Green Net Zero Energy Life Style Science Park Prototype Design

Bruce McLean Haxton, LEED® AP
International Sustainable Consultant
Design Architect
Rhinelander, Wisconsin, USA

Rick Cantwell, PE
President and CEO, Odell International LLC
Program Management and Design-Builders
Huntersville, North Carolina, USA

John Andary, PE, LEED® AP
Principal, Stantec
Mechanical Engineer & High Performance Building Consultant
San Francisco, California, USA

Tom Kubala, AIA, LEED® AP
Principal, The Kubala Washatko Architects
High Performance Building Architects
Cedarburg, Wisconsin, USA

Fred Meade
Science Park Consultant
Atlanta, Georgia, USA

Michael Perciali, AIA, NCARB, LEED® Green Assoc.
Architect, Sustainable cGMP / Clean Room Specialist
High Performance Laboratory Specialist
Princeton, New Jersey, USA

EXECUTIVE SUMMARY

Our design team will demonstrate the concept of integration of the "Net Zero Energy Building Concept", "Life Style Science Park" concept, and Green Sustainable Design. The first concept "Net Zero Energy Building Concept" (NZEB) has a few different meanings; however the one that we will use for this research paper is that the entire Net Zero Energy Life Style Science Park will all use only renewable energy. The renewable energy systems that we will illustrate on the project are: 1) solar power, 2) wind power, 3) geothermal, 4) lake cooling, and cogeneration from waste. The "NZEB Life Style Science Park" is meant to be a live, work, play, and educate environment. The "Green Sustainable Design" means that the entire design is to be as environmentally sensitive as possible. This will include a "net water use concept" and a "net waste concept". The buildings will use sustainable design and materials.

OVERVIEW FOR A NEW CONCEPT: "GREEN NET ZERO ENERGY LIFE STYLE SCIENCE PARK"

The desire of the design team is to demonstrate how the "Life Style Science Park, Net Zero Energy, and Sustainable facilities are complementary in terms of energy and resources saving. Major sources of energy savings: 1) the master planning orientations, 2) net zero energy buildings, and 3) facility cogeneration opportunities; 4) transportation energy savings with the "live, work, play and educate" concept.

The "master planning building orientations" for the new NZEB's should be designed with the long axis of the buildings in the east-west direction to reduce heat gain and facilitate natural daylighting. This orientation also should impact the site size and shape of the individual building site layouts which in turn impacts the road patterns.

The "net zero energy buildings" will not just be the research facilities, but the entire integrated science park component building types. The buildings all need to work together and need to rely on renewable energy from solar, wind, geothermal, ocean resources and other renewable energy sources. These buildings will be designed first to conserve energy resources through passive means. The remainder of the energy that is needed for each facility is obtained through renewable energy.

There will be a concerted effort to reduce waste and promote recycling and reuse. Any of the remaining "waste" will be used for the "facility cogeneration operation" will take advantage of the waste from all science park elements to reach a "zero waste" by using cogeneration to generate energy to complement the other renewable energy resources. This will be an efficient way to create energy and a "semi-closed system" of dealing with waste and generating energy for use in the science park.

The "reduced transportation costs" will save a significant amount of both energy and on resident travel time. Each family and employee will benefit from greater energy efficiency and more time to spend with family and with other life style pursuits. The quality of life will be enhanced. The amount of work can be increased with very little increase in energy.

A few other features that are integrated into the new "NZEB Life Style Science Campus" will increase the water resource saving. The rainwater caught on the roofs of the buildings and in the vehicle parking areas will be "captured" and cleansed to be used for an amenity resource (water feature). This is similar to the very creative planning accomplished at the Arizona State University Science Park, Tempe, Arizona that has used this concept very successfully. The rainwater will be caught and used for both industrial needs and for "grey water" needs related to sewer conveyance. The concepts embodied in "Cradle to Cradle"® design developed by William McDonough will be implemented as much as economically possible.

The design of this Net Zero Energy Life Style Science Park is to be used by regions and countries as a "teaching tool" and "demonstration project /proof of concept" for this new integrated urban or rural form science park community. The initial developments worldwide will be used to propel their economies into the new renewable commercial market place. Each climate type and geographic region and cultural mix will foster its own "renewable domestic building revolution" customized by the local architects and engineers to the local climate conditions.

SITE SELECTION

Site selection can also foster energy savings by locating the development in regions of reduced heating degree days and cooling degree days. Select sites based on regional criteria, renewable energy regional resources, and minimize catastrophic loss potential (tornados, hurricanes, hail, flood, tsunami, earthquake, ocean rise and other pending disaster potential). By reducing the catastrophic loss potential future economic loss will be a saving in loss if life, decreased work interruption, reconstruction costs, and future catastrophic healthcare mitigation.

Proper site selection will dramatically improve the energy performance of a science park or research facility, including maximum utilization of outdoor spaces. The research paper will illustrate the process for energy and site analysis to address concepts of solar access, air movement principals and ventilation corridors, site microclimates, resource mapping and waste stream analysis, as well as the interweaving of buildings, plantings and water features.

Description of the Design Concept Overview:

The “Net Zero Energy Life Style Science Park Prototype” is not a proposed plan but rather an idealized demonstration of what a science park of the future could be come. The country, culture, climate geography, site utilities, transportation infrastructure, educational concepts, housing standards, availability of land and a number of other parameters will of course influence the design for any real science park.

The Net Zero Energy Life Style Science Park design reflects the integration of the program elements that make up a state-of-the-art life style science park similar to the Centennial Campus at North Carolina State University, Raleigh, North Carolina and MIT Urban Life Style Science Park in Cambridge, Massachusetts: Research Facilities, Technology Incubators, Housing, Education Facilities, Hotel and Convention facilities, Golf Course, Retail, Commercial, Restaurants, Cafes, Shops and community functions. These functions promote a new “live, work, play, and educate” environment that we are trying to capture for our new prototype.

