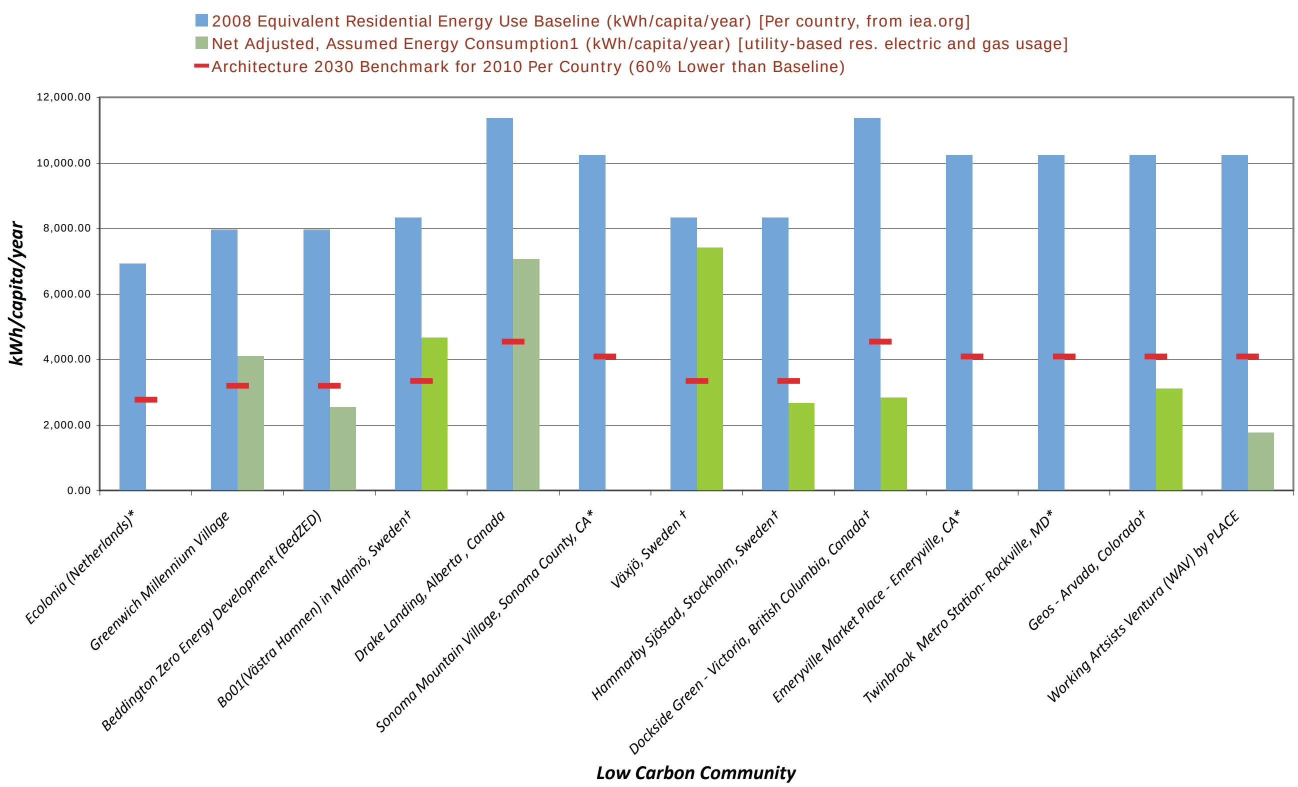
In order to compare the raw energy consumption of the communities, equivalent kWh per capita data was chosen as a metric (for both electricity and gas use). The communities were also evaluated against their own countries per capita performance as a baseline Figure 2 - Low Carbon Communities Net Adjusted Utility-Based Residential Usage Versus Equivalent Residential Baseline in 2008 shows each community's 2008 utility-based residential electricity and gas use (the net result of total energy use minus renewable energy produced on site). Two comparison metrics are provided, the 2008 per capita residential energy usage of the respective country, and the Architecture 2030 benchmark for 2010, which is a 60% reduction relative to that country. The nine communities below provide some insight into how energy efficiency and renewables reduce carbon-intensive (utility-purchased) energy use.

Data metrics for Ecolonia, Sonoma Mountain Village, Emeryville Market Place, and Twinbrook Metro Station - marked with an (*)- were not sufficient enough to be conclusive to be included in the measurable data but still provide considerable qualitative data in other sections of the report. Assumptions were necessary to convert raw data into a kWh per capita metric. These assumptions can be found in Appendix C in order to provide further details on how certain energy calculations were made. Some of the assumptions are taken from current data measures while the communities marked with a (†) indicate data assumed from goals.

Five of the nine communities surpass the Architecture 2030 benchmark for 60% (or higher) energy reduction from the baseline. Some of the more successful communities incorporate holistic energy-efficient design approaches, renewable energy sources, and a range of transportation options integrated into higher density mixed-use environments.

For example one of the greatest reductions in carbon-intensive energy usage is achieved by Working Artists Ventura. A combination of modest, affordable units with energy-efficient building design and appliances, integrated photovoltaic panels, and a walkable neighborhood with multiple alternative transportation options is dramatically reducing the residents' carbon impact (note that transportation energy is not factored into Figure 2, below). Another leading community in reducing energy usage is Beddington Zero Energy Development, which features attached, energy-efficient passive solar homes, supplied by an array of renewable energy sources, including solar photovoltaics and a biomass cogeneration plant.

Figure 2 - Low Carbon Communities Net Adjusted Utility-Based Residential Usage Versus Equivalent Residential Baseline in 2008



*Due to lack of sufficient no adjusted energy use was able to be calculated from these communities

Broader Implications

It is also helpful to put these communities into a larger context of carbon consumption world-wide. Shown below in Figures 3 and 4 are comparisons between the different regions of the world with respect to residential energy use per capita and total energy use per capita.

Not surprisingly, North America has the highest rates of energy consumption per capita versus any other region in the world. Europe comes in second. Trends within each of the regions typically show an overall rise in the energy consumption per capita from 1990 to 2005. How-ever, in both North America and Europe there is a slight decrease in energy consumption per capita between 2000 and 2005. One reason for this shift is adoption of greater energy efficiency in developed countries (for the same or better service) while developing countries are still adding services. It is important to note that future legislation and other incentive structures are key in promoting low-carbon community design as an environmental benefit but also as an economically beneficial investment, as illustrated by Geos and other communities. For in-stance, reducing utility bills keeps more money in the local economy and reducing pollution from cars and power plants reduces asthma and other negative impacts on the economy. Developing renewable energy resources provides the economic benefits associated with new industries and jobs.

Figure 3 - Trends in Residential Energy Consumption Per Capita

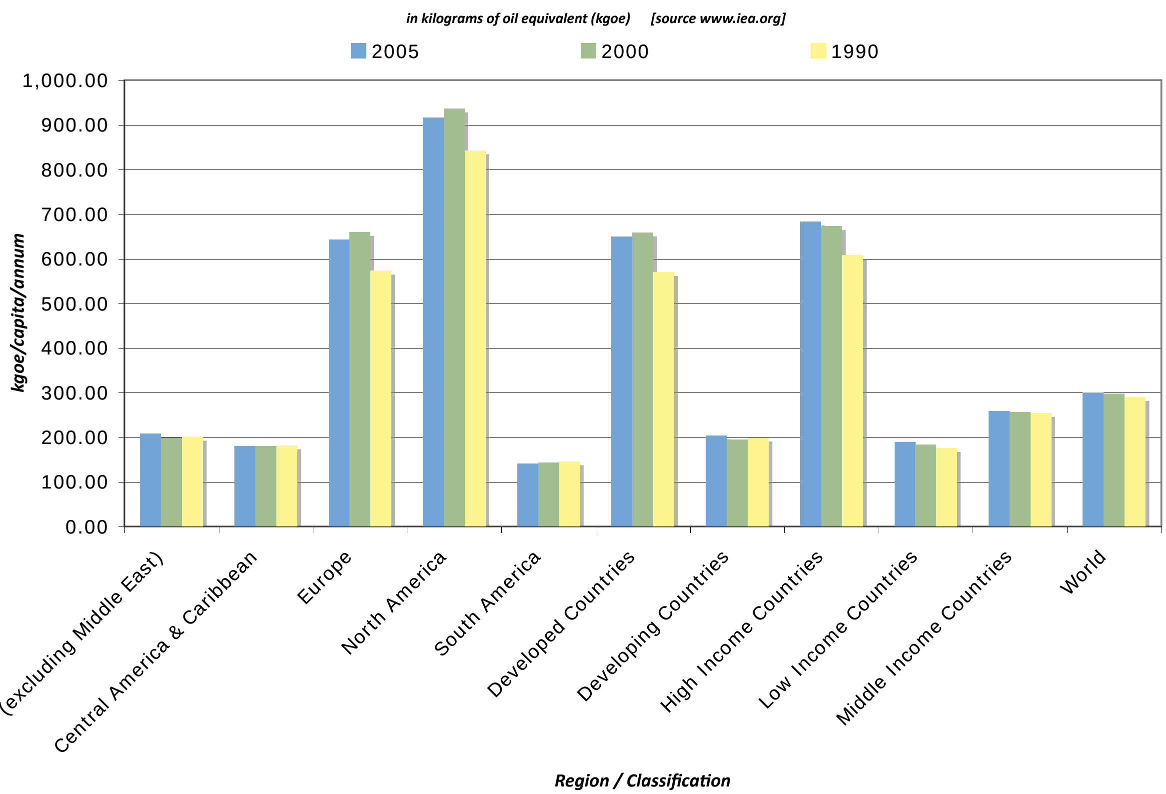
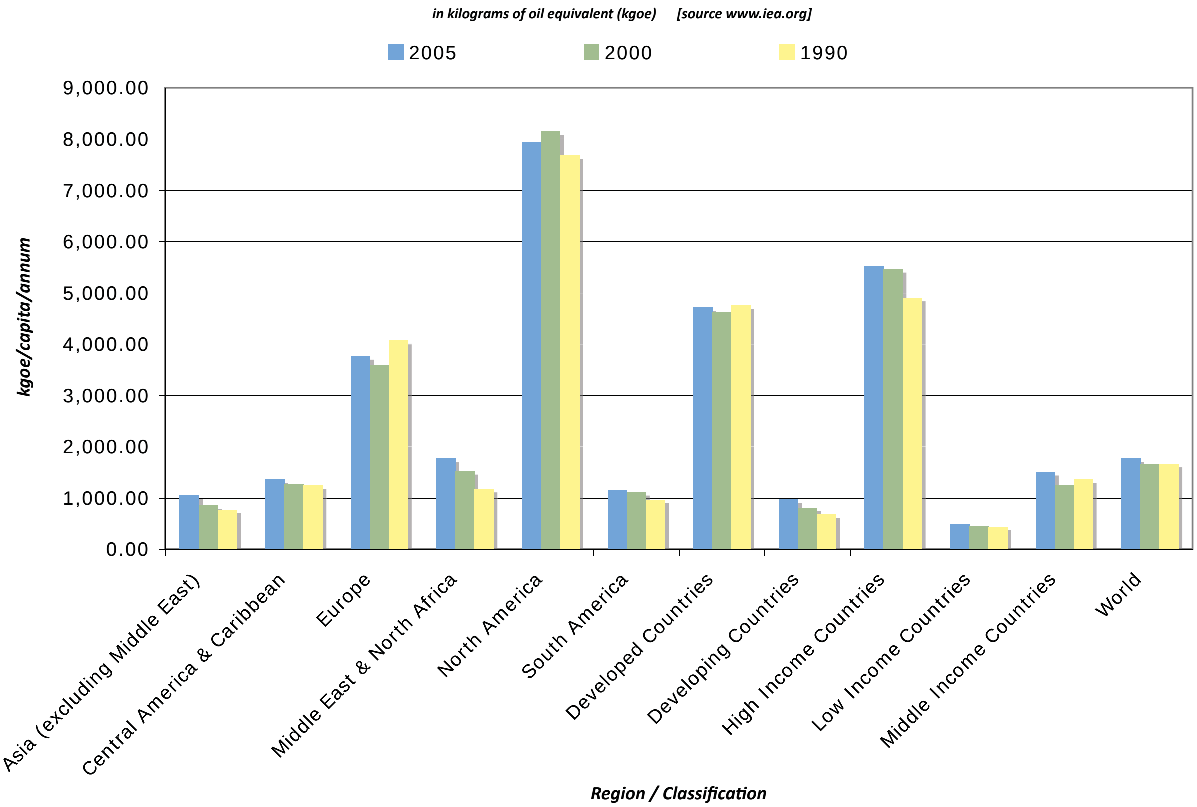