The overview concept for these life style facilities is to integrate the functions of a small fully functioning community to accomplish a number of goals: 1) the grouping of research facilities in a science park facility creates an image for the companies that enhance their marketability. 2) the quality of life for researchers and the community is increased, 3) services are shared at a reduced cost, 4) travel time to work is reduced, 5) energy for transportation is reduced, 6) the coordinated community creates a market aggregation for retail shops, restaurants, and services, 7) educational opportunities between business and eduction can become stronger due to their close proximity, 8) enhanced proximity between teachers and incubator functions will promote enhanced incubation activity leading to job creation, 9) shared environmental sustainability and energy conservation can become a show place to foster sustainable lifestyles and businesses, and 10) increased proximity of researchers will foster more interaction and synergy of research interchange.

Plan Considerations and Concepts:

The overall plan is focused on the “heart of the development” the Village Center. The Village Center is to become the center of gravity for the entire complex on a daily basis, it is where you can have lunch at noon or go to a restaurant at night. It will be where community functions take place from community meetings to a market square biweekly. The center is modeled after not only the Centennial Campus concept but also has its roots in small successful village squares around the world, i.e. St. Nicholas, Crete; Symi, Greece; Cortona, Italy; San Gimignano, Italy; Siena, Italy; Basel, Switzerland; Mykonos, Greece; Ulm, Germany; San Antonio, Texas; and Rhodes, Greece. Some of the things that make these small villages so enjoyable are the restaurants, retail, and market functions that are focused at the city center and in some cases include a dynamic water element to enhance the environment. The most notable of these is St. Nicholas, Crete and Mykonos, Greece. These villages and cities were analyzed to define the attributes that made them function as enjoyable environments. These functions were the design parameters used to design our prototype life style environment. To the life style environment we add the elements of both sustainability and net zero energy environments.

Central Village Center:

The Village Center will be a pedestrian environment with only pick-up / drop off access and service access. This automobile access is common in “life style” city centers such as the new 4 billion dollar “Life Style” Salt Lake City Center created just a few blocks west of the original Salt Lake City downtown. The autos are used both to create a vibrant center but also to function as a convenient way to buy, pick-up, and transport goods purchase at the retail located in the city center. Our limited auto access is around the village center with service drop offs and pick-up locations on the periphery of the Village Center pedestrian central area. The Village Center focuses on a body of water, similar but slightly smaller than the St. Nickolas version. This body of water is the visual heart of both the community and the village center. It is the community space that the restaurants and shops open on to.

The University campus is a contiguous part of the Village Center. For community and child safety the K-12 educational function is at the village with adequate pedestrian traffic to promote safety. Pedestrian access to the village center can be accomplished from the residential areas via the "river walkway system" similar in nature to the "river walk" in San Antonio, Texas. The grade change can permit pedestrian traffic to travel to the city center without crossing vehicular routes at the central Village Center perimeter. A weekly or biweekly market can occur at the city center piazza in the central portions of the Village Center. This would be similar to market areas in Ulm, Germany; Cortona, Italy; Madison, Wisconsin; Basel, Switzerland and many other European / Mediterranean communities. Parking for the village center and education facilities is located at the perimeter but within the village loop road. The parking structure will have a solar collector system to provide additional electrical at the Village Center.

Housing:

Housing at the "Life Style Science Park" would accommodate science park employees thereby saving both time and energy. An initial segment of housing will be developed along the river walk, with additional housing on the other river walk followed by market demand housing as close to the city center as possible. Both the residents and students (housed at the Village Center) will help provide the vitality of the 24/7/365 community that will help support the retail shops and restaurants at the Village Center. It is hoped that in the future 100% of the residents will live in the community and thereby promote the inherent energy savings and social vitality that would be promoted by this "total" live, work, play, and educate environment. Pedestrian access from the housing to the Central Village Center is via the "river walk" hardscape promenade. Vehicular access is to the back side of the residences and is coordinated to the vehicular network in the science park. The housing would have a two-story townhouse design with solar collector design toward the south of the facility similar to the Virginia Housing Study (Haxton 1974) with solar collectors on each unit. The individual units would store both electrical vehicles and smaller electric cart similar to those used in Port Aransas, Texas. Recharging of the vehicles would be accomplished both at the home and in each parking structure.

Recreation:

The main form of recreation is the 18-hole golf course located just to the outside of the Village Center loop road would act as a green space transitional buffer from the science park and would be always visible from the loop road as open space. The golf course in a few instances works its way along a water features to provide a walkway and open space circulation route from the research buildings to the Village Center. The golf course clubhouse and starting area is located in the Northwest Quadrant of the Science Park. The golf course facilities would contain a clubhouse, pool, maintenance facility, putting area, driving range and other support functions similar to a regular golf course or country club. The water elements that are also water catchment features also act as a water feature for the golf course. The entire golf course surrounding the village center acts as a visual amenity for the research sites.

Educational (University and Distance Learning):

The University campus function, hopefully focused on renewable energy education and sustainable education would be located integral with the Village Center. Within the Village Center the student residences will provide a 24/7/365 vitality, these residences should have good views of the Village Center water feature. This amount of student activity will help to provide safety for the residents in general within the Science Park. The University Campus service courts are located on the "inside" of the Village Center loop road.

Hotel / Convention Center:

The hotel and convention center will function both for the Science Park visitors and for the University visitors. The hotel and convention center within the Village Center could be integrated into the university functions (very similar to the Centennial Campus and MIT Campus). A common video conferencing center at the convention center should be used by education, research conferences, and hotel / conference functions. This video capability will promote distance learning and can function on a broader basis for sustainable development and science park functions worldwide as defined in Haxton IASP Research Paper 2009, Raleigh, North Carolina.

Research Facilities:

There is potential for approximately 60 sites for research facilities on site (compared to 32 research sites on the 320 acre Arizona State University, Tempe Science Park Campus). These sites can either be as noted on the site plan or combined into larger sites to accommodate larger facilities. The prime sites are larger and are located adjacent to the golf course, water ways and pedestrian paths. The more intense fume hood related facilities should be placed at a great distance from the housing. Since some new research functions require nanotechnology capability, a nanotechnology analysis should be completed to strategically locate these away from vibration (roadways and wind turbines) and microwave sources (and any other electromagnetic sources), i.e. away from the wind turbines and microwave uplinks. Technology incubators will be located in close proximity to the educational components thereby facilitating good access from for the teacher / researchers that would work at the technology incubator. The golf course, water feature walkways, and green space walk ways were all located to promote the easiest possible pedestrian access from the research sites to the educational facilities located at the Village Center. The research sites closest to the Village Center, should be dedicated site for University research laboratory facilities to facilitate good student access to these facilities.

Solar Collector Arrays:

Solar collector arrays would be placed on all buildings, parking shade structures, and roof tops. If the electrical demand exceeds the solar rooftop and the wind turbines and a ground mounted solar array could be accommodated on an adjacent site.

Wind Turbines:

Wind turbines if cost effective at the site would be located to the parameter of the site to provide for less turbine to turbine wind problems. The placement of the wind turbines to the perimeter of the site will help reduce vibration at the research sites. This is very helpful in reducing vibration sources near nanotechnology facilities.

Rainwater Catchment:

Rainwater will be caught on the structures and will be used for gray water uses. The entire water system will be considered a “closed system” approach as possible thereby using and recycling water numerous times. The rainwater catchment concepts will be in use in the Village Center and at the research facility sites.

ONSITE RENEWABLE ENERGY

The use of solar for electrical generation and water heating, plus the use of wind generation technologies are described below:

Solar Technologies:

Photovoltaics:

Solar cells, also called photovoltaic (PV) cells, convert sunlight directly into electricity. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the PV effect. The PV panels are mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight.

Photovoltaics are readily available, easy to install and maintain, and the cost is well understood (becoming more cost effective each year). As such, a popular method of including this technology on commercial building projects is through a "Power Purchase Agreement" with a third party that will install and maintain the system at no first cost of construction, then sell the energy back to the building owner for a pre-determined payoff period. The NZE Life Science Park has been designed for maximum solar access to take the greatest advantage of photovoltaics as the prime renewable energy source.

Solar Water Heating:

Most solar thermal systems for buildings include solar collectors that work along with a pump, heat exchanger and storage tanks to provide hot water renewably from the sun's energy. Solar hot water heating is a simple, cost effective renewable energy option. The Net Zero Energy Science Park will utilize this technology, with the panels mounted on the roof of most buildings, to provide domestic hot water throughout the year.

<u>Wind Electrical Generation Technologies:</u>

Site Mounted Wind Turbines:

The scale and variety of site (ground) mounted wind turbines available on the market today is vast. Wind energy is only useful when there is an adequate wind resource at the site of the desired energy production. Horizontal turbines are most common from small scale building sites to large scale farms. The Net Zero Energy Science Park will utilize this technology at strategic locations on the perimeter of the site, only when there is adequate wind resource available.

Vertical turbines are another wind technology option that may be applicable to a site based on the nature of the wind resource.

Building Mounted Wind Turbines:

Building mounted wind turbines are a recent technology that has several challenges for practical application, including issues of vibration, noise and performance.

<u>Waste-to-Energy Plant:</u>

The on-site Waste-to-Energy plant will burn non-recyclable waste products from the buildings and site, including biomass in the form of landscape maintenance clippings. Current stack scrubber technology allows for the clean burning of these waste feedstock sources. Boilers will be used to burn the waste feedstock and the steam produced from this process will used in a co-generation or tri-generation system that can produce electricity from a steam turbine, chilled water from absorption chillers, and hot water for space and domestic water heating. The Charleston, South Carolina site will be cooling dominated and will therefore benefit mostly from the generation of electricity and chilled water.

<u>SUSTAINABLE SITE PLANNING STRATEGIES</u>

The site planning that promoted the Net Zero Energy Life Style Science Park really rests in energy conservation, passive design, environmental psychology, and a desire to not only conserve resources but improve the existing conditions on site.

The overall planning organization is rooted in the desire to conserve energy by designing the site properly. The basic principles are: 1) Orient roadways, building sites, and buildings to promote energy conservation from the start (this means promoting buildings that are long in the east west direction and short in the north south direction), 2) Design buildings and site to promote buildings that can easily be daylit (buildings long in the east-west direction and 60' in within the north south direction), 3) plan for buildings and sites to capture and use rain water for gray water and process, 4) Organize the site to promote the use of radiant water cooling i.e. located buildings near water sources for cooling. 5) Catch water on site and the excess that is not needed for gray water or "process" water use is to be diverted to on site amenity use (body of water) or to replenish the aquifer. 6) Use deciduous trees to reduce solar heat gain, 7) Use trees as a visual buffer between uses, along transportation corridors, to enhance and soften the urban environment, 8) Use the recreational uses to buffer other uses and transportation corridors. 9) Use the education buildings as "activity generators" at the Village Center to create high use pedestrian spaces that promote both safer environments at night and vitality 24/7. 9) Create a visual focal point that will promote an outdoor amenity (Lake – Piazza) that creates value and enhances the urban lifestyle. 10) Create walking environments from the housing to the Village Center to promote a healthy walking lifestyle. 11) Promote housing locations between science park facilities (work) and recreational activities (dining, shopping, golf, tennis, and soccer) at the Village Center that promote walking, 12) Provide for the use of distributed renewable energy systems as the community growths the renewable energy systems can grow proportionally, 13) Promote a separation as much as possible of pedestrian, vehicular, and service traffic, and promote a walking lifestyle with multimode transportation options (bicycle, electric car, electric cart, bus system, segway and bus system to rapid transit). This does not preclude other forms of transportation but enhances walking. The transportation system needs to include bus transportation to a high-speed rail system nearby.