Figure 4 - Trends in Total Energy Consumption Per Capita



Lessons Learned

The process of investigating these communities uncovered many commonalities, as well as a number of differences in the strategies taken during the community development process. Many of the community projects overcame numerous challenges and some faced setbacks, as noted below, that presented conflicts during some point of design, implementation, financing or the commissioning of a low-carbon community.

For example, an obstacle in the Geos community was the requirement to provide adequate street widths and turning radius for fire engines. The original intent was to provide narrower streets to create a denser community with less asphalt. Klebl had to compromise and provide for wider streets in order to move forward to the next phase of the project.

Ongoing performance tracking is key to determining the effectiveness of low-carbon community strategies A challenge for this research project was a lack of information about the performance of many of the communities. For example, the data on the community of Ecolonia only provided energy measurements in 1993. Annual energy consumption and (as applicable) production tracking measures would help determine not only how energy-efficient the construction of the development was, but also how effectively and efficiently the development is being used.

Although some of the communities face various challenges—whether in the design, construction, or even commissioning process—others are finding success through innovations mentioned in previous sections: including technological, social, and even financial. As noted above, the key factor common to all the communities and providing the greatest return on investment, is to use basic energy-efficient planning and design tactics first before implementing more cost-intensive measures such as renewable energy supply.

Summary of Tactics for Low-Carbon Communities:

1. *Community Planning* - It is important to plan a community to enable both a diverse vibrant community and a low-carbon lifestyle, through compact, mixed-use/mixed-income planning (enhancing walkability, reducing sprawl and associated excessive transportation, reducing excessive house size, etc.). For instance, well-planned low carbon communities provide a “third place” where one can go for social interaction, in between home and school or work, without having to drive.
2. *Transportation* - the first and most important consideration is to create a transit-oriented design, which can accommodate future installations of multi-modal transit options in a convenient and appealing way Providing various transportation options is critical to minimize the carbon impact of the personal vehicle. Parking limitations as well as narrower streets (which slow traffic) will provide emphasis on the pedestrian and the bicyclist. At times a personal vehicle is essential so car-share programs as well as bike-share programs are innovative ways to accommodate periodic needs for personal transportation. Other types of public transportation such as bus and rail provide connections between communities and other regional centers.
3. *Building Efficiency* - As designers it is crucial to incorporate building efficiency measures in order to reduce the strain of energy demand. High insulation values as well as tightening building envelopes reduce building energy demands. Passive design strategies are also crucial through solar orientation. Buildings that take advantage of the low, winter’s sun angles but also provide for solar shading during the summertime reduce heating and cooling needs.
4. *Education* - Informative workshops and sessions are important in maintaining transparency between designers, planners, politicians, and residents of low-carbon communities. It is also critical to maintain programs that educate and provide buy-in and incentives for users to live a low-carbon lifestyle.
5. *Policy* - Government policies, zoning regulations, and codes can either provide incentives for or roadblocks to low-carbon community design. It is crucial to work with jurisdictions to evaluate regulations such as parking requirements, mixed-use zoning, greywater recycling, etc. in order to ensure health and safety, but also to promote effective, low-carbon community designs.
6. *Financing* - While basic energy efficiency is extremely economic, some investments (such as renewable energy generation) can be costly initially. Government subsidies, tax breaks and life-cycle accounting as well as total monthly cost of ownership—which factor in utility savings—are critical factors to consider in affordable low-carbon community planning. Providing for affordable housing is vital, often to secure financing for a project, but also to maintain community vitality, mixed use and a balance of incomes within a low-carbon community.
7. *Renewable Supply* - after energy efficiency is maximized in design, materials and construction methods, energy production can reduce carbon emissions by shifting to renewable fuel sources such as solar, wind, biomass and geothermal. Combinations of these methods firm the reliability between renewable energy sources (i.e. intermittent solar and wind).

The measures above provide a solid foundation, but not the sole means to establishing low-carbon communities. Various design challenges, political roadblocks, and new technologies are important considerations in the future of low-carbon communities, which will evolve to include new innovative forms and approaches. As architects, planners, and designers it is critical to create communities that foster social interaction and equity, human and environmental health, and long-term economic stability. Well-designed low-carbon communities can elegantly and vibrantly accomplish all of this, regardless of the particular form or approach. The selection of low-carbon communities highlighted in this paper show a variety of successful platforms for reducing our reliance on fossil fuels, decreasing our carbon impact on the environment, and providing for the health, safety, and welfare of our citizens.

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Appendix A- Detailed Community Profile

Low Carbon Communities	Climate Type[a]	Size	Population	Description/ Mission	Status	Transportation Connections	Innovations
Ecolonia (Netherlands)	Cfb: Warm temperature, fully humid, warm summer	6.67 acres	230* based on avg household size of 2.3 (x100 homes)	Ecolonia is a major EU-funded low energy housing demonstration project. The project is organised to develop a wide range of new technologies and housing designs, each focused on different ecological aspects. These include the: use of rainwater, use of passive and active solar energy, energy saving strategies, reduction in water consumption, recyclability of building materials, organic architecture, durable materials, flexible ground plans, soundproofingng, healthy building materials _The performance of buildings is subject to on-going testing, evaluation and monitoring. _Homes are arranged in groups of 8 to 18 buildings to foster a sense of community. Each group has a different environmental priority.	Built in 1989 with 100 homes	Cycling/walking is stressed with a 10 minute walk to regional transport station from center of development	_Energy conservation through the design of highly insulated windows and walls, active and passive solar design , and raw material selections that can either contribute towards a renewable life cycle or are already recycled. _Reduction of water consumption and rainwater harvesting used for irrigation, toilet flushing, and car washing. Constructed wetlands contribute towards a natural sewage treatment facility. _Walking and cycling are highly encouraged with minimal design for car based transport, which are designed for a slow speed.
Greenwich Millennium Village	Cfb: Warm temperature, fully humid, warm summer	2,700 homes, community facilities and commerci al space on 72 acres	1095 homes as of 2008 ith more than 13000 homes planned	Materials have been selected for green credentials and the modern technology ensures the construction of an environmentally sustainable village. GMV was the first substantial private development in the UK to achieve Ecohomes excellent. Homes benefit from large high performance windows, thermal insulation standards and non-polluting paint. The Combined Heat and Power system reduces CO2 emissions by producing heat through energy generation. Creating an inclusive, sustainable community has been key to this development. This has been promoted through early provision of community facilities and a community website, development of a village trust to enable residents to influence their surroundings and a mix of housing types and tenures.	As of 2008, 1095 homes and a village square built with goals of 1377 homes — 1079 apartments and 298 houses — as well as approximately 54,000 square feet of office space	7 bus routes, 2 on 24hr service | north Greenwhich Tube Station	_Although there were no legal targets for a self-sustaining community, the developers decided to apply their own. These include a reduction in energy use by 80 percent and water consumption by 30 percent. A gray-water cycling system stores drained rainwater to flush toilets. _Thirty to 40 percent of the wood and aluminum construction waste was recycled.The 80 percent reduction in energy is achieved through a combination of local electricity generation, improved insulation, and energy-efficient devices for the apartments. _To generate its own power locally, the village uses a combined heat and power (CHP) system, which provides central heating, hot water, and electricity. Greenwich Millennium Village is the first UK private housing development to incorporate CHP.
Beddington Zero Energy Development (BedZED)	Cfb: Warm temperature, fully humid, warm summer	99 homes and over 15,000 sq feet of work space on 4 acres	240*based on avg household of 2.4 (x100 homes)	The ecological footprint of the 'average' BedZED resident is 4.67 global hectares (equivalent to needing 2.6 planets of resources if everyone in the world lived like this). If the biomass CHP was working and BedZED was zero carbon as designed, the average resident would have an ecological footprint of 4.32 global hectares (2.4 planets' worth), while a keen resident, who made significant efforts to reduce their impact, could achieve an ecological footprint of three global hectares (equivalent to 1.7 planets).	Built 2000-2002	public transport, cycling, and walking with limited parking space | Tramlink service 15 minute walk from BedZed	_Zero energy—The project is designed to use only energy from renewable sources generated on site. There are 777 m² of solar panels. Tree waste fuels the development's cogeneration plant (downdraft gasifier) to provide district heating and electricity. The gasifier is not being used, because of technical implementation problems, though the technology has been and is being used successfully at other sites. _High quality—The apartments are finished to a high standard to attract the urban professional. _Energy efficient—The houses face south to take advantage of solar gain, are triple glazed, and have high thermal insulation. _Water efficient—Most rain water falling on the site is collected and reused. Appliances are chosen to be water-efficient and use recycled water when possible. A "Living Machine" system of recycling waste water was installed, but is not operating. _Low-impact materials—Building materials were selected from renewable or recycled sources within 35 miles of the site, to minimize the energy required for transportation. _Waste recycling—Refuse-collection facilities are designed to support recycling. _Transport—The development works in partnership with the United Kingdom's leading car-sharing operator, City Car Club. Residents are encouraged to use this environmentally friendly alternative to car ownership. Encourage eco-friendly transport—Electric and liquefied-petroleum-gas cars have priority over cars that burn petrol and diesel, and electricity is provided in parking spaces for charging electric cars
Bo01(Västra Hamnen) in Malmö, Sweden	Dfb: Snow, fully humid, warm summer	500 homes, commerci al and community facilities on 432 acres	3,000	Its design outcomes include a street grid distorted to gain shelter from wind. Five-storey blocks front the sea, further protecting inner buildings while reinforcing the character of the sea-front promenade. Varied forms of on-plot vegetation such as green walls and roofs reduce surface water and create identifiable locations within the development. An advanced sustainable urban drainage system creates an ecological, recreational and visual resource. A 100% local renewable energy approach adopted in the development has been successful. Orientation of building facades and roof forms maximise solar gain. In addition, solar thermal panels, wind turbines and photovoltaics help minimise energy use while maintaining the overall integrity of the architectural and urban form. Bo01 residents are encouraged to regularly monitor their energy consumption using information technology installed in their homes.	Built with focus on rebuilding the infrastructure to have 100% renewable energy sources and some new developments by 2030	Bus stops within 300m of apartments with e-bus services running on 7 minute intervals. Pedestrians and cyclists have priority in area	_The wind power plant is the backbone of the district's energy system. The plant is near enough to be connected to Västra Hamnen, but at the same time sufficiently far away to ensure that it does not disturb anyone. _Solar cells converts solar rays directly into electrical energy. _Aquifers are used to store the summer's warm sea water in the bedrock to use in the winter as district heating for residential housing. In the winter cool sea water is stored to be used as district cooling in the summer. _2,600 square meters of solar collectors connected to the district heating network also contributes to heat and hot water. Total annual heat production is 700,000 kWh, equivalent to about 10 percent of the heating and hot water used in the area. _Domestic waste is beeing converted to biogas, which is fed into Malmö's natural gas network