The primary concept of the facility plan is to promote a life, work, play, educate environment that will be exciting, cost effective, energy efficient and improve the quality of life. This development is meant to save computing time which can be use as family time or for recreation. This concept will significantly save fossil fuel for vehicles by eliminating the automotive commute to and from work.

<u>Central Utility Plant Strategies:</u>

Water Source Geo-Exchange Technology:

The overarching concept for a central energy plant is to provide a consistent source of water to each of the buildings on the site for use as a heat source or heat sink depending on the season and the nature of the building program. The water is piped around the campus site within proximity of all the buildings so that the resource can be easily used by each. For the purposes of the Net Zero Science Park concept this concept will be called the Thermal Distribution Network.

This concept emphasizes utilizing the constant temperature of the aquifer as a source of cooling (heat sink) and heating (heat source). This resource is intended to be used in conjunction with the site water features. These water features are located in close proximity to all of the site buildings for two reasons. The first is to allow the water feature to be a retention area for rainwater that will be used for irrigation throughout the site. The second use for the water features is to allow it to be the natural Thermal Distribution Network for the water source geo-exchange system, maintained at a relatively consistent temperature throughout the year. Aquifer water will be pumped into the water features and then re-injected back into the aquifer at equal or greater quantity depending on the quantity of rainwater collected. The temperature of the water that is re-injected into the aquifer shall be equivalent to eliminate the potential for thermal pollution of the aquifer (rise or decrease in the overall temperature).

The temperature of the Thermal Distribution Network is intended to be close to the aquifer temperature, which is typically between 60°F and 70°F in Charleston, South Carolina. At this temperature the network water can be used to provide radiant cooling and tempering of ventilation air in throughout the year without the need for additional cooling energy. Other spaces requiring cooling will need additional equipment to lower the temperature of the network water. As such, each of the buildings on the site shall utilize high efficiency, water-to-water heat pumps or heat-recovery chillers to provide basic cooling and heating water for space conditioning, utilizing the Thermal Distribution Network as a heat source or sink as required. This strategy provides an integrated approach to the NZE site design by allowing all cooling and heating equipment in each building to be located in mechanical rooms within the structure instead of on the roof, which will be reserved for photovoltaic and solar thermal panels.

<u>Additional Central Utility Plant Strategies:</u>

Large Body Water Source Technologies (ocean, river and lake water):
This strategy simply utilizes other natural bodies of water in the same concept as noted above "Water Source Geo-Exchange Technology", if such a resource is located in close enough proximity to the site.

Ground Source Technologies:
Horizontal and vertical geo-exchange systems utilize below grade piping systems to transfer heat to and from the earth with water. This ground-tempered water system is then typically coupled to a high efficiency, water-to-water heat pumps or heat-recovery chillers to provide basic cooling and heating water for space conditioning.

<u>Facility Design Strategies:</u>

Facility design strategies will show how the overall design, in particular space programming, affects passive energy concepts and functionality of interior space. The overall performance of the building occupants has a direct economic impact on facility economics and building cost effectiveness. Indoor air quality, thermal comfort and quality of light/daylight are highly critical in developing a holistic solution. These concepts will be illustrated in the Net Zero Energy Prototype Model.
At the forefront of the design is a whole building or integrated design strategy. This strategy starts with interactive programming, goal setting, and site analysis. All team members are involved in the interactive search for reducing the resources, energy and costs to achieve the needed facility solution. The design starts with finding passive design opportunities even at the programming and site selection stage. Refer to the resources portion of the text to be directed to Net Zero Energy interactive design session information and process. The design strategies are focused on: 1) reducing the amount of building needed, 2) maximizing passive design, 3) developing an integrated design process that develops integrated architectural / engineering solutions that are both cost and energy sensitive, 4) creating solutions that embody environmental psychology principles that improve the user functioning on a day to day basis, and 5) remembering that we are producing architecture that is meant to inspire the human spirit not just provide a roof and walls.

Architecture and Passive Design Strategies:

The easiest and less costly designs are passive design concepts for both science park master planning and facility planning. These passive design concepts will illustrate how dramatic savings can be realized through strategic science park infrastructure design, building orientation and massing, material selection and other strategies for adapting to local climate and culture.

Science Parks in the past have been designed almost irrespective of passive solar design planning principals. With the advent of both LEED® and NZEB passive design concepts, orientation is very important since it reduces the need for energy. By minimizing solar heat gain to the building and by increasing natural daylighting of the spaces, energy can be saved. This is usually accomplished in the USA by orientation of the main axis of the building in the east-west direction. This east – west orientation allows for control over heat gain on the northern and southern facades and reduces solar heat gain on the east and west facades that are very difficult to control. The use of shading devices (both vertical and horizontal) reduces heat gain and can increase daylighting with the use of proper light transmitting devices. The widths of the facility and the interior wall systems also have a significant impact on natural daylighting. Facilities that are 60 feet or less in width tend to maximize the use of natural daylighting to obtain usable light and to reduce the cooling load attributed to artificial lighting. The strategic size and location of windows, window shading and reflective devices, via computer simulation analysis can optimize natural daylighting and the entire exterior wall performance. Sloped roofs can cost effectively create an increase energy performance for solar devices located on the roof. These solar devices both generate electricity and shade the exterior surface of the roof. Increased floor height also has a positive effect on daylight distribution and performance.

The use of high mass and heavily insulated walls tends to delay the temperature transfer into the building and promotes a more energy efficient building envelope. The cost of the envelope systems should be increased to further reduce the energy needs of the facilities. Computer analysis and simulations can help optimize the exterior wall between energy savings and cost.

Passive shading devices in the form of trees can also have a positive effect on the microclimate and the exterior building envelop. Deciduous trees can be used effectively to reduce the overall energy needs of a facility and microclimate in general. It should be noted that solar collectors located on the roof also act as a passive shading device for the roof surface heat gain.

Design Integration:

The simplest strategies that result in an integration of cooling / heating systems, lighting / daylighting systems, building envelope design, reduction and controllability of internal equipment / plug loads, a robust energy management system, and intuitive building operation are the most cost effective solutions. These concepts will be illustrated in the Net Zero Energy Prototype Model.

The previously mentioned passive architectural strategies, when well designed, result in the ability to effectively utilize the most energy efficient HVAC systems. For example, radiant cooling and heating systems provide space conditioning by using water to cool or heat building interior surfaces like ceilings, walls or floors. Depending on climate, these systems utilize less energy than traditional air based HVAC solutions because water transfers energy significantly more efficiently than air. However, radiant systems have a limited capacity to cool or heat based on available surface area. If the envelope design is ineffective at reducing solar heat gain and thermal losses the radiant systems simply will not be able to maintain acceptable comfort conditions. As such, appropriate integration of passive, low energy architectural design and the radiant systems is absolutely necessary not only to achieve the desired energy efficiency, but also to maintain a comfortable indoor environment.

Building Engineering Strategies:

Cooling / Heating:

Radiant cooling is the predominant strategy for all appropriate occupied and non-occupied spaces on the site. Radiant cooling in this context refers to utilizing large surface areas such as floors, overhead slabs and ceilings as the cool surface that provides the necessary cooling as relatively high cooling water temperatures (close in temperature to the Thermal Distribution Network). These same radiant surfaces will also be used for heating. In humid climates like Charleston, South Carolina the radiant cooling systems must be coupled with a low energy desiccant dehumidification ventilation air system that is capable of controlling the relative humidity in the buildings.

Another significant component of energy use for cooling and heating in buildings is the energy required to temper the fresh air that is supplied to these structures. This applies to all the occupancy types represented on the Net Zero Energy Science Park. All buildings will utilize heat recovery systems to allow the “free” heating or cooling of the fresh “ventilation” air streams by capturing the hot or cold energy of the building exhaust air stream, which at the temperature of the building occupied zones.

Spaces that are typically not appropriate for radiant cooling are residential, high air volume laboratories, conference or meeting spaces, and other zones with excessively high internal heat loads. Residential occupancies will utilize an air-based system for both heating and cooling. Laboratory spaces with fume hoods will utilize chilled beam technology with low temperature perimeter heating panels. All other spaces will utilize displacement ventilation for cooling, and low temperature perimeter heating panels.

All occupied zones in all buildings, except those with displacement ventilation, shall utilize high efficiency ceiling fans to provide increased air velocity allowing the cooling design temperature to be increased for significant energy savings.

As noted above in the Central Utility Plant section, water-to-water heat pumps will be provided at each building to produce chilled and hot water for cooling and heating.

Plumbing:

Low flow fixtures shall be utilized throughout the site to minimize potable water usage and, therefore, the quantity of domestic hot water for significant energy savings. Non-potable water from the site water features will be used for toilet flushing and each building will be provided with a secondary piping system for this purpose.

As noted in the renewable energy section above, domestic hot water for all buildings will be provided by solar thermal systems, which will utilize the building heat pump(s) as back-up on low-solar days.

Lighting:

Low energy lighting is critical to the design of net zero energy facilities. Critical issues include low lighting power density both outside the building and inside, implementing specialized task lighting in as many spaces as possible. This allows typical work spaces to function at levels of 0.5 to 0.7 watts per square foot with fluorescent lighting, most importantly controlled to reduce levels for occupancy and daylighting levels. External site, parking and building lighting, as well as certain building interior spaces, will be lighted with LED fixtures to further reduce total site energy.

Power / Plug Loads:

Net zero energy design that uses appropriate passive and active low energy building concepts noted in this document will reduce the energy demand of all aspects of the project to the point that "plug loads" can become the largest energy consumer. Plug loads include everything that is plugged into a power outlet, plus additional electrical power consumers like server rooms, telecom rooms, kitchens, etc. Plug load reduction and control strategies include computer options (laptops versus desktops) and occupancy control strategies for workstations. This is critical to lowering total site energy use and is directly related to the implementation of site renewable energy to directly offset that energy demand.

CONSTRUCTION STRATEGIES

General Sustainable Construction Concepts:

Construction strategies will help to improve construction cost effectiveness, save resources, recycle waste, improve air quality, improve worker safety, and promote optimal building performance.

A number of factors distinguish sustainable construction practices from the: 1) Use of local materials that promote the local economy and reduce transportation costs, 2) Use materials with low embodied energy (energy to extract, manufacture, transport, and construct), 3) Waste management techniques to conserve resources, 4) Recycling construction materials, 5) Construction air quality practices that provide for worked health, and 6) Aggressive commissioning to make sure the systems are performing as designed.

DEVELOPING REGIONAL ADAPTATION TO DESIGN CONCEPTS

Different countries and regions have very unique climates, proximity to resources, proximity to power sources, cultural differences, and economic constraints that will influence the design process, material selection, and equipment selection. As this "Prototype" is adapted to other countries the design process start anew. Each geographic location and country has very specific design and cultural parameters. The prototype was meant for the United States southeastern geographic area.