[a] Source Univ. of Melbourne, via Murray C. Peel

Appendix A- Detailed Community Profile

Low Carbon Communities	Climate Type[a]	Size	Population	Description/ Mission	Status	Transportation Connections	Innovations
Drake Landing, Alberta , Canada	Dfb: Snow, fully humid, warm summer	52 high density detached housing (~ 13 acres)	125*based on avvg household of 2.4 (x52 homes)	_52-house subdivision to have space and water heating supplied by solar energy _Solar energy captured year round by 800-panel garage mounted array _Combination of seasonal and short-term thermal storage (STTS) facilitate collection and storage of solar energy in the summer for use in space heating in winter _Borehole thermal energy storage (BTES) is an in-ground heat sink for seasonal energy storage _Short-term thermal storage (STTS) tanks are central hub for heat movement between collectors, district loop (DL)/houses, and (BTES) _DL moves heat from the STTS to the houses	Final of 52 homes completed in 2007	20km drive to nearest public transportation in Calgary	_52-house subdivision to have space and water heating supplied by solar energy _Solar energy captured year round by 800-panel garage mounted array _Combination of seasonal and short-term thermal storage (STTS) facilitate collection and storage of solar energy in the summer for use in space heating in winter _Borehole thermal energy storage (BTES) is an in-ground heat sink for seasonal energy storage _Short-term thermal storage (STTS) tanks are central hub for heat movement between collectors, district loop (DL)/houses, and (BTES) _District loop moves heat from the STTS to the houses
Sonoma Mountain Village, Sonoma County, CA	Csa: Warm temperature, summer dry, hot summer	200-acre, mixed-use, solar-powered, zero-waste community	4,400 residents over 2 decades of development	Sonoma Mountain Village is a 200-acre, mixed-use, solar-powered, zero-waste community under development by Codding Enterprises. One of the greenest neighborhoods in the world, SOMO is the first North American community, and only the fourth in the world, endorsed by the prestigious international One Planet Communities program. SOMO Living supports a five-minute lifestyle, with parks, shopping, services and a town square all within a short walk of homes and businesses. Community programs, such as a car and bike sharing, walking school buses, neighborhood electric vehicle shuttles, car charging stations, community gardening and a daily farmers' market, create a culture that supports individual lifestyles. The Lifestyle Concierge Program and One Planet Living Center will offer classes on products and new technologies, host events, sell goods and offer networking around the world with fellow One Planet Communities.	In the construction stages as of 2010 with the first homes being available on the market for Spring 2011	Commuter rail linking suburb to nearby cities approved but not implemented, bike- and car-sharing programs established as well as infrastructure to reduce needs to leave town for necessities	_01: Zero carbon:Zero use of fossil fuels for building energy with 100% of power coming from renewable energy by 2020. Zero GHG's from building energy. _02: Zero waste:98% reduction in solid landfill waste, along with the rethinking of waste altogether _03: Sustainable transport:82% reduction in CO2 through programs, technology and transit with car sharing and bicycling programs, shuttles to the SMART train and _04: Local and sustainable materials:20% of materials manufactured on site, with 40% sourced from within 500 miles _05: Local and sustainable food:65% of food for the community will come from within 300 miles, as well as a daily farmers market, healthy grocery store and restaurants _06: Sustainable water:Build the entire community with 0% increase in the existing water allocation granted to previous site owner Agilent Technologies _07: Natural habitats and wildlife:27 acres of parks and open space, along with enhanced wetlands areas, green roofs to support bee gardens and edible landscaping along walking paths _08: Culture and heritage:Local and regional identity through on-site theatre, public art, story mapping and a new culture of sustainability _09: Equity and fair trade:25% affordable housing, housing for sale and rental for all income levels, local and fair trade goods for sale in the community, and the creation of 4,400 jobs _10: Health and happiness: A 5-minute lifestyle and walkable urban design, One Planet Living Center, Lifestyle Concierge Program, surveys and actions for a healthier and happier community
Växjö, Sweden	Dfb: Snow, fully humid, warm summer	50,000+ people community (7232 acres)	82,000	Unanimously voted in 1996 to stop using fossil fuels in Municipality. Where emissions of carbon dioxide from fossil fuels in the wole municipality shall be reduced by 50 % per capita by the year 2010 compared to 1993. The European Union recently bestowed its inaugural award for sustainable development on this tiny city - an award many equate with the distinction of being the "greenest city in Europe." The key to their sustainable success? A single power plant. Unlike most power plants, which rely on coal or oil as a source of energy, Vaxjo's plant runs entirely on woodchips and other biomass waste from the area's sawmills. In addition to providing electricity, the plant also supplies 90% of the city's heating and hot water.	Built, entire municipality focused on changing energy production to renweable energy	bike and car-sharing programs plus other numerous public transportation alternatives throughout city	_reduction of oil consumption in municipal energy production to district heating with biomass from the waste products of the local forestry industry with over 90% of heating supplied by district energy sources _biogas production from the waste facilities _government subsidies to invest in green technology: including improvement in transportation such as more fuel efficient cars for both the private owner as well as taxi companies _ a 1996 target reduction of 50% lower carbon emissions per capita by 2010 but expecting to meet 40-45% reductions (*with 24% at time of publication in 2005 Vaxjo set new goals of 70% reduction by 2025) _Växjö's environmental targets for 2015 ___Turn 30 percent of agricultural land over to organic farming ___Reduce paper consumption by 20 percent ___Reduce electricity consumption by 20 percent per person ___Increase cycle traffic in the city by 20 percent ___Increase the use of public transport by 20 percent
Hammarby Sjöstad, Stockholm, Sweden	Dfb: Snow, fully humid, warm summer	200 hectacre city district (494 acres)	20,000	The name 'Hammarby Sjöstad' means 'city surrounding Hammarby Lake' and this new 200 hectare city district will comprise 9,000 apartments, housing a population of 20,000 people, and 200,000 sq m of commercial floor space attracting a further 10,000 people to work in the area. Approximately half of the total area has been developed to date and it is anticipated that the final scheme will be completed by 2015. Hammarby Sjöstad is built on former industrial brownfield land located on the south side of Hammarby Lake, to the south of the city centre, which has historically formed the natural border to the inner city area of Stockholm. The project seeks specifically to expand the inner city across the water.	Retrofit project with preexisting infrastructure and facilities	Tvärbanan light railway, new bus services and a ferry service on Hammarby Sjö lake between the district's southern and northern tips	_development on a former industrial brownfield site _focus on using energy and waste recycling to provide for community's own needs _district heating with 34% from purified waste water, 47% from combustible houshold waste and 16% from biofuel (*2002 statistics) _transportation connections enhanced through public transport and car pools. Building up the infrastructure for cycle paths to reduce the amount of cars on the road _downside: gentrification has demonstrated a shift from the working class toward the wealthy being the predominate inhabitants