The sites and buildings are long in the east-west orientation which is the most passive for the North American climate. This form orientation will change for different climate types.

In centrally planned countries the aggregation of sites may be easier; therefore this may be implemented in these countries much faster than were the process of eminent domain is much slower and more litigious.

Regional site analysis should focus on site analysis of 1) renewable energy sources, 2) tax and other incentives incentives (federal, state and local), 3) catastrophic weather mitigation, 4) reduced energy demand in terms of heating and cooling (low heating and cooling degree days), 5) educational university needs, 6) need for economic development, and 7) educated high technology labor force.

It is essential that the client/design team think about sustainable Multi-tenant facilities, Pilot Plants, and Incubator facilities to make sure that the current science park and tenant needs are met for the ever changing international competitive environment that exists.

PROGRAMMING PARAMETERS:

Functional Program	(EUI) KBtu/per Sq. Ft./year	%	Total Square Feet (m^2)
Research (EUI Level 1) Buildings	100	4.4	200,380 sf (18,616 m^2)
Research (EUI Level 2) Buildings	125	16.8	768,150 sf (71,363 m^2)
Research (EUI Level 3) Buildings	150	14.0	640,600 sf (59,514 m^2)
Research (EUI Level 4) Buildings	190	9.8	447,400 sf (41,565 m^2)
Research (EUI Level 5) Buildings	230	6.8	310,840 sf (28,878 m^2)
Educational Laboratories	100	1.3	61,780 sf (5,740 m^2)
Educational Laboratories	125	1.8	83,580 sf (7,765 m^2)
Educational Laboratories	150	1.8	80,790 sf (7,506 m^2)
Educational Laboratories	190	.9	42,890 sf (3,985 m^2)
Technology Incubators	125	2.7	125,090 sf (11,621 m^2)
Educational (University)	24	15.0	686,000 sf (63,731 m^2)
Educational (K-12)	24	1.2	55,000 sf (5,110 m^2)
Hotel (210 rooms)	40	2.6	120,000 sf (11,148 m^2)
Hotel Conference Area	78	1.6	75,000 sf (6,968 m^2)
Office Buildings	24	1.6	75,000 sf (6,968 m^2)
Commercial Buildings	24	1.1	50,000 sf (4,645 m^2)
Restaurants/ Cafes / Shop	24	3.3	150,000 sf (13,935 m^2)
Housing (532 units at 1060sf per unit)	25	12.3	563,920 sf (52,390 m^2)
Golf Facilities	24	.5	23,400 sf (2,137 m^2)
Co-Generation	N/A	.4	20,000 sf (1,858 m^2)
Total			4,579,420 Sf (425,442 m^2)

Summary (building square footage/square meter %):

Research Park Laboratories:	51.8%
University Facilities:	23.5%
Hotel / Conference Center:	4.2%
Office/Commercial/Restaurants/Cafes/Shops:	7.2%
Housing:	12.3%
Other:	1.0%

Site Parameters: Acres (Hectares) (building/ function coverage of site %)

Acres for Village Center; Educational,

Commercial/Office/Cafes/Restaurants/Shops:	68 acres (27.5 hectares)	6.4%
Acres for Golf Course:	57 acres (23.0 hectares)	5.3%
Acres for Housing:	143 acres (hectares)	13.4%
Acres for Research (including University and Incubators):	713 acres (288.5 hectares)	66.7%
Acres for Water Features:	88 acres (35.6 hectares)	8.2%
Site Acreage:	1,069 acres (432.7 hectares)	100. %

SUMMARY AND CONCLUSIONS:

The Green Net Zero Life Energy Style Science Park is capable of being designed today. The architectural and engineering expertise is capable of designing net zero energy facilities. The benefits of this type of science park are: 1) reduced energy consumption, 2) use of renewable energy, 3) development of sustainable a life style, 4) promotion of science / technology education, 5) creation of an environment technology innovation, 6) promotion of technology incubation, 7) reduction of commuting time which can use for family time, 8) reduction of commuting energy use, 9) promotion of a healthy walkable community, 10) enhanced quality of life within an urban environment, 11) improve sustainable water resources, 12 focus on solving international problems, 13) promote distance learning worldwide, and 14) promoting regional economic development. By developing a Green Net Zero Life Energy Style Science Park we can save resources, use renewable energy, promote a healthy lifestyle, promote economic development, and help solve problems worldwide. The countries and regions that promote these science parks will reap the economic benefits and create a better world for the entire population.

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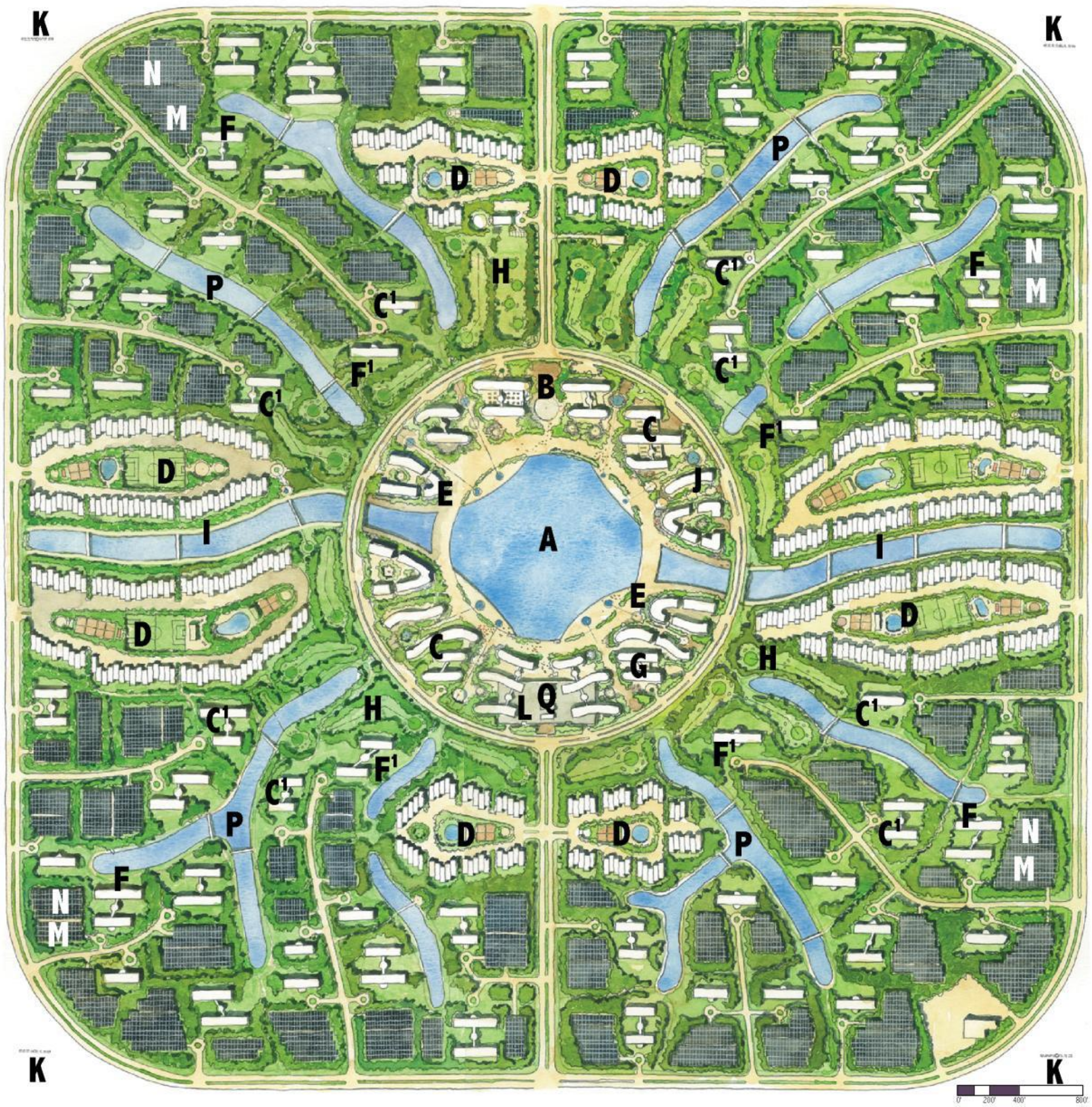
CONTACT INFORMATION:

Bruce McLean Haxton; bmhleedap@gmail.com Telephone: 801-633-3532
Rick Cantwell; cantwellr@odell-intl.com Telephone: 704-401-2050
John Andary; john.andary@stantec.com Telephone: 415-640-4415
Tom Kubala; tkubala@tkwa.com Telephone: 262-377-6039
Fred Meade; fredmeade@gmail.com Telephone: 404-433-7748
Michael Perciali; michaelperciali@aol.com Telephone: 609-851-8525

GREEN NET ZERO ENERGY LIFE STYLE SCIENCE PARK PROTOTYPE DESIGN SITE PLAN



Green Net Zero Energy Life Style Science Park Key

A Village Center / Piazza / Lake
B Village Center Piazza Market Place
C NZE University Buildings
C¹ NZE University Laboratories
D NZE Housing / Recreation
E NZE Restaurants / Cafes / Shops
F NZE Research Laboratories
F¹ NZE Incubator Laboratories
G NZE Hotel / Conference Center
H Golf Course
I Riverwalk
J NZE K-12 School
K Wind Turbine
L Village Central Parking
M Typical Solar Array (over parking)
N Typical Solar Array (ground mount)
P Recreation Water Feature / Water Retention / Cooling Source
Q Microwave Telecommunications