[a] Source Univ. of Melbourne, via Murray C. Peel

Appendix A- Detailed Community Profile

Low Carbon Communities	Climate Type[a]	Size	Population	Description/ Mission	Status	Transportation Connections	Innovations
Dockside Green Victoria, British Columbia, Canada	Cfb: Warm temperature, fully humid, warm summer	15-acre master-planned harbour front community	150 residents with a full build-out population estimated with 2500	A model for holistic, closed-loop design, Dockside Green will function as a total environmental system in which form, structure, materials, mechanical and electrical systems will be interrelated and interdependent - a largely self-sufficient, sustainable community where waste from one area will provide fuel for another. Here you will find a dynamic environment where residents, employees, neighbouring businesses and the broader community will interact in a healthy and safe environment, reclaimed from disuse and contamination. As a LEED® Platinum targeted project, Dockside Green's principles of New Urbanism, smart growth, green building and sustainable community design are all essential elements of our development plan. 1.3 million square feet, including 26 buildings and 2,500 residents	As of 2010-Partial ompletion with Synergy as part of Phase 1 and 115 residents currently with a wastewater treatment plant built (Several other buildings under construction for Phase 1)	Various connections with BCTransit Bus services, establishment of car-share program, Harbour Ferry connections, mini-transit vans as additional service to connect to select points in city	_installation of biomass gasification system to provide district energy source (heat to convert any carbon-containing fuel into a clean-burning gas using 20-30% of air needed for full combustion) Only a small portion of fuel burns completely where the "starved air" combustion process provides sufficient heat to pyrolize the balance of fuel into syngas which is then burned in a boiler. The hot water from the boiler is then distributed to supple heat and hot water for the community. _Reclaimed heat from on-site sewage treament and municipal sewage trunk lines _excess heat sold to nearby businesses _improved building design and operation to harness energy-efficient building construction
Emeryville Market Place - Emeryville, CA	Csb: Warm temperatire, summer dry, warm summer	14 acre redevelop ment	Plan intends for 674 multi-family residential units, 180,000 sq. ft. of retail, 120,000 sq. ft. of office, and parking garages	Located at the foot of the Bay Bridge, just minutes from San Francisco, the 14-acre Emeryville Marketplace will transform an outdated, suburban, auto-dominated commercial project into a vibrant, pedestrian- and transit-oriented community. Originally a trucking terminal and brownfield site, the project site was acquired and initially developed by TMG Partners in the late 1980s. In 2006, TMG, with Rockwood Capital, began to remodel the existing buildings with an eye on sustainability; the company certified the food court as a green business, began composting and recycling onsite waste, and diverted restaurant grease to biodiesel. Over the next 25 years, parking at the Marketplace will be reduced and over 1.2 million square feet of rehabbed and new office, retail, residential and open space will create a dense, mixed-use community. Emeryville Marketplace has earned stage one certification for its conditionally approved plan – the first LEED for Neighborhood Development project in the nation to achieve Platinum certification for its plan.	As of 2010 unbuilt, with current structures including 100,000 sq. ft. of office space and an additional 20,000 sq. ft. of retail space. But overall size will be 1.2 million square feet of new and rehabbed space.	Amtrak station, bike paths, walking paths, regional connection to San Francisco via shuttle to Bay Area Rapid Transit (BART) one mile away	_transit- and pedestrian-oriented mixed-use development _former brownfield site _subsidized car-share program to spur more growth in the market for car-share businesses with planning of a bike-share program _landscaping integral from ground to green roofs _comprehensive program to establish greener business models for restaurants within development _20% of units to be built are in the affordable,low income range
Twinbrook Metro Station-Rockville, MD	Cfa: Warm temparture, fully humid, hot summer	26 acres	1595 projeted housing untis	Twinbrook Station in Rockville, MD, a transit-oriented development, is a joint effort between The JBG Companies and the Washington Metropolitan Area Transit Authority (WMATA). The project will transform 26 acres of existing commuter parking lots adjacent to the red line of the Metro subway system into a 2.2-million-square-foot, mixed-use community. The first phases of the project, featuring 279 apartments and 15,000 square feet of retail space, will be complete in April 2010. At full build-out, the project will include multifamily residential with 1,595 units, 220,000 square feet of ground-floor retail, 325,000 square feet of Class-A commercial space, and a new park. Twinbrook Station has been designated a Smart Growth project by the Washington Smart Growth Alliance, received the International Charter Award for Excellence from the Congress for the New Urbanism, and was the first project in the Washington, DC, area to be awarded Stage 2 LEED for Neighborhood Development Gold-level certification for its plan.	Partial Completion	entire development focuses on the connections to the Red metro line for DC	_transit- and pedestrian-oriented mixed-use development _sustainable operations and cleeaning methods will be established on site _energy- and water-efficitent designs within buildings _projected to have 3-% reduction in water consumption compared to projects of similar scale _waste management and recycling programs established throughout construction process into occupany phases
Geos - Arvada, Colorado	Dfb: Snow, fully humid, warm summer	25 acres	700-800	Geos is where the best ideas in advanced technology, neighborhood design and community planning result in an exceptional living experience. It is a concept that encourages the interaction between family, neighbors and community. Geos is meticulously designed to bring people together and to integrate them into a fulfilling and stimulating tapestry of life that becomes the pulse of the neighborhood - all benefiting from environmental sustainability, independence from fossil fuels and the elimination of future energy costs. An additional benefit is that the technology used at Geos is proven, simple and requires very little maintenance. In fact homeowners will not even notice the technology except when they don't get an energy bill.	Planning Stages, unbuilt as of 2010	within 2 miles from commuter train line to Boulder/Denver as well as a primary bike path connects through site to Arvada	_residential buildings serve as surplus energy producers through district energy source closely placed to consumer _within 2 miles of regional public transport to nearby Denver _pedestrian-oriented with narrower street designs _passive solar design strategies determine layout with active solar strategies to defer any energy requirements _car share program with trucks and van usage through Boulder, CO _maintains and improves upon cycle path through development _mixed income project with focus on young professionals and "empty-nesters" ($30,000 - $80,000 income/family)

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Appendix A- Detailed Community Profile

Low Carbon Communities	Climate Type[a]	Size	Population	Description/ Mission	Status	Transportation Connections	Innovations
Working Artsists Ventura (WAV) by PLACE (200 residents)	Csa: Warm temperature, summer dry, hot summer	2 acres	200	The Working Artists Ventura is a mixed-use low-carbon community aimed at providing for affordable housing not only for the various artsists of the area but also addresses the need for low-income housing as well. The mixed-use development focuses on artist-friendly retail usage as well as fosters an ideal sense of community through the reduction of needing to commute everyday. PLACE hopes to create a community that fosters the idea of "be where you already want to be". Photovoltaic panels integrated within the distinct design educated the inhabitants as well as provides for nearly all of the common energy needs of the community	Recently Completed in 2009	4 transit connections located on the block	_PLACE works by invitation (government already has a better idea of sustainable initiatives and should be more open to changing zoning, code issues) _Successful in working with a city manager receptive of making changes _LEED-driven project but with principles taken much further _large investment into solar panels as an integrated design option _provide education to inhabitants on proper usage and energy reduction techniques _4 mass transit lines on block with a car-share program and bik storage to provide a variable of transportation options

Below is a list of communities that were looked at before narrowing focus on the research to the communities above.

Low Carbon Communities	Climate Type[a]	Size	Population	Description/ Mission	Status	Transportation Connections	Innovations
Jackson Square Redevelopment Initiative, Massachusetts	Cfa: Warm termparture, fully humid, hot summer	11.2 acres	436 projected housing units	In 2006, Jackson Square Partners (JSP) received grant funding from an anonymous foundation to incorporate green design strategies into the development plans for Jackson Square. The project team used the green principles developed with the community to identify and evaluate specific environmental targets for almost every aspect of the project. The result is a 50-page "Green Guidelines" document that serves as a road map for the developers and their teams. It includes both prescribed master planning elements and a variety of environmental targets for individual buildings. Two key components of the project's green strategy are onsite generation of renewable and low-carbon energy from sources such as solar, wind, biofuel co-generation and geothermal, and green roofs that will cover 70% of the roof area on each building. As a result of the community's commitment to a healthy, sustainable development, the project team adopted green guidelines for construction that combine an appropriately dense mix of homes, stores, community facilities, and civic and open spaces. Guiding green principles for the project include providing alternative tra	Unbuilt, awaiting funding as of 2010		
King Abdullah University of Science and Technology (KAUST)	BWh: Arid, desert, hot arid	149.21 acres of 9,000 acre		KAUST integrates sustainable measures into the design of the entire community. The University demonstrates new ways to build in the region, and new ways to live that promote responsible stewardship of energy resources. The unique desert climate of Saudi Arabia and the Middle East create opportunities and challenges for KAUST, including ample sunlight, limited rainfall and potable water resources. KAUST has an important role to play in conserving these resources, finding new and innovative methods to manage and sustain them, and exploring and developing alternative energy sources.	Built		
Center for Regenerative Studies (Cal Poly Pomona University)	Bsh: Arid, summer dry, hot arid	16 acres within larger university campus		_advance the principles of environmentally sustainable living through education, research, demonstration and community outreach. _climate action plan, a detailed road map for carbon emissions neutrality by 2030			
Lloyd Crossing (Sustainable Urban Design Plan- Portland, Oregon)	Csb: Warm temperature, summer dry, warm summer	35-Block study with potentialfor 10.9 to15.6 million sq ft		_Predevelopment Metrics (Baseline goals) ----- 681 tons CO2 used | 495 tons O2 released |186 tons CO2 fixed _Incremental energy efficiency strategies (on-site and off-site) to achieve carbon neutral balance			
"The Willows"- Leduc, County- Alberta, Canada	Dfc: Snow, fully humid, cool summer			The intent is to design and develop a pilot sustainable community with a zero carbon environmental impact that will showcase innovative green systems for water, grey water, waste treatment, power generation and green living practices with a focus on research and education for sustainable development. A number of design charrettes have been held and more are planned for the coming months with the goal of achieving best practice for the village .			

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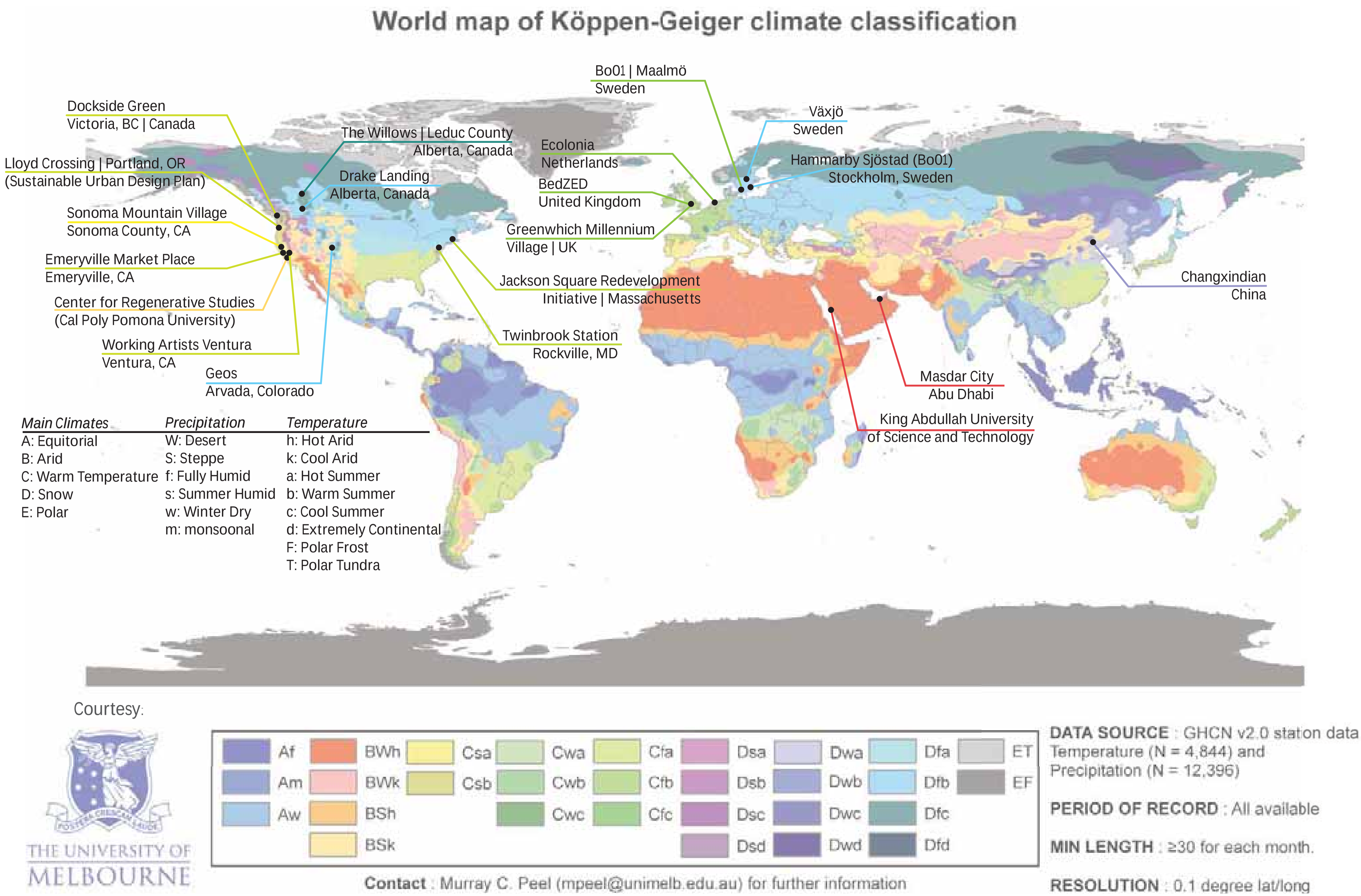
Appendix A- Detailed Community Profile

Low Carbon Communities	Climate Type[a]	Size	Population	Description/ Mission	Status	Transportation Connections	Innovations
Masdar City, Abu Dhabi	BWh: Arid, desert, hot arid	2.3 sq miles or 1472 acres		Masdar City is an emerging global clean-technology cluster located in what aims to be one of the world's most sustainable urban developments powered by renewable energy. This US$22 billion free zone located about 17km from downtown Abu Dhabi will eventually be home to companies, researchers, and academics from across the globe, creating an international hub for companies and organisations focused on renewable energy and clean technologies.			
Changxindian, China	Dwa: Snow, winter dry, hot summer	500 hectacre or 1235 acres		Changxindian is Beijing's first sustainable community and one of the most important development areas in the city's rapid growth. The 500ha study area includes future residential, commercial, eco-industrial park (Zhongguancun) and open space for a planned population of approximately 70,000. The concept plan was developed based on a Sustainability Framework which clearly sets out a vision, objectives and performance indicators. Energy, water, waste, environment, ecology and transport strategies and indicators were developed to drive the preparation and evaluation of planning options and to achieve low carbon targets.			
Camp Arroyo (Livermore, CA)	Csa: Warm temperature, summer dry, hot summer	138-acre park		A core goal of the site construction is to incorporate responsible building practices such as using recycled, sustainable materials; installing energy efficient lighting and climate control; preserving natural features including trees and wildlife habitats; and reusing existing infrastructure. The ecologically friendly design encourages students to visualize innovative building practices.			
Cambridge Co-housing | Cambridge, Massachusetts	Dfb: Snow, fully humid, warm summer	1.5 Acre Developm ent		_"In design, construction, and development of our site we are committed to environmentally sustainable practices. _"We will emphasize conservation, recycling, non-polluting energy sources, and other environmentally sound practices"			
Puget Sound Environmental Learning Center	Csb: Warm temperatire, summer dry, warm summer	6 acre developm ent on 255 acre property		_through strategies to maximize energy efficiency, minimize building footprints, keep materials out of the waste stream, use materials efficiently, and emphasize recycled content. _Buildings were also designed to minimize interior finishes. Where required, low-emission stains, paints, sealants and adhesives were used. Formaldehyde-free wood products were used in building interiors. To ensure the best possible IEQ, mechanical and electrical systems were commissioned prior to occupancy, and carbon dioxide sensors continually monitor air in primary spaces.			
Hidden Villa (Los Altos Hills, CA)	Csb: Warm temperature, summer dry, warm summer	1600 acres reserve with minimal developm ent		_educational facility in Los Altos Hills of California that provides environmental stewardship through educational programs. It is a nonprofit educational organization that uses its organic farm, wilderness, and community to teach and provide opportunities to learn about the environment and social justice. Hidden Villa stretches over 1600 acres of open space in the foothills of the Santa Cruz Mountains, about 40 miles south of San Francisco			
Solar Decathlon Villages (temporary)	Cfa: Warm termparture, fully humid, hot summer	15 acres of National Mall, Washingto n, D.C.		The U.S. Department of Energy Solar Decathlon challenges 20 collegiate teams to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. The winner of the competition is the team that best blends affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency.			

[a] Source Univ. of Melbourne, via Murray C. Peel

Appendix B - World Köppen-Geiger Climate Map



Appendix C - Energy and Data Assumption Calculations

Greenwich Millennium Village-

Source: *“Table 2- Performance Improvements Achieved (http://assets.ecorussia.info/assets/paragraph_attaches/5946/paragraph_media_5946_original.pdf?1270204230)*

Initial 1999 Benchmark of 28, 920 kWh per dwelling
Current Achievement of 66% Savings with CHP and Biomass
1-(.66x28920 kWh)= 9832.8 kWh/ Dwelling
(2.4 persons /dwelling) x (9832.8 kWh/ dwelling) = **4,097 kWh/ capita**

Beddington Zero Energy Development (BedZED)-

Raw data from *bioregional.com* explicitly states 2,579kWh for electricity and 3,527 kWh for heat (from natural gas) with a total of 6,105 kWh/ household

Assuming with a national household size of 2.4/dwelling then 6,105kWh/2.4 people/unit= **2,543 kWh/ capita/year.**

From *bioregional.com*
Solar PV panels provide 20% of the electrical demand. The combined heat and power plant (CHP) delivers the remaining electricity and all the hot water through a district heating system, using local waste wood from the Croydon TreeStation. The company operating the CHP ceased trading in 2005, so the CHP isn’t currently in use.

Bo01(Västra Hamnen) in Malmö, Sweden-

From *Canada Mortgage and Housing Corporation (CMHC) website at www.cmhc.ca,*

Each apartment unit was originally designed to use no more than
105 kWh/m2/year in energy (70 kWh/m2/year in heating, 35 kWh/m2/year in electricity).
The International Institute for Industrial Environmental Economics estimated the average
energy use in conventional Swedish apartments is 175 kWh/m2/year.

Energy
Bo01 uses a district energy system that is entirely powered by renewable energy sources. Electricity is generated by solar and wind energy, while hot water heating comes from seawater and solar energy. Hot water heating is distributed through a pipeline, which was installed concurrently with other municipal infrastructure, such as sewage and waste pipelines.

- Heat extracted from seawater is stored in a natural underground fresh water aquifer. In summer, warm water (21ºC) fills cavities in the limestone ground, and cold, stored water (16ºC) is pumped up and used for a district cooling system. In winter, a heat pump raises the temperature of the water to 64ºC. A total of 4,000 MWh of heat is supplied annually, while a reversible extraction pump provides 3,000 MWh of cooling in summer. The geothermal system supplies 80 per cent of all heating/cooling requirements; photovoltaics supply the remainder.
- 1,400 m2 of solar collectors on roofs and walls (see picture) generate energy for space heating and domestic hot water needs.
- A wind turbine located three kilometres from Bo01 produces two MW of electricity annually, enough for household consumption, heat pumpsand a recharging station for electric vehicles.Wind energy generates the majority of electricity required (99.5 per cent), and photovoltaics supply the remainder.
- A semi-transparent 120 m2 skylight with integrated photovoltaic on the roof also produces an additional 12,000 kWh of electricity each year (enough for five apartments).

Avg living space/ capita : 44.5m^2
Raw data 105kWh/m^2 allowed x (44.5m^2) = **4672.5 kWh/capita**†

Appendix C - Energy and Data Assumption Calculations

Drake Landing-

From www.dlsc.ca/brochure.htm

Space Heating is at 60% , Water Heating at 20%, and leaves an assumption of 20% of Plug Load

Raw Data from table from Energy Comparison Tables on Drake Landing Brochure:
[1kWh= .0036GJ]
68GJ for space heating (18,888.89 kWh)
18GJ for water heating (5,000 kWh)
21.5 GJ for plug load (5,972.22kWh)
(68+18GJ)/ x = .80
x=107.5 GJ (29861.11kWh energy annually used per household)
29861.11kWh / 2.6 per household = 11485.04 kWh / capita electricity consumed

From Energy Comparison Table:
Solar Power for Space Heating: 60GJ
Solar Power for Water Heating: 9GJ

Total Solar Power Production Per Household: 69GJ (**19,166.67 kWh**)

19,166.67 kWh / 2.6 per household = **4417.32 kWh solar power energy on site/capita**

11485.04 kWh/captia consumed – 4417.32 kWh/capita produced = **7067 kWh net, adjusted energy consumed**

Växjö, Sweden-

Energy per capita reduced by 7.2 % is now at 9,274kWh per person and year with fossil fuel emissions reduced from 4.6ton/person in 1993 to 3.2ton/person in 2003. (www.unep.org)

-Växjö's environmental targets for 2015
-Reduce electricity consumption by 20 percent per person

9,274 kWh/capita (.80) = **7,419.2 kWh/ capita**†

Hammarby Sjöstad, Stockholm, Sweden-

Source: *pvnord.org*

Goal of 60kWh / m^2/year (with 20kWh electrical and 40kWh for heat)

60kWh/m^2 (44.5m^2) = **2670 kWh/capita**†

Dockside Green-

Source: docksidegreen.com / docksidegreen.visitblestrategies.com

-50% modeled energy consumption less than Model National Energy Code (Canada)
-Average residential electric consumption of 5056 kWh/year
-Average residential natural gas consumption of 35GJ(9722kWh equivalent) per household

5056kWh(.50) = 2532.5 kWh/dwelling / (2.6 capita/household) = 975kWh
9722kWh(.50)= 4861kWh/ dwelling / (2.6 capita/household) = 1869.6kWh
1869.6 kWh + 975 kWh = **2845kWh/capita**†

Appendix C - Energy and Data Assumption Calculations

Geos, Arvada, Colorado-

Source: Near Zero Energy at Geos Presentation
Goal of 80% Savings versus Colorado Standard of 10710 kWh/household
Geos: 8066kWh used with 8103 kWh produced by PV

8066kWh / 2.6 per household **= 3102 kWh**† per capita consumed
8103kWh / 2.6 per houshold = 3116.53 kWh per capita

Working Artists Ventura, Ventura, California-

$20 monthly bill vs $165 comparable
$240 vs $1980 yearly
1773kWh vs 14626.6 kWh

$240/ (*$135.37/1000kWh) = **1773kWh**

vs $1980/ (*$135.37/1000kWh) = 14626.6kWh comparable

*Rate of $135.37/1000kWh
(source from www.jae.com, Southern California Edison (2009 Rates include base rates, fuel adjustment charges, and applicable franchise fees)

† Indicates the energy assumptions reflect goals set forth for each community.

Appendix D - Email and Phone Interview Transcripts

Interview Outline Questions-

What is your involvement within this community?
What is your definition of a low carbon community?
What are the intentions of building/designing/rehabbing this community?
What is the status of the community (built or unbuilt, planning phase)?
What is the layout of the community (urban or suburban, density, multi-use)?
What is the average income of the occupants?
What sort of measurements is the community measuring?
- What utilities are being monitored?
- What units are being used?
- Why are they being measured?

Is there on site renewable energy?
How are the energy needs being fulfilled?
What policies helped this community?
What sort of policies were an obstacle?
What is the focus/mission of the community?
What sort of things worked for your community?
Were there any intentions that were eventually not applied within the final design of the community?
Were there any pitfalls or disadvantages?
What was the single-most unexpected thing that occurred?
How was the project financed?
- Were there any government subsidies?

Who are the intended residents?
What makes this project stand out from another community?
Who is the driving force for the development of the community?
- Government?
- Few political leaders?
- Organization?
- Residents?

Is there a plan for the future to expand?
How does the community interact with existing/ surrounding areas?
What is the most important thing you hope to convey?
What advice would you give for those looking to redevelop and rehabilitate existing communities?
What is the most successful aspect of this community?
Do you mind If the AIA can utilize you for further information on low carbon communities in the future?

Appendix D - Email and Phone Interview Transcripts

Interview Outline Questions-
Geos,- Arvada, Colorado
Norbert Klebl, President
Phone Interview on August 17, 2010

What is your involvement within this community?
President/owner of project

What is your definition of a low carbon community?*
"Zero net energy can be defined in terms of site energy (used at the building site) or source energy (sometimes called primary energy). For electricity purchased from a utility, the source energy used to produce and distribute the electricity is typically about three times as much as the delivered electricity. From a societal point of view, source energy better reflects the overall consequences of energy use. The U.S. Department of Energy's Building America (BA) residential energy efficiency research program defines a zero energy house as one that has predicted zero net source energy consumption over the course of a year using typical meteorological year weather data and BA Benchmark assumptions on occupant behavior based on average U.S. behavior in terms of temperature setpoints, miscellaneous electric loads, and hot water use."
For more information, go to www.buildingamerica.gov. See also Walking the Talk—Habitat Goes Green, page 32.
Source: A Cold-Climate Case Study for Affordable Zero Energy Homes by Paul Norton and Craig Christensen, NREL, presented at the SOLAR 2006 conference in Denver, Colorado.
*information not original to the phone interview added from alternate source

What are the intentions of building/designing/rehabbing this community?
The project emphasizes the needs for a shift of energy production within the residential sector of the building industry where surplus energy can be put back into the grid.

What is the status of the community (built or un-built, planning phase)?
Un-built but plans are in progress and waiting for financing.

What is the layout of the community (urban or suburban, density, multi-use)?
Vertical, multi-use 25-acre development with 15 units per acre on 20 acres of built space. Seven hundred to eight hundred inhabitants projected with household sizes averaging 2.5 units per household.

What is the average income of the occupants?
Mixed income project with $30,000 - $80,000 per household.

What sort of measurements is the community measuring?
What utilities are being monitored?
What units are being used?
Why are they being measured?*
Electric usage will be monitored on a kWh unit basis per household with an average of 2.5 units per household. Electric consumption and production will be the primary measured parameters where the homeowners will be able to monitor usage.

Is there on site renewable energy?

Solar power generation on residential end of design coupled with ground source heat pumps.

How are the energy needs being fulfilled?*

Integrated solar panels providing 3.5 kW of power per household. This coupled with passive solar design and high-efficiency insulated construction techniques help to lower energy demands.

What policies helped this community?

Collaboration with the community as well as ongoing negotiations with the public utility providers to establish time-of-day rates in order to balance out the electrical demand of the community. Major appliances can be programmed or suggested to be used during off-peak hours.

What sort of policies are an obstacle?

Existing financial market slump has hindered the start of the project with hopes of receiving financing on top of Norbert’s own private financial investments.

What is the focus/mission of the community?

What sort of things worked for your community?

Were there any intentions that were eventually not applied within the final design of the community?

The fire department required the original street plans to be wider in order to accommodate for the turning radius and width of the fire trucks within the community.

Were there any pitfalls or disadvantages?

The roads had to be widened and took away from the aesthetics of narrower roads and less asphalt within the project.

What was the single-most unexpected thing that occurred?

How was the project financed?

Personal finances as well as negotiations with investment funds as Norbert owns the land.

Were there any government subsidies?

Who are the intended residents?

The anticipated occupants are down-sizing “empty-nesters” and young professionals. The pricing rages from $250,000-$500,000 with an average of $350,000 for 1000-2500 sq ft residences with an average of 1600sq ft.

What makes this project stand out from another community?

The community is aimed at being utilized as a pedestrian, neighborhood-oriented use with little impact on energy where resources can be used to foster urban agriculture.

Who is the driving force for the development of the community?

Government?

Few political leaders?

Organization?
Residents?

Primarily personal interest from Norbert and the design team of Michael Tavel Architects and David Kahn Studio.

Is there a plan for the future to expand?

There are 27 acres to the north that are available future expansion. To the west is a golf course and to the east is a commercial area of the nearby Arvada.

How does the community interact with existing/ surrounding areas?

The town of Arvada is excited with the project and is thoroughly involved with the project in all stages. An existing bike path will be maintained as an essential part of alternative transportation with a regional transit station 2 miles away that connects to the city of Denver.

What is the most important thing you hope to convey?

Norbert estimates that the annual mortgage cost of all the extra features needed to achieve net zero energy is offset by the annual tax and energy savings, based on today's cost of energy.

What advice would you give for those looking to redevelop and rehabilitate existing communities?

There needs to be a paradigm shift on how houses are being built. There is a need for tighter homes, high-energy efficiency of technology, and homes being built and planned within mixed-use areas. In planning, a solar-oriented community there is a need to foster both active and passive solar design techniques. It is important to note that through incentives, higher-cost and energy-efficient homes can cost as much as standard built homes in the long run.

What is the most successful aspect of this community?

(Not applicable since in planning stages)

Do you mind If the AIA can utilize you for further information on low carbon communities in the future?

Agreed to help with future endeavors.

Appendix D - Email and Phone Interview Transcripts

Interview Outline Questions –
PLACE Working Artists Ventura (WAV)
Chris Ventura, President
(612) 309-3889
Conducted and Transcribed August 17, 2010

What is your involvement within this community?

-As President of PLACE, Chris has been involved since the conception of the project after receiving an invitation from Ventura to build a low carbon community. Integral in the process is to educate the inhabitants as well as fully involve the community throughout the whole process.

What is your definition of a low carbon community?

-n/a

What are the intentions of building/designing/rehabbing this community?

- The city of Ventura approached PLACE to develop a low carbon community to cater to the needs for a living and working place for artists of the community. Also what had needed to be addressed was affordability in order to have a mixed-income of occupants as well as artist-friendly retail.

What is the status of the community (built or unbuilt, planning phase)?

-Recently finished

What is the layout of the community (urban or suburban, density, multi-use)?

-Vertical mixed-use development on a 2 acre block in Ventura with about 200 inhabitants.

What is the average income of the occupants?

-n/a

What sort of measurements is the community measuring?

What utilities are being monitored?

- Electrical energy usage and solar power production

What units are being used?

- Kilowatt -hours

Why are they being measured?

- In order to assess and evaluate the net-zero energy goals still under evaluation. The current energy bills average $20/month per household versus a comparable household in the same area with the same utility rates of $165/month per household.

Is there on site renewable energy?

- Photovoltaic panels are incorporated into the design

How are the energy needs being fulfilled?

-PV panels seek to offset the energy costs in hopes to achieve a net-zero energy consumption

What policies helped this community?

- The city of Ventura, California approached PLACE in order to develop this project. PLACE works by invitation only which means that the city was well-aware of the complexity of developing a project that would require flexibility of policies, regulations, zoning, and other issues.

What sort of policies were an obstacle?

-Because of being approached by the city of Ventura, the major obstacle of zoning hindered some of the progress on the project.

-Cities often utilize separate departments that are segregated in workflow with little to no intercommunication. By separating these departments hinders the success of being able to carry on a project such as WAV.

What is the focus/mission of the community?

- By working with the community throughout the whole entire process as well as the government along with others involved within the process of establishing a low carbon community will ensure an overall success of the project. Living in a different place than where you work is carbon-intensive.
- Rather than commuting to do simple tasks as going to the grocery store, going to school or work, and then commuting once again to go back home why not place everything within a walk-able or bike-able means of reach? And in response to that the simple answer should be “Be where you already want to be.”

What sort of things worked for your community?

- Community involvement throughout the whole process was crucial in establishing credibility within the mindset of the community. By working with the government through the whole process PLACE worked to break down barriers between the varying government agencies in order to ensure the success of the project.

Were there any intentions that were eventually not applied within the final design of the community?

-n/a

Were there any pitfalls or disadvantages?

- The largest barrier was the inter-government agencies not communicating between each other. PLACE addressed this by placing a member of each agency within every meeting and any other correspondence between all agencies involved: including electrical, plumbing, mechanical, etc within the whole design process
- Another roadblock we

What was the single-most unexpected thing that occurred?

How was the project financed?

Were there any government subsidies?

-Private and public investments along with tax credits (such as energy tax credits, new market tax credits, etc) helped to subsidize the financing as well as since PLACE is a 501(c)(3) organization they could sell off the tax credits to major corporations to lower their taxes as well.

Who are the intended residents?

-Primarily artist residents along with marketable residential units balanced with affordable housing units in order to establish a broader mixed-income occupancy.

What makes this project stand out from another community?

-Rather than going to Ventura, PLACE was approached by Ventura to establish a community that addressed the needs for an artists’ community the reflected upon a mixed-income of occupants as well as an artist-friendly retail within the ground floor commercial spaces.

Who is the driving force for the development of the community?

Government?

Few political leaders?

Organization?

Residents?

-The city of Ventura as well as the rest of the community were in major support of establishing a community within this 2 acre block to not only encourage more development but also to encourage a low-carbon lifestyle

Is there a plan for the future to expand?

Not currently from the WAV community but Ventura has approached PLACE to address some future projects due to the success of this project.

How does the community interact with existing/ surrounding areas?

The community was doubtful of the idea of a mixed-income development and the feasibility of this working but as of now the community has embraced the overall impact of the project on the surrounding area. Four major lines of metro public transportation are located on this block.

What is the most important thing you hope to convey?

Working with the community throughout the entire process as well as being inclusive of everyone involved on the project provides for a better success story for establishing such a community.

What advice would you give for those looking to redevelop and rehabilitate existing communities?

(SEE ABOVE)

What is the most successful aspect of this community?

-By working with the existing community and town of Ventura, PLACE is able to establish a community that aims at closing the loops on low carbon communities. The hope of each community is to be more reliant on growing its own food, providing education, creating energy, sustaining jobs, and recycling waste in efforts to reduce the need to be a transit-dependent development.

Do you mind If the AIA can utilize you for further information on low carbon communities in the future?

-Chris is excited to see the forthcoming research and is willing to be a resource for future needs of the AIA COTE Research.

Other Comments/Notes/Suggestions:

-PLACE: Projects Linking Art, Community, and Environment
- Seeking LEED Gold certification
- Car-sharing program $7/hr (covers fuel, maintenance, cleaning, upkeep)
- Cash for Clunkers Program (some residents no longer have owned cars)
- Go beyond LEED in design
- Seeking net-zero energy
- Bike Lockers facilitate “right-sized” transportation
- Include everyone with real, authentic participation of communities: “no one is as smart as everyone”
-“Be where you already want to be” – communities should provide a place to live/work/play/educate with minimal needs for commuting between each
- Average American spends 6 weeks commuting every year
- Reduce reliance on transportation instead of solely creating high efficiency buildings
- Provide incentives for low-carbon design and disincentives for high-carbon
- Government must streamline and communicate between all agencies in order to address policy issues
- Problem with low carbon design today is the conflict between policy failures and market failures
    - Original idea was to rely on market to drive changes in design
    - Policies failed to address the failure of market to drive low carbon design

- Zoning principles of past separated districts by usage (bedroom communities, industrial areas, business districts, lack of parks, etc)
- People question subsidies b/c they question: “How does this project benefit me?”
- Projects should take LEED principles much further in order to drive market
-Design intentionally more modern with integrated PV panels provide as an educational aim”
- (IE) Toyota’s Prius car design stood to emphasize the change in energy consumption of cars and how newer technologies are changing design

Appendix D - Email and Phone Interview Transcripts

Response to Interview Questions –
Sonoma Mountain Village
Via email:
Ryan Sakata <RyanS@Codding.com>
Received August 25, 2010

What is your involvement within this community?
Developer of this community.

What is your definition of a low carbon community?
A community with a one planet ecological footprint.

What are the intentions of building/designing/rehabbing this community?
The plan calls for building a community with a one planet ecological footprint. Zero use of fossil fuels for building energy highlights this goal. Lifestyle impacts are also address through the One Planet Communities® program which outlines the sustainability action plan for building the project.

What is the status of the community (built or unbuilt, planning phase)?
Unbuilt

What is the layout of the community (urban or suburban, density, multi-use)?
The community is a redevelopment of an old high tech campus built by Hewlett Packard in the 1980's. The community will be a new urbanist mixed use community.

What is the average income of the occupants?
What sort of measurements is the community measuring?
What utilities are being monitored?
What units are being used?
Why are they being measured?
All utilities are being measured as part of a global update of the One Planet Communities developer network. We will use standard units to measure power, water, waste etc.

Is there on site renewable energy?
Yes. 100% off all building energy use will be powered by on-site renewable sources.

How are the energy needs being fulfilled?
Primarily through Solar PV, however as more technologies become more viable they will be evaluated individually for appropriateness.

What policies helped this community?
Greenhouse gas & landuse legislation have helped our project (AB32, SB375 etc.)

What sort of policies were an obstacle?
PUC Rule 16 has been a barrier we are working to break down as well as legalizing the adoption of Greywater in Sonoma County.

Appendix D - Email and Phone Interview Transcripts

What is the focus/mission of the community?

The mission is to provide an example of truly sustainable development that does not harm the environment or quality of life for the residents.

What sort of things worked for your community?

We are still in the planning/design phase of the project and will update as we move forward.

Were there any intentions that were eventually not applied within the final design of the community?

We are still in the planning/design phase of the project and will update as we move forward.

Were there any pitfalls or disadvantages?

We are still in the planning/design phase of the project and will update as we move forward.

What was the single-most unexpected thing that occurred?

We are still in the planning/design phase of the project and will update as we move forward.

How was the project financed?

Were there any government subsidies?

We are still in the planning/design phase of the project and will update as we move forward.

Who are the intended residents?

We do not have a specific demographic. The community is designed to be open.

What makes this project stand out from another community?

It is the only officially endorsed One Planet Community® in all of North America.

Who is the driving force for the development of the community?

Government?

Few political leaders?

Organization?

Residents?

Private developer.

Is there a plan for the future to expand?

No. The project will remain as is once the community is fully built out.

How does the community interact with existing/ surrounding areas?

What is the most important thing you hope to convey?

N/A – we have not started building yet.

Appendix D - Email and Phone Interview Transcripts

What advice would you give for those looking to redevelop and rehabilitate existing communities?

That communities with One Planet ecological footprint communities are not only possible but should be the standard for community development.

What is the most successful aspect of this community?

Political support is key, existing high quality infrastructure is also a premium when it comes to building green communities.

Do you mind If the AIA can utilize you for further information on low carbon communities in the future?

Feel free to inquire as necessary.

Appendix D - Email and Phone Interview Transcripts

Interview Outline Questions-
Twinbrook Metro Station
Tony Greenberg, JBG
Email Interview , Received on October 27, 2010

What is your involvement within this community?

Development Manager

What is your definition of a low carbon community?

Incorporating cost effective strategies throughout the acquisition, design, construction, and operation phases to reduce the amount of energy consumed and single occupancy vehicle trips as a result of the development. Proximity to mass transit, especially Metro, has the greatest impact on reducing carbon emissions and is essential to creating an effective low carbon community.

What are the intentions of building/designing/rehabbing this community?

Make use of an vastly underutilized area of “undeveloped” land that is geographically centered amongst a major residential community, an flex-industrial heart of manufacturing, production, and services, and a retail epicenter

What is the status of the community (built or unbuilt, planning phase)?

The entire plan has been approved in the “Preliminary Development Plan” and subsequent individual phase “Use Permit” levels. The first phase of which has just completed construction- two mixed use buildings totaling 279 residential units, with 15,500 SF of ground floor retail, and a structured parking deck.

What is the layout of the community (urban or suburban, density, multi-use)?

The community is surrounded by a scale of zones from dense suburban to urban. Twinbrook Station is designed to urban standards- with buildings tucked tightly amongst wide walkable sidewalks and grid like streets with on-street parking. Each building brings individuality in the architecture of the buildings as a whole, but also in each ground floor retail space within every structure.

What is the average income of the occupants?

Our project is 15% affordable (moderately priced dwelling units, mpdu) across both rental and for sale housing. Add this to the location efficiency, which makes living here inherently more affordable.

What sort of measurements is the community measuring?

What utilities are being monitored?

Utilities are either sub-metered by each individual tenant, or allocated by space/occupancy- either as allowed by local utility authorities.

What units are being used?

Gallons, kilowatt/hr.

Why are they being measured? To allocate utility expenses among tenants and encourage responsible and efficient consumption.

Is there on site renewable energy?

No

How are the energy needs being fulfilled?

Local water, electric, and gas companies provide a loop through the parcels of the community.

What policies helped this community?

…Shared parking,

What sort of policies were an obstacle?

n/a

What is the focus/mission of the community?

Ultimately, we envision Twinbrook Station as connecting, energizing, and revitalizing Twinbrook. The land is being transformed from a grossly underutilized expanse of surface parking to an award-winning TOD that connects the surrounding fragmented uses.

What sort of things worked for your community? …Proximity to metro, knowledge of surrounding area in order to tailor to needs/wants, taller building heights at metro, reducing towards adjacent residential neighborhood, different architects/architecture,

Were there any intentions that were eventually not applied within the final design of the community?

…still potential to incorporate some things, but architecturally speaking…pedestrian bridges over streets, vehicular crossing of metro/rr tracks?,

Were there any pitfalls or disadvantages?

...more visibility from metro tracks = less visibility from Rockville Pike. While the metro runs through the project and is one of our biggest advantages, it can also be a barrier to pedestrian interaction between each side of the project. We spent a significant amount of time during the design phase to ensure the project feels whole and envelopes, rather than dissected by, the metro.

What was the single-most unexpected thing that occurred?

…real estate market between RFP response in 1998, to initial design in 2004, to first phase construction completion in 2010---time because of market, and working in public/private partnership

How was the project financed?

…private

Were there any government subsidies?

No

Appendix D - Email and Phone Interview Transcripts

Who are the intended residents?
...anyone and everyone

What makes this project stand out from another community?
...proximity to metro, proximity to retail, residential, commercial (lab/office) and industrial

Who is the driving force for the development of the community?
...privately driven, publicly steered?

Is there a plan for the future to expand?
...still working on completion

How does the community interact with existing/ surrounding areas?
...EARLY AND OFTEN…JBG has investment in entire neighborhood, and personal relationships with all neighbors.

What is the most important thing you hope to convey?
We are building a community from a parking lot – we hope to convey success through a desire to live, work, and shop at Twinbrook Station.

What advice would you give for those looking to redevelop and rehabilitate existing communities?
...time, initial investment, existing infrastructure isn't necessarily there in re-development projects

What is the most successful aspect of this community?
So far, Twinbrook Station has won several prestigious design and construction awards. However, the most successful aspect of our project will be realized only after the entire project is built.

Do you mind If the AIA can utilize you for further information on low carbon communities in the future?

No. Please feel free to contact Tony Greenberg at:
(240) 333-3789
tgreenberg@jbg.com

Appendix D - Email and Phone Interview Transcripts

Interview Outline Questions-
Växjö, Sweden
Via email:
Nilsson Sarah (Sarah.Nilsson@vaxjo.se)
Magnusson Therese (Therese.Magnusson@vaxjo.se)
Johansson Henrik (Henrik.Johansson@vaxjo.se)
Received August 16, 2010

What is your involvement within this community?
- In this case, when talking about low carbon community, we refer to "Fossil Fuel Free Växjö". This means the entire geographical area of the municipality, and not only a small city district or so. This means that the involvement/role played by the City of Växjö, is to make it easier and more convenient for the citizens to live more climate friendly. The City of Växjö has adopted its target Fossil Fuel Free by year 2030, which means that we have to do everything we can to reach that target. This includes the range from large scale and small scale investments by the city, support good initiatives from the companies and helping the citizens to act more climate friendly.

What is your definition of a low carbon community?
- A low carbon community is a community where the energy systems are based on renewable sources instead of fossil fuels. In Växjö we want to reach zero fossil CO2 emissions by 2030.

What are the intentions of building/designing/rehabbing this community?
- As already mentioned, the low carbon community in this case is the entire geographical area of Växjö. It is important to state that in order to reduce climate impact, we can not aim all resources to focus on small districts – instead the focus must be the entire community. So, regarding buildings etc, new buildings must be as energy efficient as possible, and the energy that is used must come from renewable energy sources. Regarding the old building stock, most of the buildings are already using renewable energy sources. Therefore, the biggest work lies ahead in refurbishing the buildings so that they use less energy.

What is the status of the community (built or unbuilt, planning phase)?
- Irrelevant question in our case since we consider the development in the entire municipality.

What is the layout of the community (urban or suburban, density, multi-use)?
- The municipality of Växjö is 1925 km2 big. It has over 82 000 inhabitants. Around 60 000 of them lives in the city, the rest in smaller villages or in the countryside. Växjö is a medium-sized Swedish municipality, and is both urban and rural. Växjö is a regional centre, has around 8000 companies and one university.

What is the average income of the occupants?
- I am not sure about the average income, but the GDP/capita and year in Växjö is 332 000 SEK (~35 000 €).

What sort of measurements is the community measuring?

Appendix D - Email and Phone Interview Transcripts

- Växjö has adopted an environmental program that contains several indicators to be measured (not only climate related). Below I have made short list where several indicators have been aggregated to one point:
  * ecological purchases
  * ecological agriculture
  * individual sewage with good purification capacity
  * fossil CO2 emissions
  * energy consumption
  * renewable energy
  * travels by bike, public transport and car
  * waste amounts and waste management
  * nature reserves and nature preservation areas
  * green areas in relation to built area
  * particles in the air
  * water quality in the lakes
  * phosphorus and nitrogen in the lakes

  What utilities are being monitored?
- When it comes to energy and CO2 it is the total supply and emissions for the entire community – buildings, industry, transports etc.

  What units are being used?
- GWh, kWh/capita, ton CO2, kg CO2/capita, number of travels, km/car

  Why are they being measured?
- It is the only way to monitor the progress towards the targets in the Fossil Fuel Free program.

Is there on site renewable energy?

- Yes, in the city-centre of Växjö, a combined heat and power plant is producing district heating and electricity, mainly from biomass (90-95%). In the four biggest villages there are also district heating plants using biomass (90-99%). Then of course quite many houses are using pellets and wood. Solar panels are used for hot water in some households. The biggest solar heating use is at the swimming hall. PV plants exist on three schools. One wind mill stands in the countryside, and very soon we will try a small-scale urban windmill. Small hydropower plants also contribute to local electricity production. Biogas is produced locally at the sewage plant, and is being used for heating, electricity and vehicle fuel.

How are the energy needs being fulfilled?

- The following is the total energy supply of Växjö in 2009 (with electricity I mean electricity that was not produced locally):
  * Woodfuels: 967,76 GWh (39,9%)
  * Electricity: 454,35 GWh (18,7%)
  * Gasoline: 380,96 GWh (15,7%)
  * Diesel: 330,77 GWh (13,6%)
  * Oil: 100,86 GWh (4,2%)
  * Heatpumps: 68,2 GWh (2,8%)

* Peat: 52,33 GWh (2,2%)
* Ethanol: 23,77 GWh (1,0%)
* Aviation fuel: 15,30 GWh (0,6%)
* FAME: 13,39 GWh (0,6%)
* Hydropower: 9,60 GWh (0,4%)
* Biogas: 5,30 GWh (0,2%)
* LPG: 4,19 GWh (0,2%)
* Ecopar: 1,02 GWh (0,0%)
* Windpower: 0,82 GWh (0,0%)
* Solar energy: 0,65 GWh (0,0%)
* Straw: 0,4 GWh (0,0%)

All in all, 56% comes from renewable energy, 37% from fossil energy and 7% from nuclear energy.

What policies helped this community?

- Unanimous political commitment to climate issues, the courage to set long term targets and visions – targets that go much further than the period the politicians are elected for. The introduction of the CO2 national CO2 tax and the green certificates for electricity are of course also important for the development. In order to start some new investments and try new ideas, financial contribution from the Government, national authorities and the European Union have been important.

What sort of policies were an obstacle?

- Also here, national and EU legislation can be an obstacle. One concrete example is connected to the emissions from the transport sector. About 5% biofuel is blended into ethanol and diesel nationally. This could be increased to 10% without harming the engines, and the fuel companies are willing to do so. However, the EU definition on gasoline and diesel only allow maximum 5% blending of biofuel, and it is a long process before that changes. National taxation could also be an obstacle, as well as low electricity prices.

What is the focus/mission of the community?

- To become free from fossil fuels, and therefore give no CO2 emissions. That means that we will take our local responsibility for a global environmental problem.

What sort of things worked for your community?

- The conversion from oil to biomass in the district heating has been very successful. Also the work with connecting the buildings to the district heating systems, and in many cases make a conversion from electric heating to district heating. We also have good experiences in building more energy efficient buildings. Thanks to different stimulations (local subsidies, free parking) we managed to introduce environmental friendlier vehicles among the public quite early.

Were there any intentions that were eventually not applied within the final design of the community?

- That is hard to say, since it is difficult to say that there has ever been a final design of the community.

Were there any pitfalls or disadvantages?

- Not really. Renewable energy is cheaper and more environmental friendly. It generates local jobs which is good for the economy. One disadvantage could be that if we want to try new things before everyone else, it also means that we will be the first one to face possible troubles. One example is that many years ago, a solar energy driven district heating plant was tried. It had serious problems, and still people of Växjö "knows" that solar energy does not work.

What was the single-most unexpected thing that occurred?

- The interest from international media from all over the world and the many study visits.

How was the project financed?

- Some parts have of coursed been financed by the government and the EU, but most activities have been financed by the municipality, the companies and the citizens.

Were there any government subsidies?

- Yes, for instance within the so called "local investment programs for ecological development" and the "local climate investment programs".

Who are the intended residences?

- All the citizens in Växjö.

What makes this project stand out from another community?

- That we do not consider just a small area. We are making this change throughout the whole municipality. We decided this very early, and in fact without really knowing how to get there and what actions we needed to do.

Who is the driving force for the development of the community?

Government?

- Yes, since there is a national interest in reducing the climate impact of Sweden. But of course, the Government is not the big driving force – we want to go further than the Government.

Few political leaders?

- Yes, since the politicians are interested in sticking to their commitment from 1996, when they decided that Växjö is to be a fossil fuel free community. Local politicians may be the biggest driving force, since they are interested in making Växjö as good as possible to live and work in.

Organization?

- Different organizations and companies are very important in order to reach the final target. Therefore, cooperation with them is crucial. City administration is well organized and has a strong cooperation with the politicians.

Residents?

- Also what the residents are doing is very crucial for the success. The residents have becoming a more important driving force, since they help the municipality to pin-point deficiencies in the progress.

Is there a plan for the future to expand?

- No, we think that already covering the entire the geographical area is good enough. On the other hand, we are most happy to share our experiences with other cities. Of course, we want to export the regions knowledge and equipment to other areas and countries.

How does the community interact with existing/ surrounding areas?

- There are no other areas within the municipality, but of course some relations depend on what happens in the region and in the neighboring municipalities. This is considered for example when discussing public transport.

What is the most important thing you hope to convey?

- The most important thing is to show that you can actually do quite much on local level. You don't need to wait for international agreements in order to start taking your own responsibility. To show that living in a fossil fuel free community can actually be convenient and feasible, and does not mean that we have to "go back to the stoneage".

What advice would you give for those looking to redevelop and rehabilitate existing communities?

- Start with things that are easier and have big effects, for example changing fuel in an existing energy system doesn't mean that you need to do so much changes in the infrastructure, but can still have a huge effect when it comes to CO2 emissions. Look at your own community and proceed from there; for example what materials are available, sewage, waste, cooling water etc. Maybe you can not do exactly everything that has been implemented in another community and maybe not in the same way. Every community is different, take advantage of that.

Would you say this community is successful?

- Yes, we are already having high share of renewable energy (56% - and that includes energy for transport). Our CO2 emissions per capita have been reduced by 34% between 1993 and 2009. During the same time, the economic growth per capita has been 70%. The CO2 emissions are currently 3 tons per capita, which is half of Sweden's emissions and also below global average.

Do you mind If the AIA can utilize you for further information on low carbon communities in the future?

- No, that is perfectly OK.