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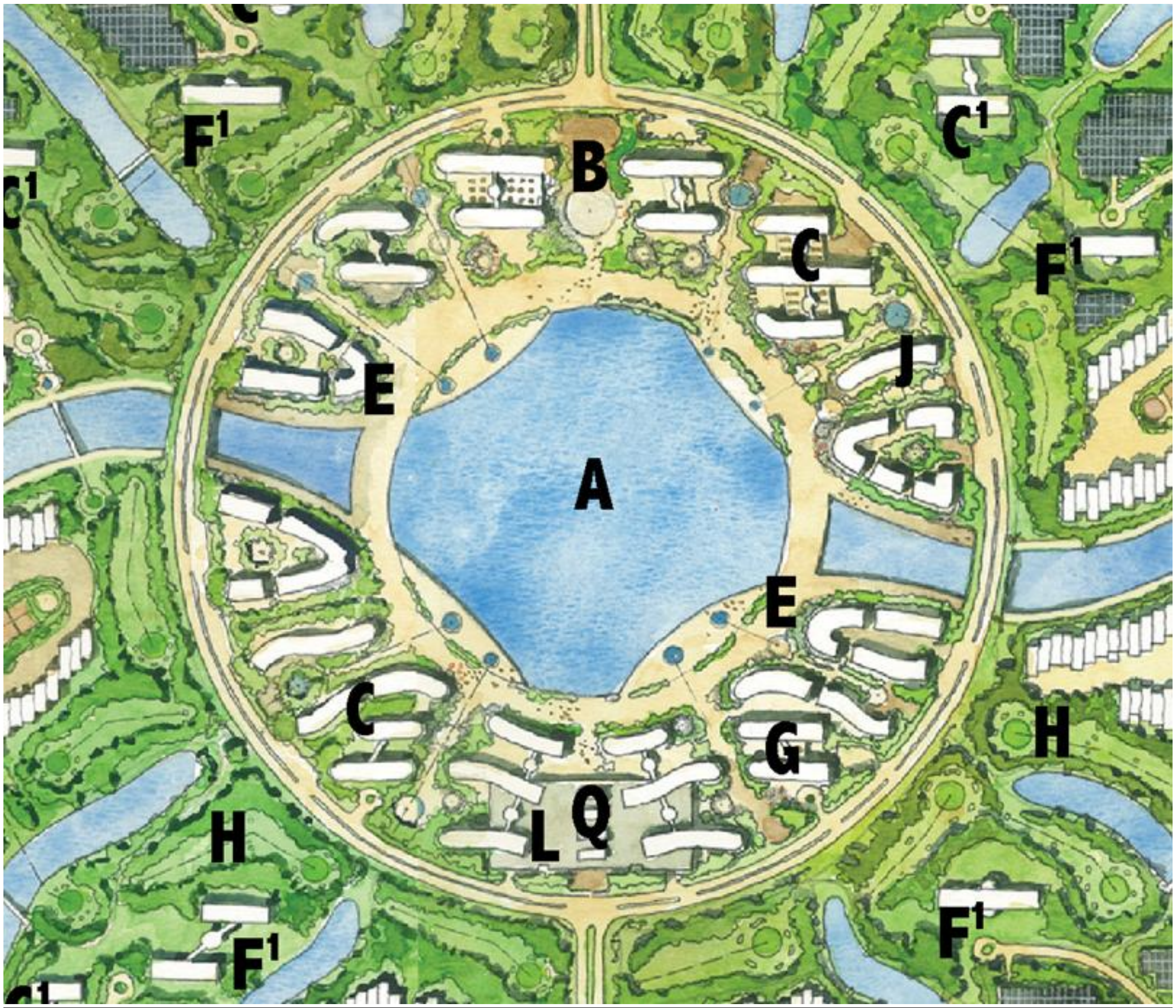
VILLAGE CENTER, UNIVERSITY CAMPUS, AND CENTRAL WATER FEATURE

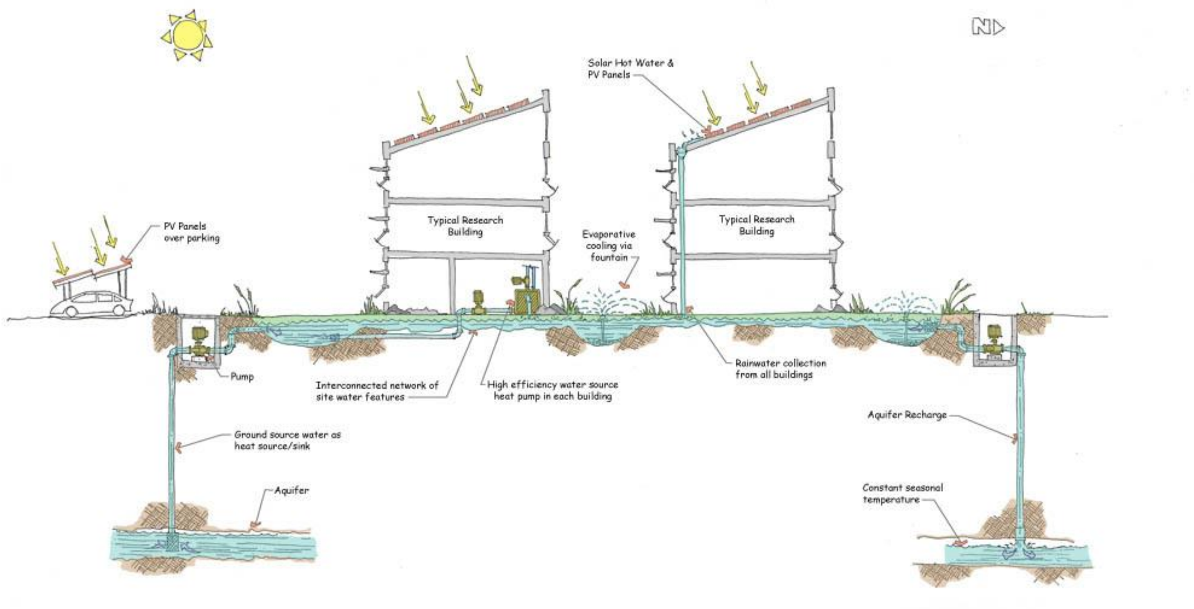


BIRDS-EYE VIEW

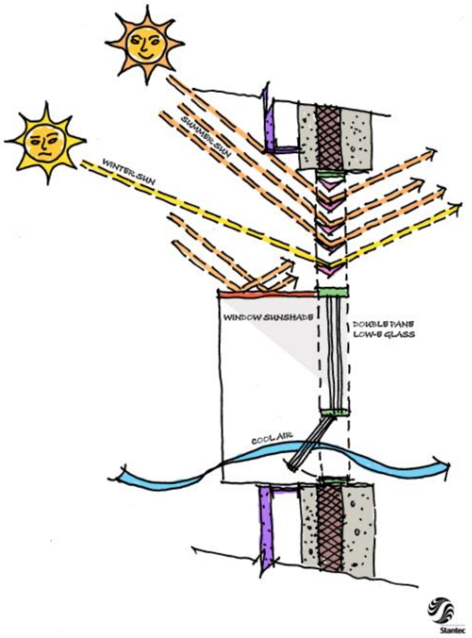
WATER WALKWAY

ENGINEERING SYSTEM CONCEPT SKETCHES

Engineering Water Retention and Cooling Concept:



Exterior Wall Engineering Concept:



Laboratory Atrium Engineering Concept: