



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

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# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### The Challenge: Design A Sustainable City for 200,000 for Chongming Island

The challenge to the IPRO team was to design a city for the westerly portion of Chongming Island that would be sustainable, economically viable and compatible with those parts of the Island that are to be maintained in their natural state or for continued agricultural uses.

#### The Vision: A Sustainable High Tech City for Chongming Island

Chongming Island is the largest alluvial island in the world, situated between the mouth of the Yangtze River, China's mainland, and the Pacific Ocean. It is across a river channel from Shanghai, one of China's largest economic centers. At present, Chongming Island has a rich agrarian culture, protected wetlands. The plan is to develop several small cities on the Island while holding intact its ecological and agricultural ties to nature in hopes that Chongming will remain unsullied by pollution, overpopulation, and urban sprawl. This is a proposal for one such city, designed as a sustainable city that is economically viable and a center for education, innovation, science, technology, ecology, with strong ties to the global economy.

#### Current Energy Crisis

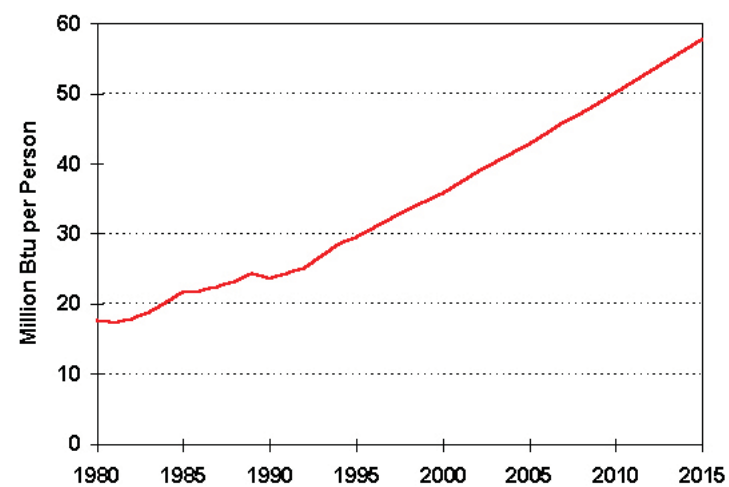
China is currently experiencing one of the most massive rural to urban migrations to date, bringing the ever-looming problems of pollution, productivity, and progress to the forefront of China's plan for the future. This drastic change makes the necessity of a viable solution glaringly salient.

China consumes three times as much energy per dollar of gross domestic product (GDP) as the world average, and twice the average for all developing countries. China's per capita energy consumption has grown from less than 18 million Btu in 1980 to about 31 million Btu in 1996. It is projected to reach 58 million Btu by 2015. A consequence of China's rapid economic growth has been severe environmental pollution, including acid rain, thick smog, toxic waste, water pollution, and carbon emissions. China accounts for about 13% of world carbon emissions, ranking second behind the United States.

A new sustainable strategy must be designed to mitigate the environmental impact China is creating in the world. A sustainable approach to urban planning, transportation systems and housing may help to avert the egregious and growing role of China in the global environment.



Energy Consumption per Capita



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

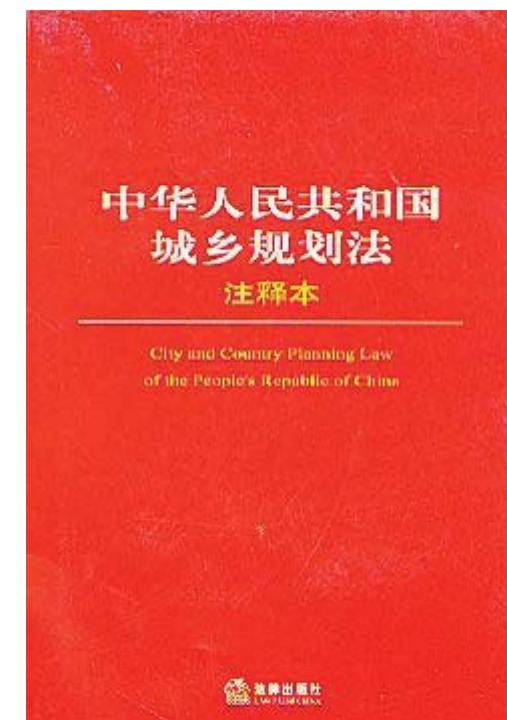
## City Planning in China

Urban and rural planning is getting more attention from the Chinese central government. A new law "The Urban and Rural Planning Law of the People's Republic of China" was adopted at the 30th meeting of the Standing Committee of the Tenth National People's Congress of the People's Republic of China on October 28th, 2007 to substitute the old law "The Urban Planning Law of the People's Republic of China". This new law clarifies some basic principles of urban and rural planning has been promulgated and come into force on January 1st, 2008.

### The basic principles of urban planning

Urban and rural planning shall be worked out and implemented by following the principles of planning the urban and rural areas as a whole, reasonable layout, saving the land, intensive growth and planning before constructing so as to improve ecological environment, enhance the conservation and comprehensive utilization of resources and energy, protect farmland and other natural resource as well as cultural heritages, maintain local features, ethnic features and traditions, prevent pollution and other public nuisance, and satisfy the needs of regional population development, national defense construction, disaster prevention and alleviation, public health and public safety. Construction activities in the planning area shall be conducted by observing laws and regulations governing land management, natural resources and environmental protection, etc. (Urban and Rural Planning Law of the People's Republic of China, Article 4)

The basic contents of urban planning  
The overall planning of a city or town shall include: the overall arrangement for the development of the city or town, functional zones, land use layout, comprehensive traffic system, regions prohibited, restricted from or appropriate for construction and various kinds of special planning, etc. The following contents shall be included in the overall planning of a city or town as mandatory contents: coverage of the planning area, scale of the land used for the construction of the planning area, land used for infrastructure and public service facilities, water head sites and water system, basic farmland, and land used for afforestation, environmental protection, protection of natural and historical cultural heritages, and disaster prevention and alleviation, etc. The planning period of the overall planning of a city or town is usually 20 years. The overall planning of a city shall forecast the long-term development trend of the city and make corresponding arrangements. (Urban and Rural Planning Law of the People's Republic of China, Article 17)



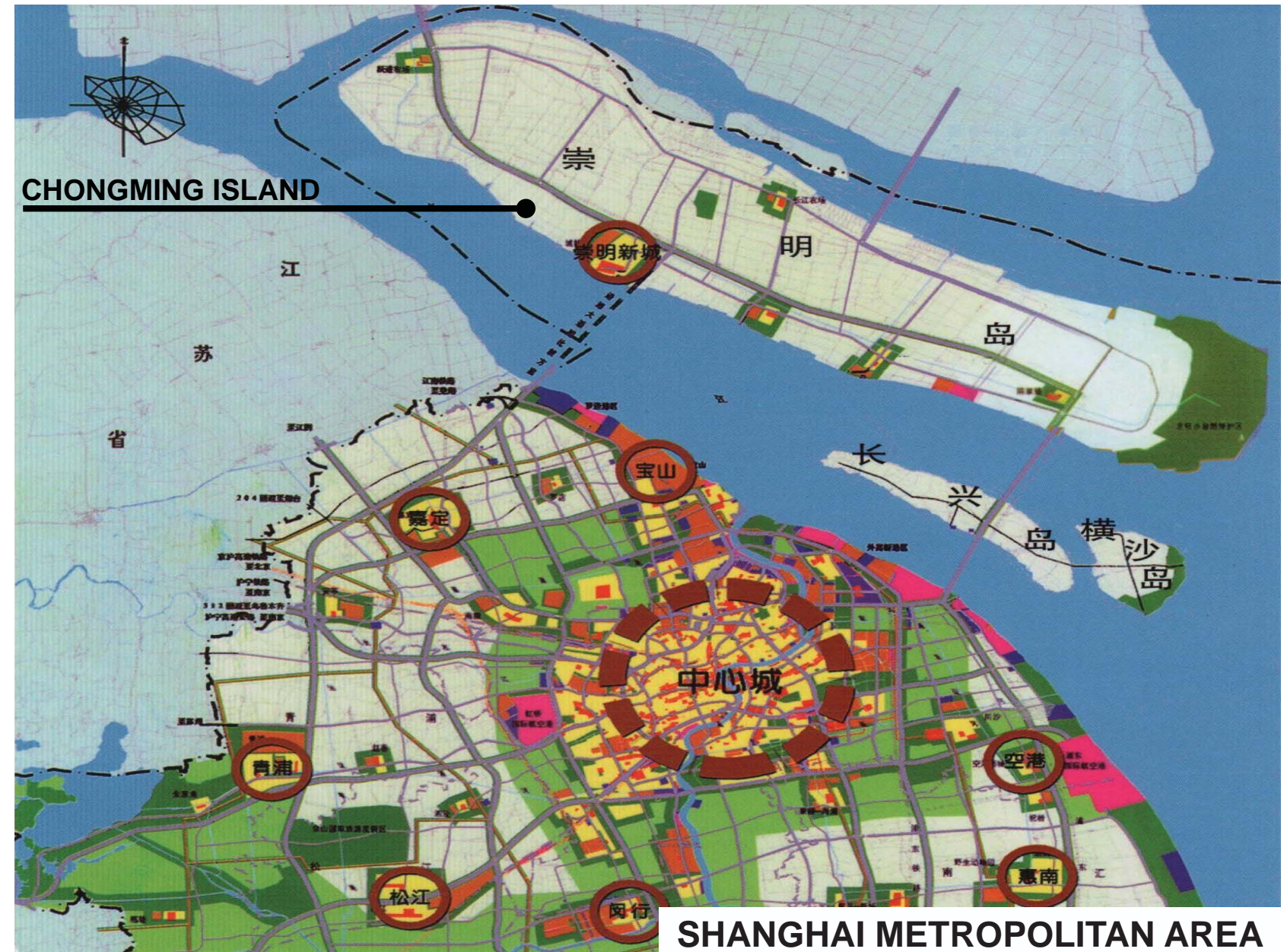
# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Site Analysis | Shanghai: An industrial powerhouse

Because of Shanghai's physical location at the mouth of the Yangtze River, it has had a long history of international intrusions into its economy and culture continuing through WWII. After the war, a strong central government isolated China and the potential of its unique trading position remained dormant. Then, as the Chinese economy began to open up in the early 1980's, Shanghai started an unprecedented urban growth building over 3,000 high-rise buildings within the last 20 years. However, while it has grown rapidly, it has also produced the almost insolvable urban problems of severe pollution, traffic congestion and a construction boom of energy-inefficient high-rise residential and office buildings that now consume twice the energy of more sustainable buildings. Shanghai has a population of over 20 million and has vaulted itself into becoming one of the 16 most significant cities in the new global economy. More important, it now also has the opportunity to learn from its existing urban conditions and assume a leadership role in the development of sustainable new cities in China.

One of the five counties which make up Shanghai is Chongming County, which includes an island located seven miles by ferry across the Yangtze River from the city. Somewhat isolated because of the restrictions of ferry access, the island has remained mostly rural agrarian. With a land area of 750 sq miles and its close proximity to Shanghai it is ripe for urban development. Currently, proposed transportation connections, including a bridge from Shanghai to the south end of the Island as well as additional ferry service as needed, indicate that soon it will be plucked.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

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### Site Analysis | Chongming Island

Formed by the Yangtze River during different historic flood stages, Chongming Island is now the “world's largest alluvial island” that is characterized by its fertile soil conditions of compacted silt. The resulting long tradition of agriculture has kept the land use relatively undeveloped even with the increased daily ferry service to Shanghai and the obvious contrast with its growing prosperity.

In general, land in the northern portion of the island is government owned with large fields of rice and other agricultural products that are farmed with simple mechanization. Farming in the southern part of the island is from smaller leased parcels of land that are still scaled for manual labor and are farmed by individual families with almost no mechanization. Within small rural villages there is an evolving family pattern. The grandparents stay home to farm the small plots and take care of the children. Typically, the parents of the children do not farm and have other jobs to provide financial support.

These long stable generations of being close to the land has instilled firm convictions about the environment. A survey was conducted during a 12-month period from March 2001 to 2002 that involved county government officers, school teachers, local farmers and workers to assess their position on indicators that were related to development strategies for Chongming Island. Ranking number one, two and three were Ecological Protection, Environment Quality and Waste Treatment and Management with Disposable Income per household being a strong fourth. This data was considered a bottom-up endorsement for the sustainable development policies being established by the Shanghai and Chongming County governments.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Site Analysis | An Urban Plan for Chongming Island: Skidmore, Owings and Merrill

As the winner of the Chongming island planning competition, SOM has quickly redefined some key concepts of urban planning. The most notable shift in thinking was implicit in the project, design with sustainable principles in mind first and foremost. The Chongming Island plan was to continue the island's sustainable history while allowing for its development.

The SOM plan focused on six main concepts for sustainable development of the island:

#### - Wilderness and Ecosystems

This principle seeks to maintain the natural ecology of the island. This would allow for the proposed communities to be closely tied to ecosystems. This preservation of the environment would position Chongming Island as a "premier ecological tourist destination."

#### - Organic Farming

Providing an outlet for the direct sale of agricultural product will increase both the quality of life for the farmers already on the island as well as those who decide to move there. The food grown throughout the island is among the highest quality agricultural product available in China. Allowing its continued cultivation is essential in developing a sustainable plan for the island.

#### - Green Systems

The plan focuses on water management as the most important green system to be developed in the scheme. The island's location and geography make water management among the most significant factors in the planning of the island. Proposed systems interior lakes would prevent saltwater intrusion, recharge the water table and help restore the wetlands.

#### - Transportation

The transit strategies for the island rely on creating alternative means of transportation to the automobile. Achieving this means providing "walkable cities" as well as a transit system with greater efficiency than a car. Automobiles will be accepted as a reality on the island and will favor the use of new hybrid and fuel cell technologies. The island would be connected to the mainland via expanded ferry services. It would be interconnected via a rail line running along the south shore of the island as well as a limited set of island streets ensuring access to all parts of the island.

#### - Green Villages

The plan calls for the creation of 40 new farming villages. These villages would focus around the proposed island lake systems and provide farmers with communities to support their needs.

#### - Coastal Cities

The final part of the scheme calls for seven new cities to be planned as fully sustainable showcases of best practices for 21st century urban planning. Each city will be planned to be fully self sufficient and should make use of the waterfront as public use space.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

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### Site Analysis | Pearl City Location

The SOM plan calls for two coastal cities on the westerly half of Chongming Island. The first calls for development around Pearl Lake and the second would lie between the first and Chongming City, halfway along the south coast of the island. Together the population of the proposed cities is about 200,000. Our plan calls for one city of 200,000 to be placed southeast of Pearl Lake, in between the two proposed cities. This allows us to further reinforce the concepts of sustainable planning in three main ways:

- Reduce the area of urban development caused by two separate cities
- Increase the urban density to allow for a light rail transit system
- Preserve the natural ecology of the lake, wetlands and shoreline as well as allow fish farms to remain in operation on the north end of Pearl Lake

The benefits of these concepts are evident in that they will provide space to increase the island's current population by 33% on less than 1% of its land area, eliminate dependency on cars by providing efficient transit, and allow for the continued sustainable environment present on the island today.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Site Analysis | Chongming Island Social Demographics

Chongming County has been a traditionally agricultural society, with historical political roots in favor of this. Currently, we can see the growth rate of the population is declining by 2.4%, per year, probably due to the fact that so many Chinese are moving from rural environments to more urban environments, but if we look at the fact that in 2006 they experienced a birth rate of 5.93% and a death rate of 8.33%, it would appear that they have a relatively large older population, with many newborns occurring as well. This would lead one to assume that while there are a large amount of older people, the population is certainly booming with new additions to their society. By the end of 2006, Chongming had a population hovering around 700,000. The native ethnicities of Chongming inhabitants include a majority of Han, with several other minorities including: Mongolian, Hui, Man, Zhuang, Bai, Yi, Chaoxian, Uyгур, Buyi, Hani, Tujia and Tibetan.

The work force of Chongming can be summarized by the following: by the end of 2006, employees of the whole county amounted to 31,000, including 14,000 enterprise employees, 14,000 employees in various institutions, and 3,000 employees in the governmental organs and organizations. Though training programs to help individuals are becoming more widely used, we can see that most of the current residents are either unemployed or probably working as farm laborers, not to be found in these statistics. The only other viable reason for the low amount of employment rates compared to the total population could be attributed commuters working in Shanghai, though finding accurate statistics on this can be a troubling experience.



1 - <http://www.cmx.gov.cn/cmwebnew/node2/node21/node22/userobject1ai9741.html>

2 - <http://www.cmx.gov.cn/cmwebnew/node2/node21/node22/userobject1ai9745.html>



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Site Analysis



#### Island Geography

Chongming Island (located at 31°39'43"N 121°28'41"E) and is growing at a rate of 150 meters every year toward the East China Sea. This is a result of the sedimentation at Yangtze River the river delta. The level of grade on most of the island is plus or minus 4 meters.

#### Climate

The annual mean air temperature between 1959 and 1986 was approximately 15.3 °C. The coldest month was January, with a mean temperature of 2.7 °C, while the hottest month is August, with a mean temperature of 27.6 °C. The average annual precipitation, from 1987 to 1990, was around 1022mm; 70% of all the rainfall was experienced during the months of April to September.

#### Irregular Tides

Chongming Island also undergoes irregular semi-diurnal tides. The maximum tidal range was from 4.62-5.95 meters, while the average tidal range was from 1.96-3.08 meters.

#### Soil Conditions

The soil salinity range is from 2-6%; the soil consists primarily of sand (higher concentration when approaching sea). The presence of silt and clay is higher where sand content is lower. The wetland has an inclination of less than 1%.

#### Wind Rose Diagrams

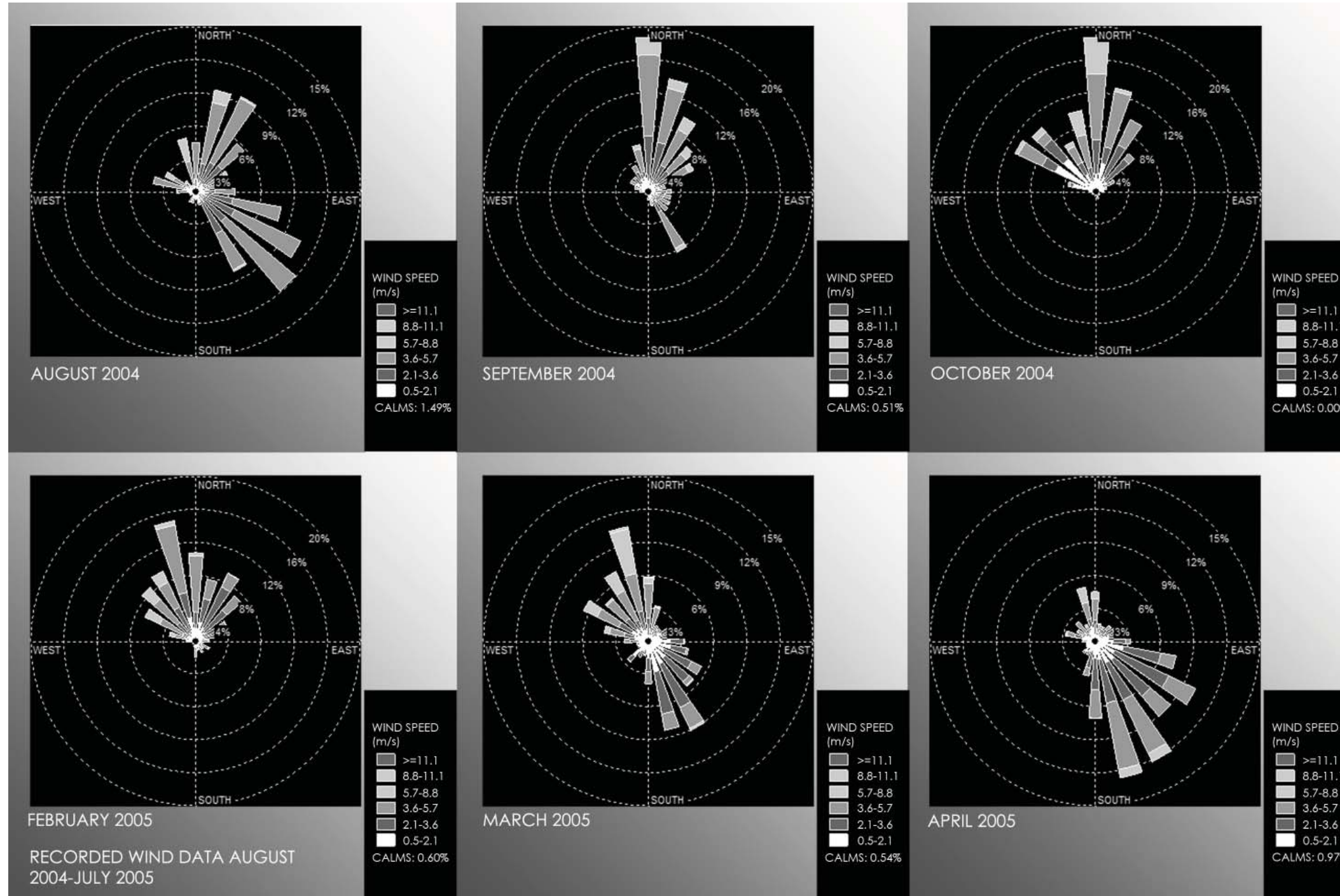
The information presented on the following pages was gathered in 2005 on Chongming Island. Although the height of the device through which this data was acquired was only 5 meters, the data represents the most detailed description of wind patterns available. This data was gathered at 30 min intervals and monthly averages were derived from these.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

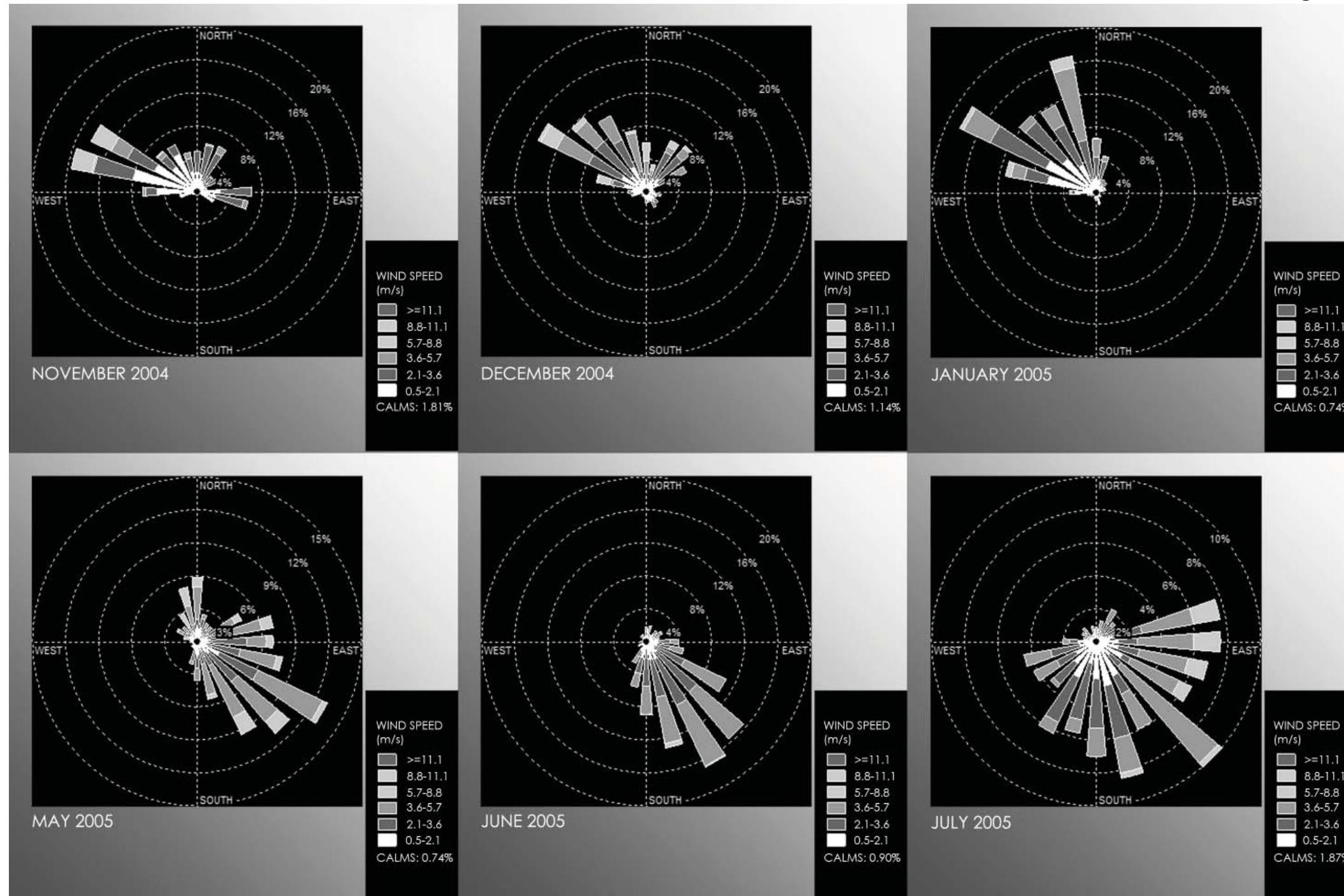
## CHONGMING ISLAND, CHINA

### Site Analysis | Wind Data



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Site Analysis | Wind Data



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Culture | Existing Cultural Heritage and Facilities

#### Cultural Heritage

Chongming Island has a long history of culture with valuable cultural heritages. The five most famous culture heritages are:

- The Peony Pavilion - a traditional Chinese opera
- Yingzhou lute music
- The Shoulder Pole Play - so named because all of the instruments and materials involved in the performance can be packed onto one shoulder pole. The result is a traveling performance put on by a single performer
- Chongming Zaohua - a tradition of painting of flowers on the wall behind the cooking oven throughout the countryside
- Chongming weather forecast proverbs

These heritages are recognized by Shanghai as well as the United Nations. ([www.tocm.cn](http://www.tocm.cn))



#### Public Culture Facilities

The main public culture facilities on Chongming Island include:

- Chongming Cultural Palace (total area 60,000 SF) featuring a playhouse, showroom, dry run room, instrument music room, ball room, karaoke room, card room, classrooms, and meeting rooms
- Chongming Library (total area 75,000 SF) featuring 430,000 books and public reading room
- Chongming Theater, a 1300 seat auditorium
- 14 culture centers (total area 80,000 SF) including 18,600 books and public space
- 21 culture auditoriums with 30 sets of cine-projector

([www.cmx.gov.cn](http://www.cmx.gov.cn))



#### Various Culture Activities

Cultural cause has gained new achievements and colorful cultural lives have provided spiritual food for people on the island. In 2006, successful efforts have been made to launch "9th Culture and Arts Festival" and "River and Sea Flavors" theatrical festivals, "Youth Singer Contests" on the Island, "Art Works Exhibition for Mainland China, Hong Kong and Taiwan", "Exhibition of Works of Huang Pimo from His Six Decades of Engagement in Arts", and "The 2nd Zaohua Contest." Theatrical performances on the Every Week Performance Square have amounted to over 1000. At the same time, "Hundred, Thousand and Ten Thousand" project for promoting culture to the countryside had been conducted and over the course of the year there were some 850 theatrical performances, attracting 4.5 million people. A thousand movies went to the countryside and their audience has reached over 1.15 million people. Tens of thousands of books have been gifted to the countryside, enriching the people's cultural and amusement life. Broadcast television and newspaper media have fully exert the publicity and guidance function of media by focusing on publicity of construction goal of Chongming Ecological Island Area, practice of functional orientation in the three islands, new suburban area and new rural area construction, construction of harmonious society, etc. In 2006, Chongming People Broadcasting and TV Station broadcast for a total of 3376.2 hours and 4380 pieces of news. Chongming TV broadcast a total of 3946.4 hours and 2593 pieces of news. The project of cable TV in every household has been gradually promoted. In the whole year, newly increased TV user terminals amounted to 5142 households and by the year-end the terminal users amounted to 64,000 households. ([www.cmx.gov.cn](http://www.cmx.gov.cn))

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Culture | The Problems and their Solutions

### Main problems

Due to the agriculture nature and the underdeveloped status of the economy, there is hardly any culture industry on the island. Only several Karaoke rooms, card rooms and billiards rooms have been established using office space. Currently the development of culture on the island mainly depends on the support of government. But in 2007, the townships' budget for culture use averaged only 0.5-0.9% of the whole budget expense which even falls behind the required ratio for Shanghai of 1%. As a result, the lack of governmental budget appropriation has led to the underdevelopment of culture industry on the island. The average area of culture facilities per capita is only 0.068 sq.m./person. Some cultural workers have given up their work citing low wages. Townships are facing the problems of personnel shortages and inadequate facilities, which make culture events at the township level impossible. Some treasured traditional culture forms are at the edge of extinction due to lack of funding. ([www.cmx.gov.cn](http://www.cmx.gov.cn))



In the long run, the sustainable development of a city depends on the continuous creativity and productivity of the human beings in that city.

### Culture characteristic

The whole city will be made a showcase of sustainable development in order to display a sustainable way of living, working, and entertaining. By showing related concepts, technologies, materials, and designs to the world, we can show how sustainability can be achieved. "Since culture represents a crucial means of self-definition, providing individuals with traditions and continuity with the past, cultural policies worldwide should aim at providing the maximum opportunities for all people, encouraging ethnic, cultural and individual diversity." (Cristina Losito, Culture and Development: A New Paradigm) We are aiming at attracting creative people for our economic development, so we must allow and encourage the coexistence and blending of different ethnic cultures. Respect of different lifestyles and traditions will be the norm. The city will be made open and free to any thoughts or ideas within the framework of relative laws. Popular and exquisite culture will be made equally available to ensure the comprehensive development of all people and to provide sustainable drive for the city's development.

### New Cultural Facilities

To satisfy the needs of 200,000+ people, our city will require a multifunctional theater, a major library system and a performing arts center. Additional culture sites will be placed within each of the city's neighborhoods to satisfy cultural needs at a more local level.

### Economic Strategy

Sports games, entertainment contests, and art-work exhibits can all be sponsored by interested enterprises. In return, the enterprise can advertise its own product and service to the audience to enhance their overall awareness. Tickets can serve as a regular income resource of culture events and culture tourism. Organizations or individuals may offer their donations to help with the development of art forms they are interested in. This framework of charity and non-for-profit organizations can support many different art forms. Government subsidies can be given to support the art form that is on the edge of dying out or to provide special culture service to low-income audiences. Grants can be given to organizations or individuals who have made great achievement to the development of culture.

### Development methods

Facility spaces will be designed with multiple purposes in mind. For example, to reduce cost the library hall can also be used to hold exhibitions. Income from enterprise sponsors can be used to cover operational expenses of large scale cultural events. Established government subsidized organizations can provide financial aid and consultative services to help promising culture companies.

### Regulation and Control

Local media may give free or reduced ad fees for public culture events in effort to boost awareness. All outdoor enterprise ads may contain a certain percentage of public ads, especially about sustainable development.

# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Enticing the Elusive Creative Class

A viable city needs an economic base capable of generating income sufficient to support its population. The Island context is not conducive to manufacturing, but its location across a river channel from Shanghai is conducive to an economy based on innovation and high tech development. This type of economy requires a place that will attract workers who are creative and innovative. The new city must not be one dimensional in its aim, but must encompass all aspects of largely creative centers. Creativity be thought of as the engine that drives economic growth (Florida p. 27). In American high-tech creative cities, around 30% of work is done in the creative sector. In denoting a sector as creative one means fields involving science, technology, engineering, info-tech, bio-tech, arts, music, culture, design, architecture, urban design, landscape architecture, and the knowledge based professions: law, health care, and finance (Florida p. 25). The challenge is to design a city while avoiding a division between the 30% of the workers doing creative work and the other 70% of the work force that are not in the creative sector. This may be accomplished by offering services such as education, health care, housing, and other social services that are equally available in quality and accessibility.

By building a climate that is conducive to creativity, that attracts and mobilizes people, one does not need to look much farther than their own back yard. Creativity comes from people, not just the elite upper echelon, but from all people, from all backgrounds, from all ethnicities (Florida p. 27). Creativity is blind. It doesn't distinguish between class, race, and sexual orientation.

"Every single human has creative potential. Every single human being is creative" (Florida p.27). In realizing this it may not be as necessary to draw the top talent. While I am not diminishing the capabilities of talented people, they are important to a burgeoning high-tech city, it may be more important to provide support systems that create and tap into the abilities of the local people.

Moreover, people who would potentially be drawn to a new city are not looking purely for work. They are looking for a place to live. People want history, they want culture, and they want to feel at home. "What people are searching for is the ability to connect the dots of technology, culture, society, economy, and build a truly creative world in which each and every human being can maximize their potential" (Florida p.37). People want communities where they can live and build an identity, friendships, associate-ships, and be around families (Florida p. 31). Ideas and innovations are obviously the answer to economic growth.

"But in a global environment where growth relies on cultural, entrepreneurial, civic, scientific, and artistic creativity, openness to new ideas and to new people becomes especially crucial. Places that are open to immigration, to alternative lifestyles, to thinking outside the confines of social status and power structures will benefit enormously in the creative age. This is one of the hardest things for places that are stuck in more traditional or industrial age mindsets to deal with, but it's a new set of economic and social rules and realities that they'll have to confront unless they want to get swept away by the global economy." (Florida p. 37)

What our city should be looking to accomplish is harnessing the creative potential of people living in Chongming and attracting others to do creative work for Chinese and multi-national corporations that will be attracted to the City. Ideally, the City will provide access to political and social structures for everyone, not just the privileged. It will have a fine school system providing superior education, not just in math and science, which are exceptionally important, but also in language, culture, and the arts (Florida p.38). "That's how to build a real and sustainable society, from the ground up, organically, sometimes over long periods of time. Do that and the elusive global creative class that everyone wants to attract – and for good reason – will see a genuine and inspiring place and want to live there" (Florida p.38).



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA



## Transportation | An Overview

Efficient transportation is critical to the functioning of a city. Modern cities rely on cars which cause congestion. This wastes time and energy and the resulting pollution is a public health problem. A sustainable city must have a better way to move people. Pearl City's transportation will cover five areas; rail, bikes, roads and cars, parking, and walking.

### Light Rail

Light rail transportation will be the main form of transportation interconnecting the city. It is quick, efficient, and has a large capacity. Trains will travel in a two track loop allowing for the most efficient method of travel in the city.

Light rail systems are often added after a city is built and do not always effectively link areas of the city. The rail system here is used as a driver for the planning of the city. This offers the ability to plan for access to public transit from all areas of the city, to all areas of the city.

### Bikes

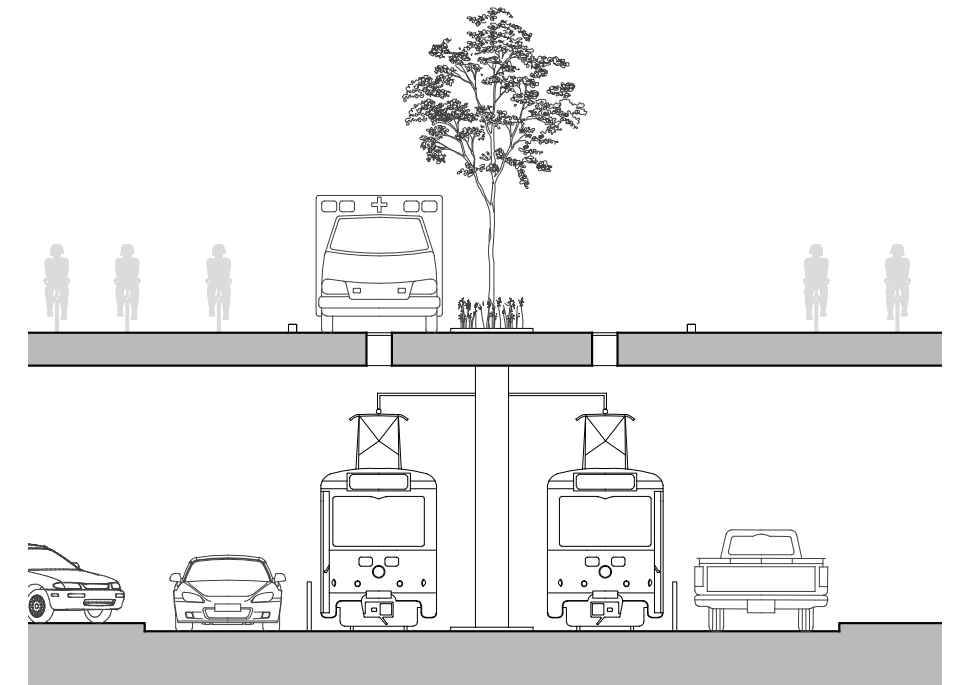
Bikes are an ideal form of transportation. They are non-polluting, efficient, take up little space, and are faster than walking. Pearl City will embrace bikes. Within every neighborhood, car-free streets will give plenty of space for residents to ride their bikes. All roads will provide ample space for bike traffic. Additionally, there will be an expansive series of interconnected paths running between neighborhood units, offering exercise and scenic views of both the coast and the natural ecosystems which will frame the neighborhood units.

### Roads and Cars

In most cities, roads and the entire transportation system are designed for cars. Pearl City will be different. Due to walking distances and the light rail system, citizens will not need to rely on cars for everyday use. The city is planned on a concept of two layers. On the upper level of the city there will be narrow roads designed primarily for pedestrian traffic and bikes. Emergency vehicles will be able to use these roads. The lower level of the city will feature wider roads designed to guide cars through the city without disrupting the more park like landscape of the elevated level. These roads are intended for deliveries, emergency vehicles, and to allow residents to move their cars to and from parking.

### Parking

Parking will be important for discouraging the use of cars. There will be no surface parking, nor any individual spaces along the sides of roads. These only serve to encourage wasteful short trips. Instead, parking will be concentrated in parking lots located on the ground level. Lots will be adjacent to the residential buildings which they serve. Putting vehicles on the lower level offers a variety of advantages: it protects them from weather; ensures that parking lots do not pervade the urban landscape damaging the appearance of what is to be a sustainable city; and most importantly, allows for park land where there would otherwise be vast areas of exposed pavement that helps contribute to the urban heat island effect.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Transportation | Light Rail Transit Details

The manufacturer chosen to provide the LRT transportation system for the city is Alstom. Alstom is a transit service provider headquartered in France. Having a global presence in over 70 countries Alstom is a leader in the manufacture and design of numerous recognized transportation systems.

The choice of this company is due to their innovative product line and commitment to sustainable and environmental solutions. The train style that we have chosen is the Citadel version of the train. A highly modular system, this system is able to run on their INNO-RAIL technology. This eliminates the need of overhead wires enabling portions of electric lines to reside safely underground providing both aesthetics and energy savings. These sections can be placed within the town center eliminating the necessity for overhead power.

These trains are also enabled to utilize Alstom's flywheel system storing energy during transit to provide energy storage of 4kWh and 325 kW of peak power. This is captured during the vehicle braking and can be used to provide energy on the sections of track that are powered underground and limiting the amount of overhead wires necessary to power the system in between population centers.

This system was also chosen for its modularity. The trains are available in 20/30/40 meter lengths and can carry between 145 to 302 passengers.





# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Transportation | Connecting to the mainland

Currently, Chongming Island is quite disconnected from the mainland. In order to make development a possibility, two methods of connections must be added to increase efficiency of travel to Shanghai. To get to the island now, limited ferry service is the only option. To alleviate this problem a proposed bridge is being constructed to allow for constant vehicular traffic to and from Chongming. The bridge will make landfall on the island's east end. Our city placement on the west end of the island allows for both automobile connection as well as segregation from heavy traffic a bridge will perpetuate.

### Direct Hydrofoil Service

Since our city will not be in relative close proximity to our city, we will also provide additional ferry service straight to Pearl City. This service will make use of state of the art hydrofoil ferries which are much faster than typical ferry systems. This service will be predominantly for business and professional class travelers so speed and comfort are important. Hydrofoils provide a benefit to the heavy traffic waterways around Shanghai by creating less of a wake. This is important because of Shanghai's shipping industry places heavy needs on the Yangtze. Ferries crossing this shipping route must be able to navigate the freighters in order to provide expanded service to our city. Hydrofoil boats also operate with lower engine emissions. This makes them a far more sustainable choice. Additionally, they also offer a reduced fuel consumption of approximately 30% when compared to traditional diesel powered sea vessels.



Proposed Connections from Shanghai to Chongming Island



Proposed Chongming Bridge  
Image courtesy <http://www.geocities.com/charliecguo/bridge.html>



Typical Hydrofoil Ferry Service

# DESIGN OF A SUSTAINABLE CITY IN CHINA

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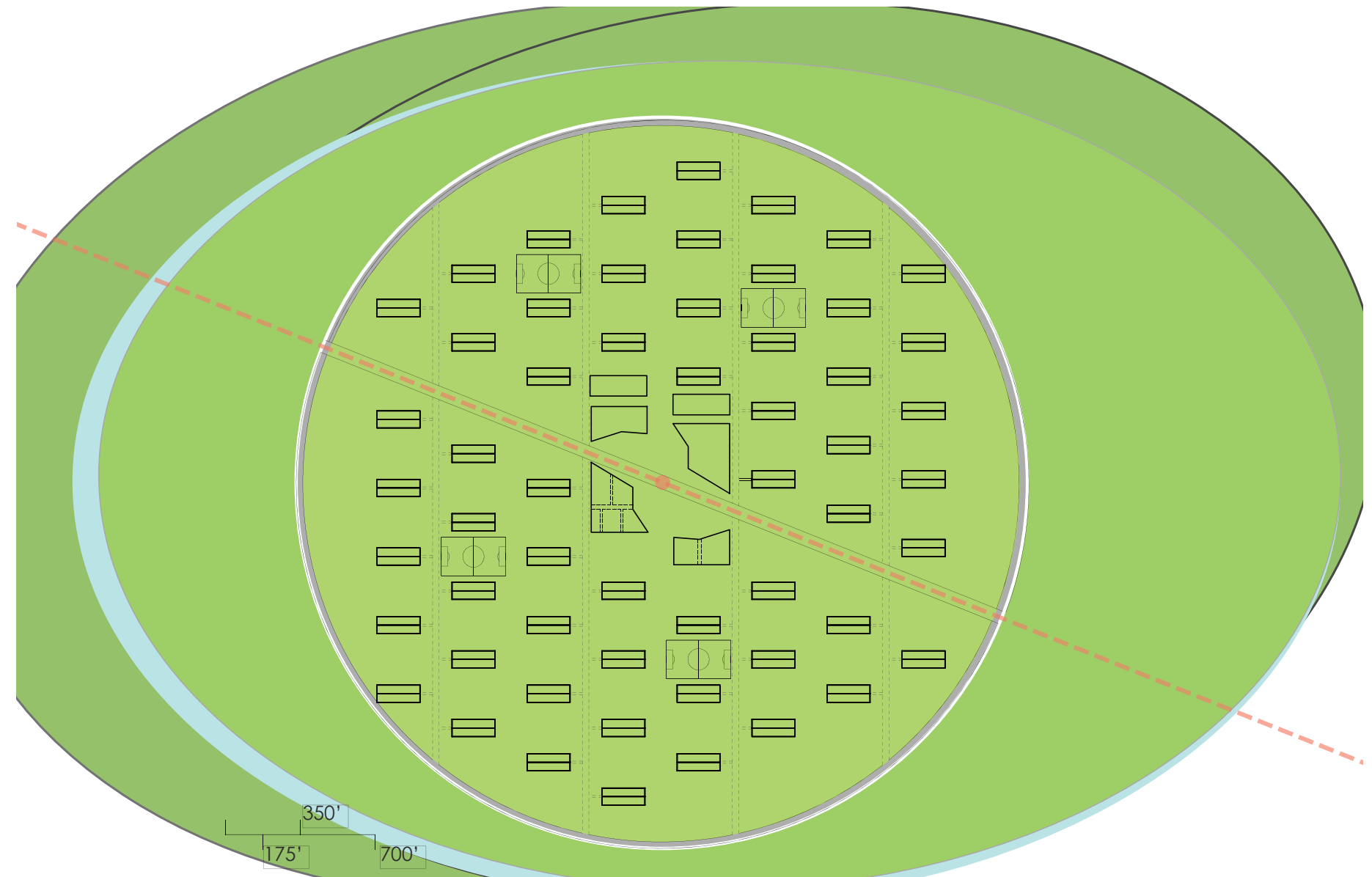
### The Urban Village | A Neighborhood of Neighborhoods

The effort to produce a sustainable city must arise from its planning. One of the key issues in developing a city is the fact that the way in which people and goods move around urban areas determines their structure and how they function. Typical city planning today is car-centric. We rely on the automobile to get us to goods, work, and school. This has allowed for lower density development and led to massive urban sprawl. It would devastate the ecology of the island were development to lead to massive urban sprawl and the destruction of hundreds of square miles of natural habitat and sustainable agriculture. To design a sustainable city we must think about a sustainable structure for our city. Creating a strong relationship with the surrounding farm villages is essential to the success of the city. Minimizing the area footprint of our city allows for reduced impact on the land so that the city becomes a boon for island.

#### Urban Village

The principle concept in the planning of our city is the urban village. The urban village provides a fundamental building-block in creating a sustainable urban form. Each is focused around a local center and is limited in size to become a walkable community. A walkable community is defined by its quality of pedestrian access to most of the facilities and services needed for daily living. These units need to be of a sustainable density for the plan to work. This we approximate at 30,000 people per neighborhood. We based the size of the neighborhoods off a maximum five minute walk to and from the neighborhood center and a light rail transit node. To achieve our desired density, high rise living was the only option. High rise living offers the additional opportunity of truly maximizing green space throughout the city.

Urban Planning and Design, Patrick Clarke

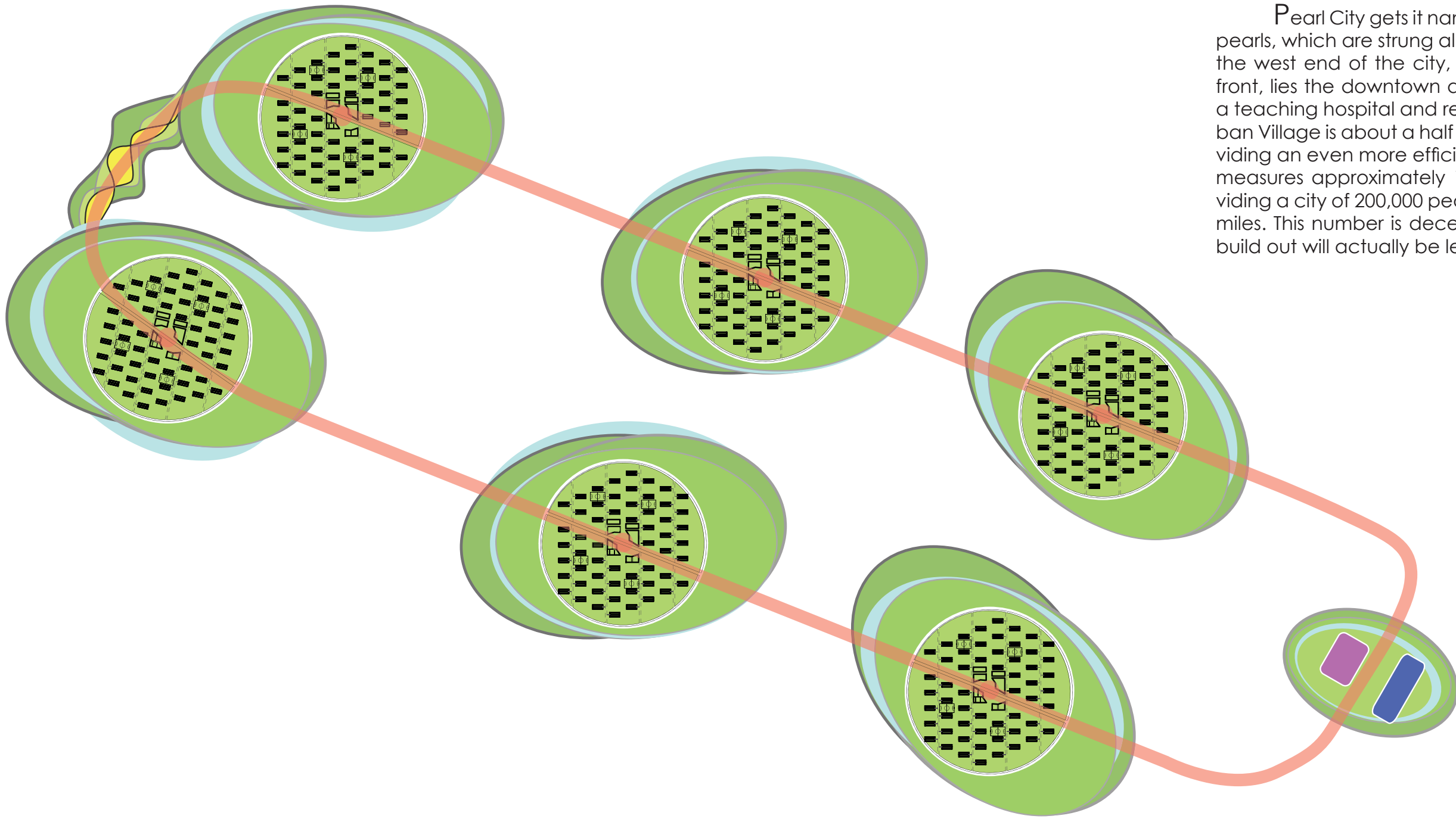


TYPICAL URBAN VILLAGE SITE PLAN

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Pearl City Concept

Pearl City gets its name from the urban villages, pearls, which are strung along our light rail system. At the west end of the city, along Pearl Lake's waterfront, lies the downtown district. To the east end lies a teaching hospital and research university. Each Urban Village is about a half mile from its neighbor, providing an even more efficient transit system. The city measures approximately 1.5 miles by 3.5 miles. Providing a city of 200,000 people on less than six square miles. This number is deceiving however, as our city build out will actually be less than 2 square miles.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### City Program

#### Housing

CITY POPULATION: 200,000      AVG. DENSITY: 2.7 RESIDENT/UNIT  
60% OF RESIDENTS ARE IN A FAMILY

UNIT TYPE	NUMBER (%)	UNITS	AVG SIZE (SF)
3 BEDROOM UNIT	15	9,990	1,000
2 BEDROOM UNIT	70	46,620	900
1 BEDROOM UNIT	10	6,660	700
STUDIO UNIT	5	3,360	400

#### Schools

TYPE	AGE	NUMBER	POPULATION	AREA/CHILD (SF)	GROSS AREA (SF)
KINDERGARTEN	3 - 6	60	100	16	1,600
PRIMARY	6 - 12	6	2,000	22	44,000
JUNIOR HIGH	12 - 15	6	1,000	22	22,000
SENIOR HIGH	16 - 19	6	1,000	22	22,000

#### Cultural Center

The cultural center serves as a public space for social interaction. These center are very similar to what Americans would call a community center. In fact, it serves essentially the same purpose, but more emphasis is placed on these cultural center as they also serve to replace, in some regards, places of worship. Our city would use these centers as community anchors for the development of neighborhood centers at each transit node. Each center would have an open hall space, a small branch of the citywide library system, a branch of the city government, as well as meeting rooms open for small groups. The city downtown will have a larger cultural center which will serve as the main library, government center and performing arts center.

#### Commercial

The city will have commercial and retail space both distributed in each neighborhood as well as focused at the city downtown. In each neighborhood there will a minimum of 200,000 square feet of mixed use commercial space including both retail and office uses. Daily goods, such as a grocery and pharmacy, should be included at each neighborhood center so that everything one would need in a day is within walking distance. Additionally, each neighborhood would have office space to provide residents live-work opportunities. The city downtown would feature a full service shopping center, entertainment center, as well as the city's main business center. Combined, the shopping and entertainment centers would be about 1 million square feet. The business center would have four office buildings each of approximately 50,000 square feet for a total of 200,000 square feet. Additional commercial space will be provided for disbursed throughout the city in the form of technology and research incubator space for developing companies.

#### Government

##### Administration

While a strong central city government would be in place in the city downtown, many of the services it offers will be available in each neighborhood. Each village will have its own branch of the government which will also offer typical necessary services. Distributing the city government allows for closer attachment to the people of the city. It also helps keep the size of our city's downtown down.

##### Medical services

The main medical service provided in the city will be a teaching hospital at the east end of the city. Additional medical clinics and triage units will be provided for each neighborhood. Since residents will not always have direct access to cars, distributed clinics will reduce the resultant demand on emergency services.

##### Emergency Services

Emergency services will be provided for in each neighborhood. There will be a police stations in the center of each neighborhood. Fire Stations will be placed between neighborhoods as demand dictates service for two villages per unit. Neighborhood top level roads would easily permit access for all emergency vehicles and will be the only motorized vehicles permitted on the elevate city layer.



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## City Program

### Urban Amenities Eco-Tourism

One unique aspect of our city is its sustainable status. This allows us the opportunity to add a convention center and four hotels to go with it. The convention center will allow for conventions, exhibitions, as well as performing arts as it will have both large hall space and a 1,000+ seat auditorium. Both the hotels and the convention center will be placed within walking distance to the city downtown.

### Transit Hub

A transit hub will also be at the west end of the city near water access to best connect Pearl City with the rest of the Island as well as Shanghai. New hydrofoil service will provide a direct link to Shanghai, while a rail line along the south shore of the island connects all of the new cities which will dot its coast. Interconnectedness is essential for our city to deter our city's guests from even thinking about bringing a car.

### Teaching Hospital

An 800 bed teaching hospital will be at the west end of the city. This hospital will serve the entire westerly half of Chongming Island, including Chongming City. It will have the most advanced medical systems available including CT and MRI technologies.

### Research University

As part of a larger university, our graduate university will have a population of 6,000. Studies will expand current work with agriculture processes, but will focus on augmenting the rich research and development technology industry present in Pearl City. Together with the teaching hospital, the research university creates a smaller neighborhood which will be separated from the rest of the city to the west, but remain efficiently accessible via connection to the city's light rail transit system.

### Urban Open Space

High rise living options afford our city an unprecedented amount of urban open space. Our vision for much of this space is landscaped park. A place where Children can play safely and residents can feel close to the natural environment. This open space also presents the opportunity of giving each neighborhood its own unique texture.

### Urban Open Space

Our compact city creates the opportunity to reconnect the city to its environment as well as its rural feel. Between the urban villages large areas of preserved wetlands habitat and organic farming will continue to their sustainable operation. City pedways and bikeways will travel through these urban spaces providing an ever closer connection for the city's 200,000 inhabitants and its eco-tourists.

### Power Generation

Power for our city will be provided from both a wind farm, north of the city, and an underwater current farm south of the city. The wind farm will have an area under 9 square miles and will coexist with the current agrarian society. Energy will also be provided by a new technology similar to a wind farm, but located under water and powered by water currents.

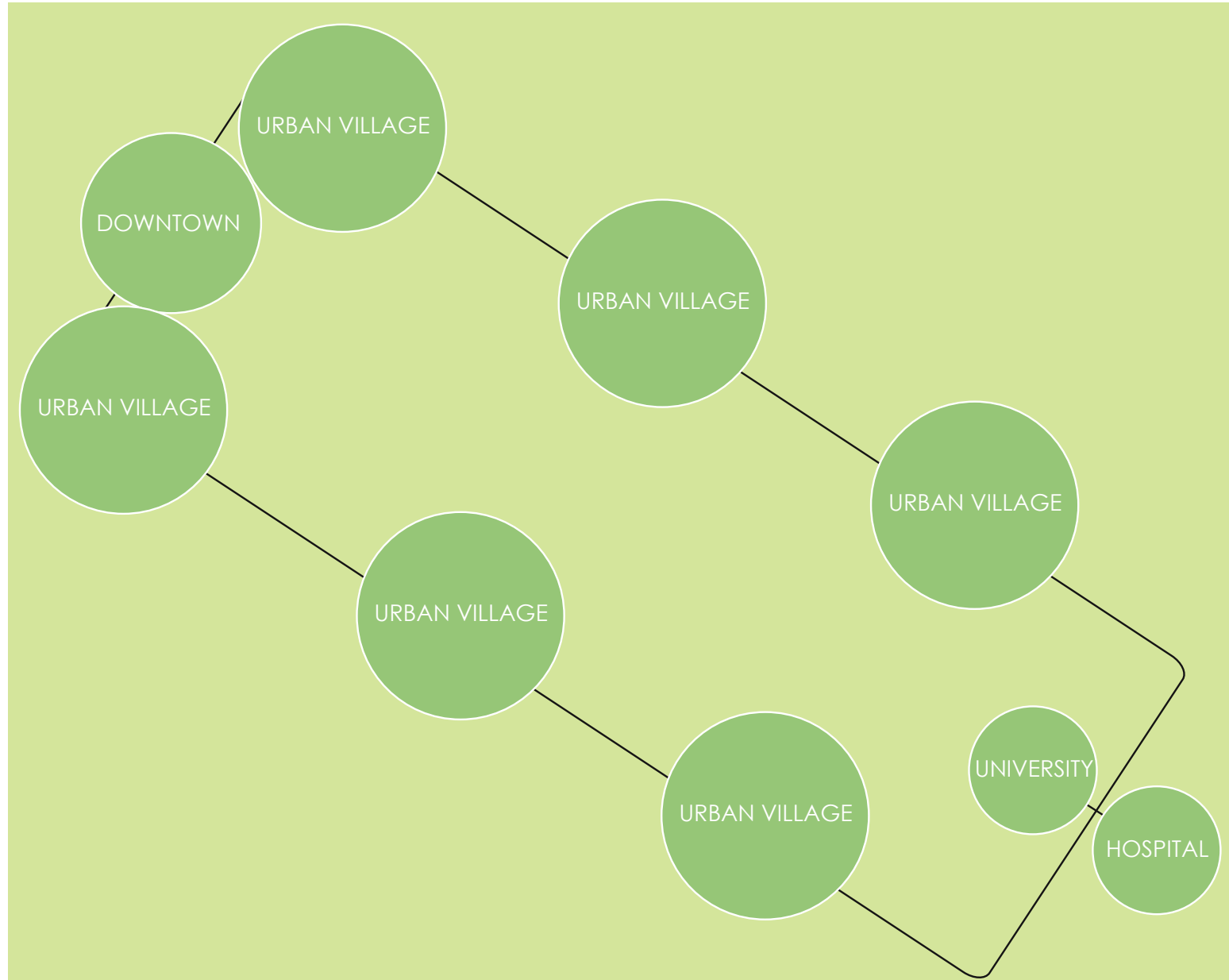
### Waste Management

Waste management will be provided from in close proximity to the city. Care will be taken to use the most sustainable technologies available and to protect the surrounding ecology. One concern is the high level of the water table and its contamination. Additional energy will be supplied by the city landfill operation via landfill gas collection and on site direct energy generation. The energy supplied by the landfill will help reduce the need for nonrenewable energy

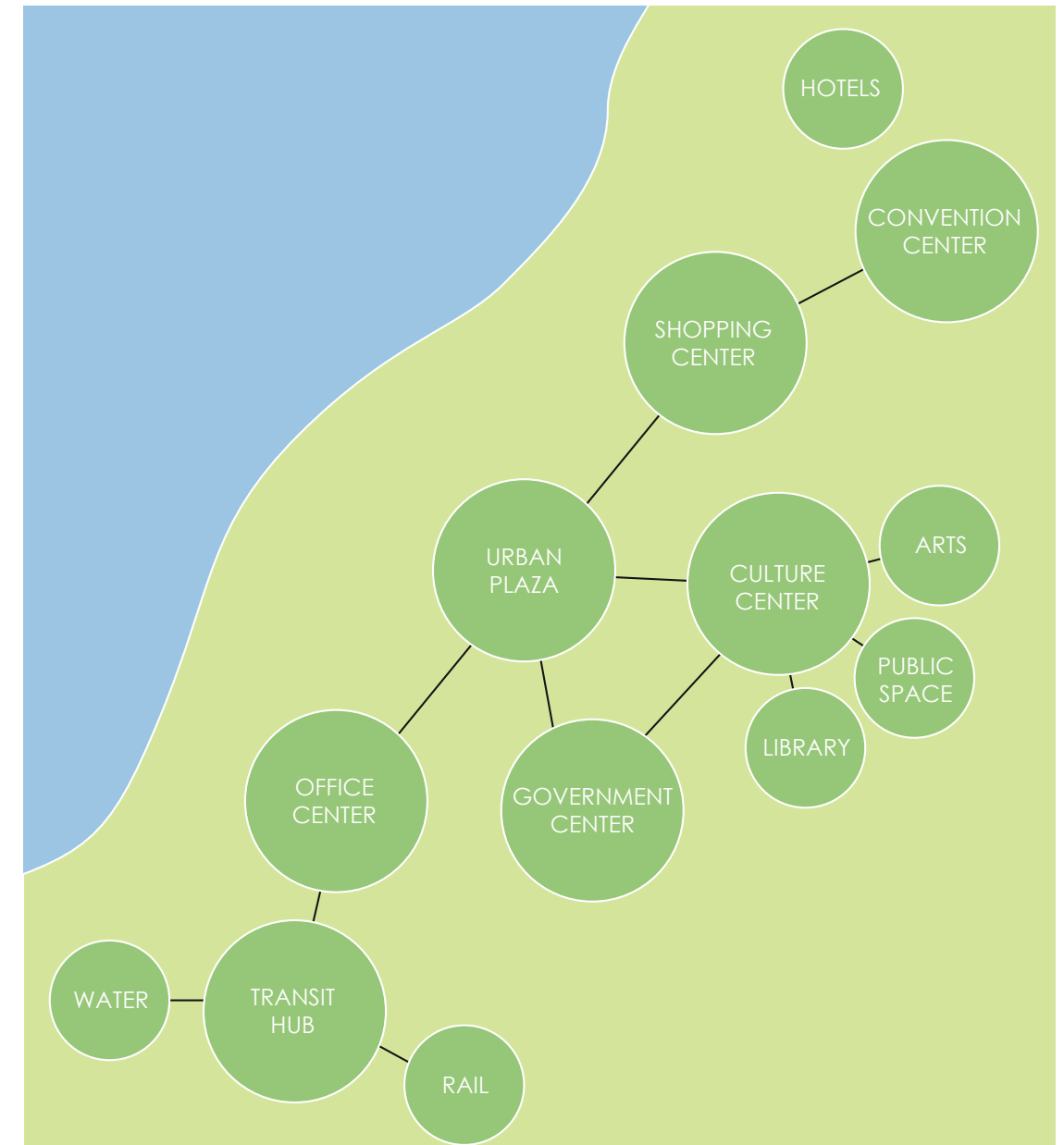
# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### City Program | Schematic Layouts



City Organization

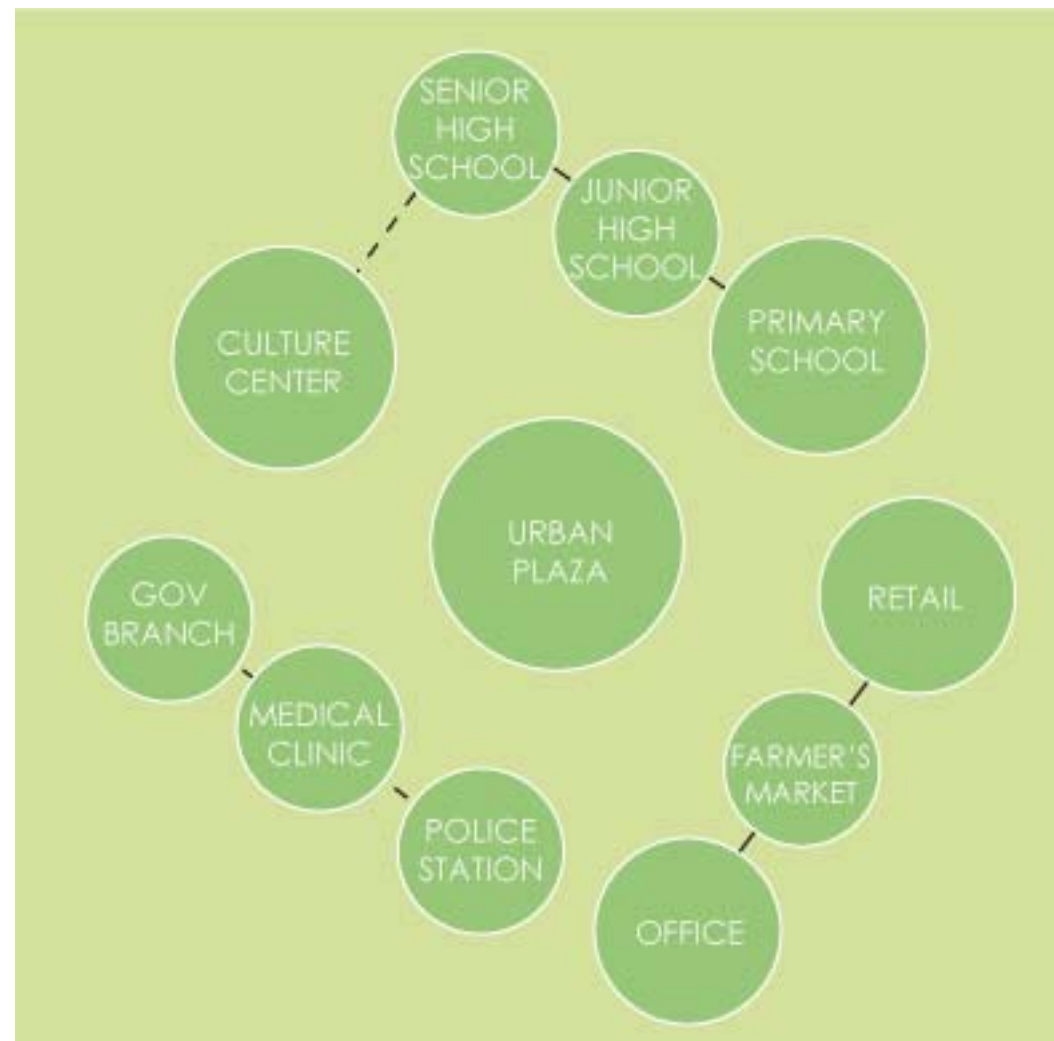


City Downtown

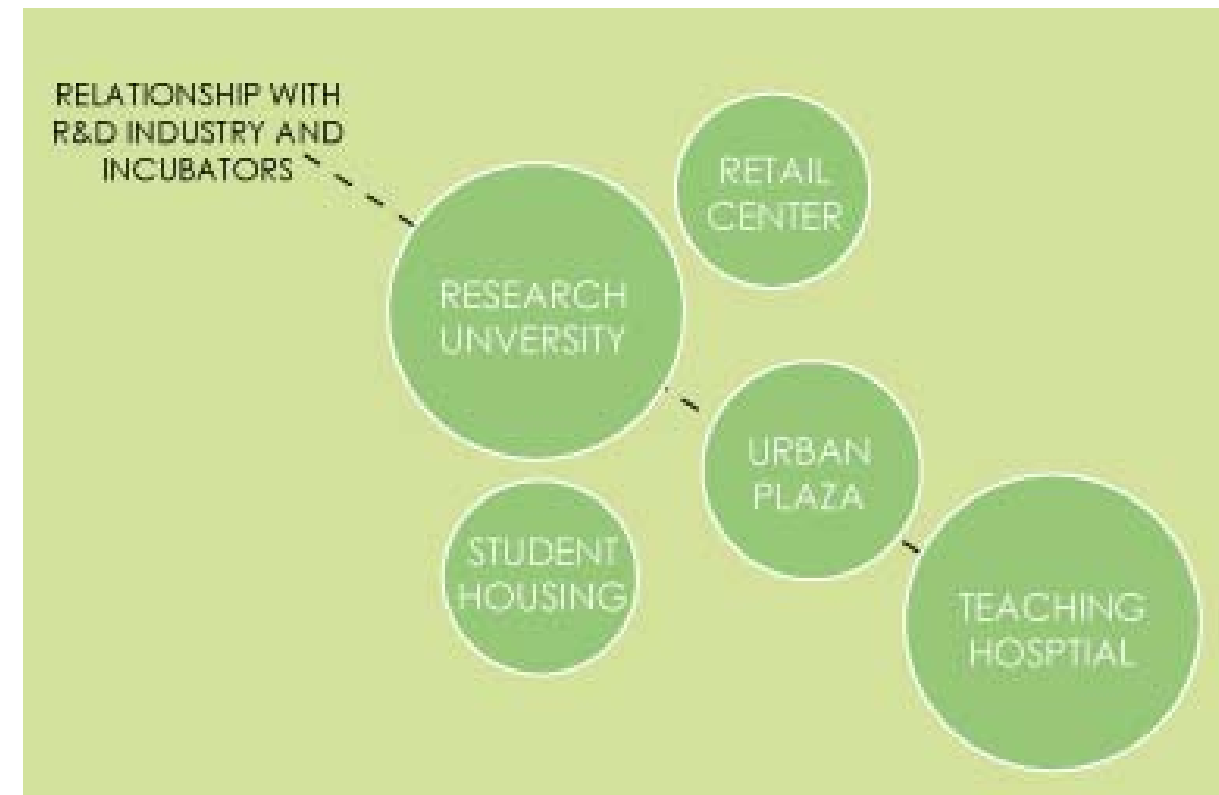
# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## City Program | Adjacency Diagrams

Adjacency diagrams help determine the location of program elements by direct and indirect adjacencies. Direct have a solid line, indirect a dashed or hidden line. While, the diagrams are quite simple, they convey a powerful message in their simplification of such a complex problem.



Typical Urban Village Center



Hospital and University

# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Residential | Cultural Issues

When designing the housing for Pearl City, a multitude of cultural issues began to emerge. We soon realized that the constituency who would be occupying the city, though they will be more affluent and a good majority of the population will be younger than what is represented in other parts of China, there were some fundamental cultural issues that needed to be taken in to consideration.

The most important of these issues was the incorporation of Feng Shui principles in to the architecture and design aspects of the buildings themselves. Though completely understanding Feng Shui can take a lifetime of study to master, we were able to develop some key principles that would help incorporate the values of this ancient Chinese cultural practice in to our modern sustainable city. We quickly found out through our Chinese consultants that this would be no easy task.

Feng Shui is an ancient Chinese practice that utilizes the laws of both Heaven and Earth, to help improve one's life by receiving a positive "flow of energy," commonly referred to as "Qi." Most of today's Feng Shui schools teach that it is the practice of arranging objects to achieve harmony with one's environment. It is also used for choosing a place to live, for plotting a burial site, and still others use it for agricultural planning. Proponents claim that Feng Shui has an effect on health, wealth and personal relationships. So what does this mean for the architecture in Pearl City? Of course, many high-rise buildings (which are prominently used in our city for their sustainable capabilities, efficiency, and also to meet the demand of a very dense population), do not currently incorporate feng shui principles, so we had to become creative when interpreting so-called tenants of feng shui.

Though feng shui is one of the most important design aspects of the residential buildings, tenants of these buildings also need to be able to hold on to other key cultural principles. Chongming Island is known for its population of several different species of birds and hence, bird habitat conservation remains an important aspect of the surrounding area. Since Pearl City only takes up a relatively small portion of Chongming Island, other parts of the island are conserved to maintain the bird sanctuaries.

The incorporation of green space in the city will also allow for the native population to continue their agricultural efforts and enjoy the native vegetations, without much interference from the bustling city life. It is also our intention to have local farmers bring their goods to market in Pearl City and deliver fresh produce and other goods to the inhabitants of the city on a daily basis. Unlike in the United States, food in China is required to be as fresh as possible for the average consumer to buy it (as our Chinese classmates informed us), which means there should be a potentially thriving ability for a local farmers' market to be utilized.

### STEPS TO INCORPORATE FENG SHUI IN OUR CITY:<sup>123</sup>

- Avoid placing buildings at the end of Roads
- Edges and corners of buildings should not face directly at dwellings
- Dwellings should face the south
- The shape of the dwellings should be a rectangle or square
- Green space should be maximized with garden areas
- Avoid transparency in dwelling units

1- <http://www.fengshuiarch.com/fengshuiarchitecture.html>  
2- <http://www.fengshuiarch.com/fengshuiarchitecture.html>  
3- [http://www.fastfengshui.com/links\\_fengshuiarchitecture.htm](http://www.fastfengshui.com/links_fengshuiarchitecture.htm)



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Residential | Schematic Design

### Housing Goals

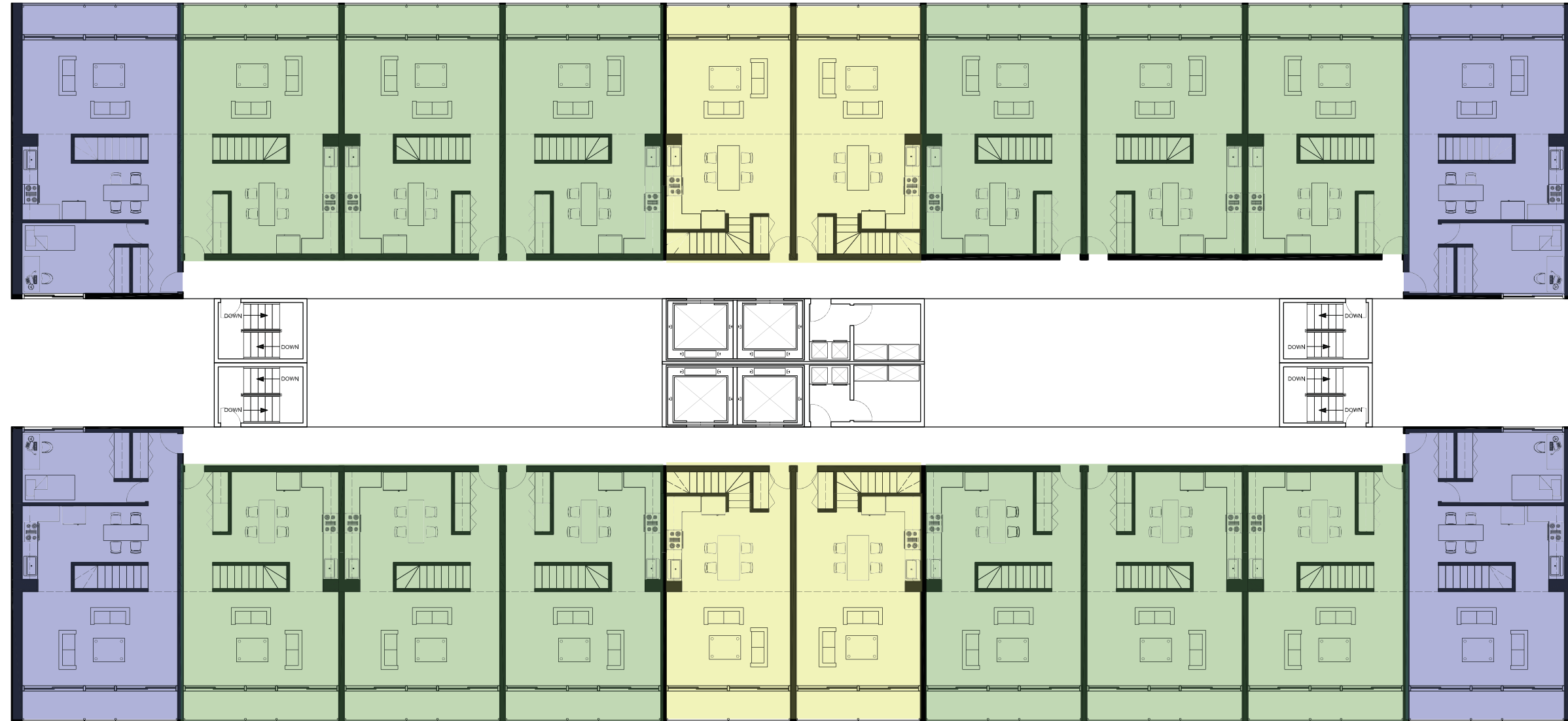
It was our intention to design a residential building with maximum density according to numbers provided by city planning group. The building should feature passive as well as active sustainable features. The residential building should prove to be efficient of area, as Chongming city should be hyper compact in keeping with a smaller footprint of environmental impact.



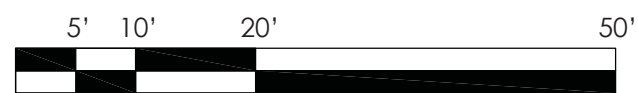
# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Residential | Schematic Design



LOWER LEVEL FLOOR PLAN



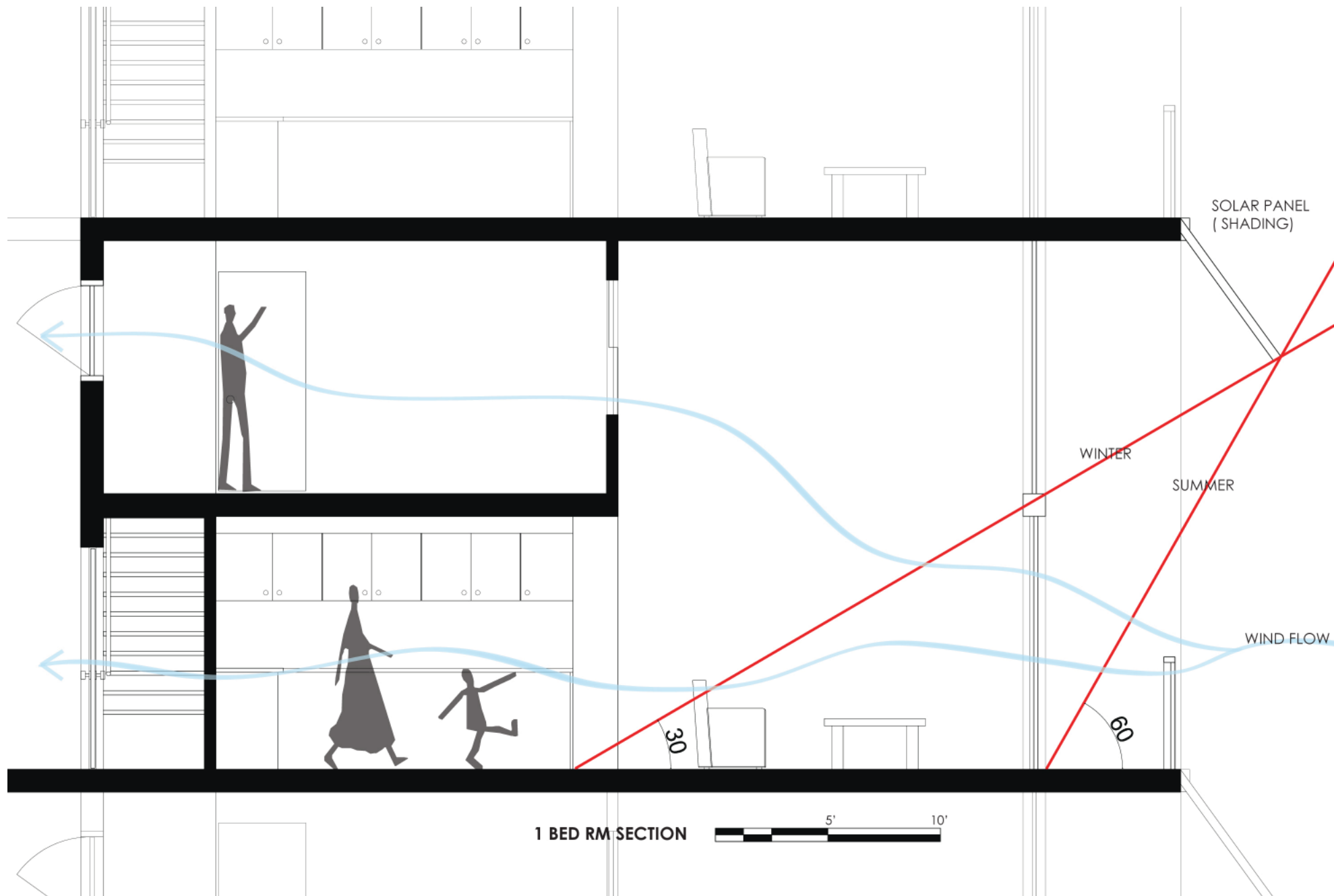
- 1 BED
- 2 BED
- 3 BED

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Residential | Schematic Design

### Sectional Ventilation

The though ventilation was achieved by providing openings at both sides of each apartment unit, allowing for a more efficient cooling in the summer months, which will help avoid the extreme use of air conditioning. The double height of the apartments provides for effective passive solar strategies to maximize the natural light gain and minimize the heat gain at critical points in the year, as well as year round. The first story of the building was elevated to provide for natural cooling at ground level as well as water pools, a chinise cultural feature very much appreciated by city dwellers as these water mirrors cool the air around them and provide for recreation areas. The strategies for plumbing systems and layouts are in keeping with maximum efficiency by having back to back restrooms and minimal corridor space.



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Business and Commercial | A Sustainable Vision

Aspects of a well designed, sustainable commercial sector:

- Diversified commercial products
- Convenient transportation
- Energy efficiency
- Environment friendly
- Huge diverse workforce pool
- Regulated and efficient public services

#### Orientation and Opportunity

The optimal sources of revenue in this town should be exhibition, convention and tourism. These industries attract thousands of visitors all around the world to come to the new city annually which provides endless commercial opportunities.

#### Diversity of the commercial market:

Chongming Island is an important extending space for Shanghai's commercial development. The diversity of commercial products, huge space for warehouses, mature market management and relatively cheap and available land will be the obvious advantages of the new city. Convenient transportation provides direct access to the Changjiang delta which is one of the most dynamic economic zones in China.

As a major organic farm land of agriculture, Chongming Island has the highest quality food production in the Shanghai region.

Encompassed by rural high technology agriculture farmland, ample supplies of fresh fruits, vegetables, fisheries and other agriculture products can be provided to the city with a relatively low price continually.

#### Retail

The sustainable zoning design eliminates the boundary of living community and commercial center which provides the widest developing room and the lowest transport cost for retailers.

The advanced green living standard and comfortable natural environment will attract thousands of new citizens to move into the city. This gives retailers broad commercial opportunities.

#### Workforce:

The R&D institute located in the east part of the city supplies over 1000 graduate high-tech advanced workforces annually to the local and international workforce market. Amenity living environment and enormous working opportunities around Chongming Island and Shanghai city will attract thousands of elites from many fields and locales to join the new city. The rapid development of intensive mechanized agriculture around the area will free thousands of hands from the farm.

#### Technology

The new city is a combination of current advanced technologies. No matter where you live in the city, you can easily enjoy the surprise and joy which technology can bring to you. The broad wireless internet service covering the whole city would create access to your office from anywhere.

#### Public service

Infrastructure is constructed by the local government. Simplified license applying processes saves enterprises a large amount of time. All kinds of government subsidy and loans will be granted to energy-efficient and environmental enterprises. An Incubator established by the local government provides the bridge to loans, necessary development spaces, and tax exemption policy services businesses middle and small.

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Business and Commercial | Schematic Neighborhood Business District Design



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### City Downtown

Pearl City will have its own unique downtown district. Located at the west end of the city, the downtown will stretch along the waterfront of Pearl Lake. In keeping with the preservation of vast areas of open space in our city, the downtown's density will be mitigated by parks as well as natural ecosystem preserves.

The downtown will feature an office center, a shopping and entertainment center, the city's central government, a central culture center including the main city library, hotels and a convention center. Transit connections to Chongming City, via rail, and Shanghai, via hydrofoil ferry, will be at the south end of the downtown area, in proximity to both a planned Chongming rail line as well as a small harbor for ferry access. The office center will consist of 4 buildings totaling approximately 2 million square feet of office space. The shopping and entertainment center will include major as well as boutique retail, a cineplex, restaurants and bars, as well as a boardwalk type market and entertainment area.



Renaissance Tianjin Hotel, Shanghai



Shipai Town Hall, Dongguan



Shanghai Museum and Archive



Shanghai Grand Theater

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Convention Center

### Convention Center Program Projections

FUNCTION	DESCRIPTION	SIZE (SF)
Main Lobby	Lobby space to provide overflow exhibit space and connect all spaces	17,000
Exhibition Area	Large Hall Space for Service of 5000 visitors	35,000
Meeting Rooms	20 meeting rooms provide private meeting places	4,500
Auditorium	Lecture, presentation and performance venue with 1000+ seats	25,000
Theater	Secondary auditorium with seating for 500+	4,300
Banquet Rooms	3 full service halls for private parties or special conventions	6,500
	Basic Program Area	92,300
	Gross Building Area	180,000

As an example for sustainable practices, we project a significant eco-tourism market as well as great interest for our city to have a first class convention center. The basic premise for our convention center is that it should have a capacity around 5,000 visitors. For a precedent we used Atlapa Convention Center in Panama City, Panama. We used this information when projecting programmatic requirements.

To remain on the leading edge, our city's convention center should represent the most advanced concepts in sustainability. Our second case was based off the proposed Masdar Headquarters from Adrian Smith and Gordon Gill Architecture. Located in the center of Masdar, United Arab Emirates, the headquarters will be the world's first mixed use positive energy building in the world. To accomplish this, the architects employed one of the large photovoltaic arrays in the world, the largest solar driven cooling and dehumidification system in the world and wind turbines integrated into the building. The center also projects to consume 70% less water than similar complexes.

While Masdar offers ample sunlight for its PV array, its harsh climate presents additional challenges which drove the design of Masdar Headquarters. The design of our convention center should be similarly driven, but Chongming's climate is a bit more forgiving than that of the UAE. Pearl City's convention center should feature integrated wind turbines, high efficiency water use, as well as solar thermal controls.



**Masdar Headquarters**

Image courtesy of Adrian Smith and Gordon Gill Architecture, <http://www.smithgill.com/MasdarHeadquarters.htm#>

# DESIGN OF A SUSTAINABLE CITY IN CHINA

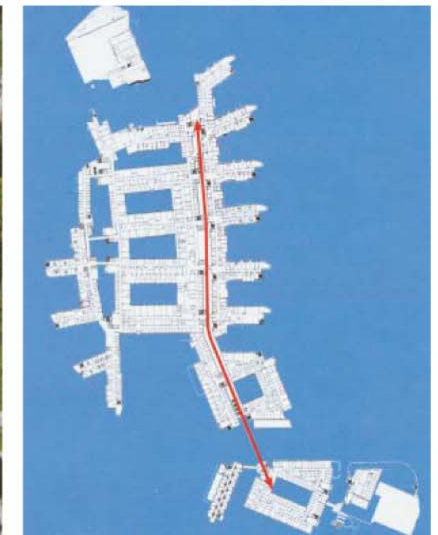
## CHONGMING ISLAND, CHINA

### Teaching Hospital

Our city will have a hospital uncharacteristic of a 200,000 population city. It will plan for service of 300,000+, which includes our city, Chongming City and the westerly agrarian population. It also will be a teaching hospital, so there would also be a need for resident and employee housing within walking distance to the hospital. This reinforces the concepts of a live-work city.

The hospital would be located at the east end of our city, next to a research university. Together, along with the housing necessary for the students, faculty and staff populations for both would necessitate a smaller commercial district located between the two, next to the hospital's own transit connection. The hospital would need to have connections to the nearby highway.

The following data represents a basic use projection and program for the type of hospital we think our city should have.



**Oslo National University Hospital, Oslo, Norway**  
Image Courtesy Hospital is a City, Peter Ellis

		200k Pop	350k Pop	Number of Rooms		Number	DGSF/Unit	DGSF
Bed Use Rates					Beds	800	1000	800,000
China 2003	2.34 beds/1000 population	468	819	800	Interventional Suites	60	3200	192,000
US 2003	2.6 beds/1000 population	520			Labor & Delivery			50,000
Caif 2003	1.9 beds/1000 population	380			Emergency Room			60,000
Kaiser 2006	1 beds/1000 population	200			CT	12	1500	18,000
					MR	10	2500	25,000
MR Use Rates					Other Radiology			67,000
US 2004	26.6 MR/M population	5.32	9.31	10	GI			35,000
CT Use Rate					Echo, Dialysis, EEG, Pul Fcn, Physical Therapy, Respiratory Therapy, Pharmacy			120,000
US 2004	32.2 CT/M population	6.44	11.27	12	Laboratory			88,000
					Kitchen			63,000
OR Use Rate					Dining			31,500
US	113 ORs/M population	22.6	39.55	40	Materials Management w/Dock			50,000
					Housekeeping, Plant, Security			50,000
Interventional Rad Suites				8	Administration			100,000
Cardiac Cath Labs				12	Public Spaces & Conference Space			50,000
					Total DGSF			1,799,500
Total Operating and Interventional Suites				60	Factor, DGSF to BGSF			1.50
					Total BGSF			2,699,250



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Research University

As a leader in research and development as well as high-tech industry, Pearl City will host a satellite campus of a top tier research university. This university can be a satellite of either an American or Chinese school, or even a joint venture between schools from each country.

We project a student population of approximately 10,000 students and about the same number for faculty and staff. It will be necessary to provide housing for all of the students at the university, as well as the majority of faculty and staff. Programs for the university would likely specialize in sustainability, agriculture and aquaculture, as well as the typical programs indicative of a top research university.

Along with the hospital's housing needs, we can project nearly a full service urban village to be able to sustain itself at the east end of Pearl City. Accordingly, access to daily goods and services will be available on site. This allows students to segregate themselves from the rest of the city when they need to focus on schoolwork. A light rail transit stop will also be placed between the hospital and the university. This allows students as well as faculty get to the university without relying on cars.

The university is also in an excellent position for the creation of small business incubator spaces. Business incubators allow for up and coming business ventures to create a community with each other and have a forum for the exchange of their ideas between ventures.



Beijing University, Beijing, China

# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Open Space | The Result of a Compact City

The space between townships within the city will be preserved for multiple purposes. The main function will be that of a nature preserve; a natural wildlife haven, which will not only foster the wildlife itself, but also allow the citizens of the city to engage with nature. The townships will be connected through three different pedestrian pathways, as well as light rail transit. One pedestrian path will be the express path, following the route of the light rail transit. This will be a direct connection between townships for pedestrians. The other two routes are scenic routes; one along the outskirts of the city, and one inside the wildlife preserve which will encourage pedestrians to "get lost in nature". The path that follows the coastline will provide views out across the Yangtze River, into Shanghai. The other path will allow one to observe the wildlife sanctuary intimately. Boardwalks above the retention basins will allow pedestrians to get close to various forms of wildlife, while allowing this wildlife to be relatively undisturbed. Heavy forest will line the outside of this preserve, to serve as a buffer zone between the city and nature. The interior of this preserve will then consist of natural wetlands/meadows.

The city will also be connected via an efficient and low impact system of bikeways. These bikeways will run express to the city downtown, as well as interconnects each node through the natural landscape.



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

Open Space | The Result of a Compact City



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Power Generation | Small-scale Solar Energy

In order to make the high-rise buildings more efficient and also to contribute energy back in to the buildings, two solar technologies will be utilized on a small-scale. These two technologies include photo voltaic solar panels for collecting energy and external solar shading methods, which will be used to maximize efficiencies with heating and cooling. All though these technologies are by no means at their peak, they are being used more and more by developers and offer benefits that were previously unimaginable. If energy consumption is going to keep at its already steady pace of growth, especially as the frequency of individuals moving from rural to urban environments continues, the use of energy-producing technologies is critical.

To achieve maximum solar panel usage, photo voltaic solar cells could be installed on solar panels on the curtain wall of the buildings. Systems like these are being used around the world, including places like highly-dense Manhattan. In addition, rooftops could easily house solar panels to maximize efficiencies when the sun is overhead. The use of these panels will offer the ability for a building to offset the amounts of energy it will require to be inhabited.

A relatively easy technology to use is the incorporation of external solar shading panels on the outside of building windows. External solar shading offers the ability for solar heat reductions (up to 95%), thus limiting or eliminating the need for air conditioning and can also be used to maximize day-lighting. During colder months, these panels can also be used as insulators, which will protect the building from having to be heated artificially.

Essentially, this technology involves installing panels across building windows, which can be oriented differently throughout the day to maximize natural lighting, without letting too much unneeded light and solar activity in to the building. These systems are used in many forms and have been integrated throughout the globe for building efficiencies.

The main problems with these systems are that they are troublesome for residential units because the windows need to be able to open, though this can be accounted for in more advanced systems that can have their panels opened manually. Also, cleaning the actual windows can be problematic, though an automated system could be set up to clean the windows. Otherwise, the shading panels must be installed at a distance far enough away from the window so that someone may be able to position themselves between the window and the panel to manually clean the windows.

<http://news.thomasnet.com/companystory/482967>

[http://www.levolux.com/L\\_products/specialist\\_venetian\\_blinds\\_details.htm](http://www.levolux.com/L_products/specialist_venetian_blinds_details.htm)

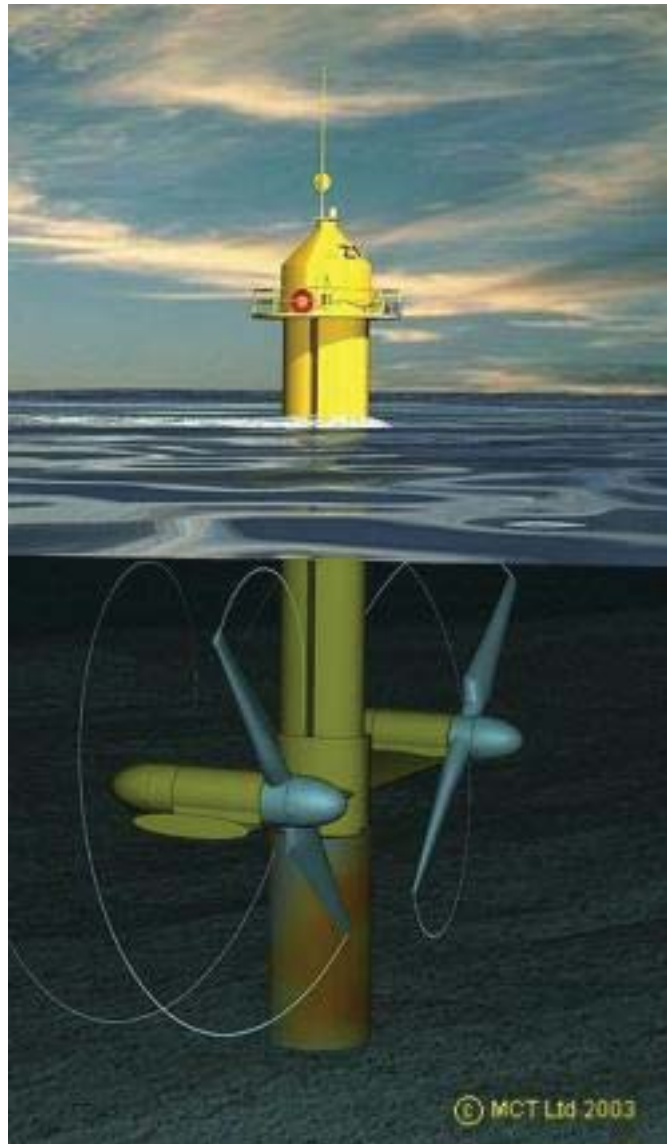


University of Hertfordshire, UK

Image Courtesy of Levolux, [http://www.levolux.com/L\\_case\\_studies/.htm](http://www.levolux.com/L_case_studies/.htm)

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Power Generation | Underwater Current Farming



In today's age of sustainable technologies, one of the main concerns with developing new ways to power our cities is the aesthetics of major "energy farms." We have been able to see the backlash of massive wind farms, solar farms, and electric cars (many say they are a sore to the eye), but what if we were able to utilize a comparable technology, without having to see it or hear it? This is where the new technology of kinetic underwater current farming comes in to play.

Essentially, this new technology uses turbines that look similar to what is being used in wind technology, but these turbines are submerged under water where they can take advantage of strong currents to turn the turbines. These turbines will have to be anchored to the sea floor, but should cause minimal damage over time, especially as the technology matures. Once the turbine is anchored to the sea floor, a generator enclosed in a water-proof casing must be installed as well, which can then connect to the local grid and output the captured energy.

Currently, many of the products utilizing this renewable source of energy are fish-friendly, which means that fish can swim right through or around these turbines without having to worry about their safety (an improvement over past under water current technologies.) Of course the site needs to be carefully picked, but once the area is secured, there should be minimal intrusion upon the local flora and fauna.

The output of this underwater technology tends to be as efficient, if not more so, than other forms of renewable energy, and it also tends to be cheaper per kW per hour than wind farms.

In Korea, tidal water plants are being constructed right now very successfully, generating 254,000 kW per hour. Once constructed, this plant will be able to meet the energy needs of a 500,000 person city, though it is quite large-scale, one can easily see the potential of using water as an energy source. In Manhattan we are seeing the technology discussed here being put in to place in the East River. "The Project is progressing from an initial demonstration array of six turbines to a complete arrangement of 100-300 turbines. At full capacity the project could generate up to 10 MW, enough to power nearly 8,000 New York homes."

In order to reach the maximum efficiencies and outputs gained by this technology, we have chosen a site between our city and the small island directly south of the city. We propose placing 10-20 of these turbines underwater, which should generate a decent amount of electricity in to the grid. Since these turbines do not require dams, we can simply install these pieces underwater at the end of a river, where current flow is at generally higher points than compared with other sites. Since the technology can be employed in a range of sites, expansion of these farms is relatively easy and certainly cost efficient.



<http://english.donga.com/srv/service.php3?bicode=020000&biid=2004100167138>  
<http://verdantpower.com/what-initiative>

# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Waste Management | Wind Farming

Wind is a readily available resource on Chongming Island, but the proper placement of the turbine farm is still crucial. Based on the previously shown wind analysis data, it was determined that the optimal location for a wind turbine farm would be to the northeast of the city. This location was decided upon primarily because the majority of winds are coming from a range consisting of west winds to south winds (270 degrees in the diagram). Since the winds coming from the southwest were clearly the least frequent, it was decided that the city to the south west would not be a great obstacle for wind collection in terms of year round harvesting. The area of the turbine farm will be 8.85 square miles (4.47 miles x 1.98 miles). The area results from the prescribed spacing set forth by the New York State Energy Research And Development Authority.

This dictates a spacing of 10 rotor diameters, on center, between each row of turbines in the direction of prevailing wind; the distance of only 3 rotor diameters is prescribed between turbines within each row. Since we are concerned with multiple directions of wind year-round though, the 10 diameter spacing was used for both situations.

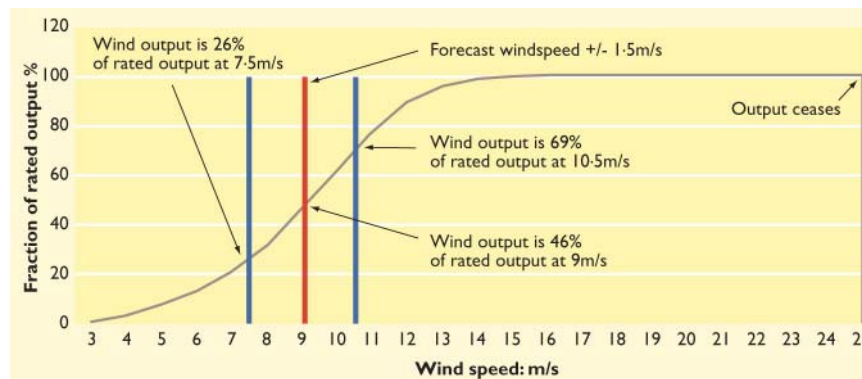


Image Courtesy of Hugh Sharman, 'Why UK wind power should not exceed 10 GW'

### Expected Power Generation

The turbines in the farm are estimated to produce 2.5 MW of power per turbine (as will be explained), thus a total of 125 MW of power is produced through the entire farm, per year. These estimations are based in part, upon turbine capacity information found on the Danish Wind Industry Association website, and in part, upon a precedent installation near Shanghai.

The Shanghai installation is composed of eleven, 65-meter diameter turbines (three of which are on Chongming Island), which are each capable of producing 1.5 MW of power. According to the source (Wu Chong of the China Daily), this installation can adequately supply all the energy needs of 20,000 Chinese people.

### Energy Use Estimates

Our estimation would assume a consumption of only .825 kW of energy, per person, per year. Using this information, we substituted an average consumption of 1.2 kW of energy, per person, per year. This led to the use of turbines with 80-meter rotor diameter; these turbines are each expected to produce an average of 2.5 MW energy per year, based on the average capabilities of turbines of this size, (found at wind-power.org). Thus our wind farm is expected to be able to produce an average of 125 MW energy per year; this would mean approximately 40%-50% of the entire city's energy consumption. Each turbine can account for the energy needs of 2,083 people (assuming a 1.2 kW energy consumption per person, per year).

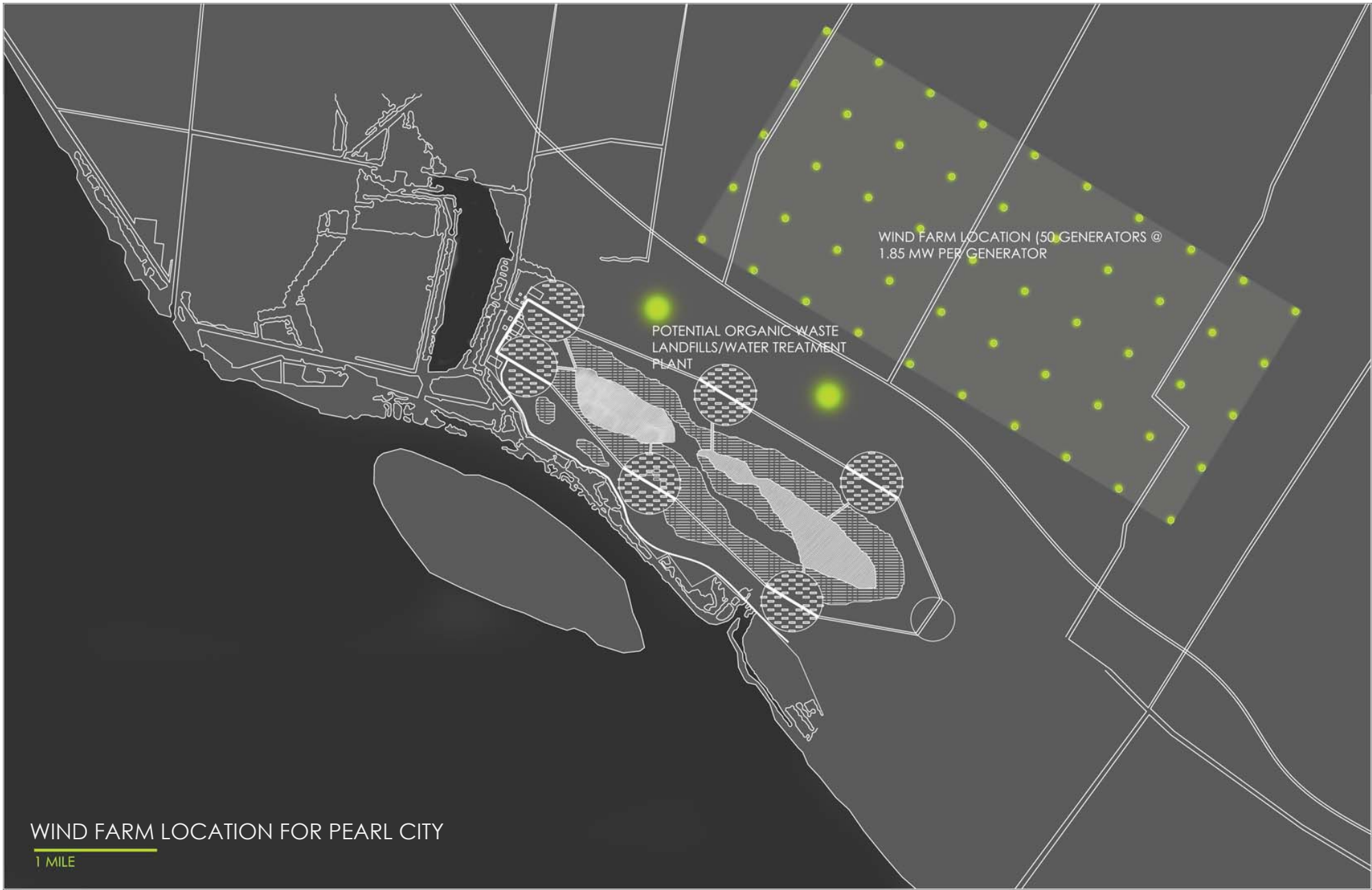


Elsam's 160 MW Horns Rev offshore wind farm in western Denmark. Elsam is the largest independent owner of wind turbines in Denmark.

<http://www.kentishflats.co.uk/>

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

## Power Generation | Wind Farming



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Waste Management | Water Management

#### Wastewater Systems

Wastewater systems are at the forefront of sustainable technologies that are being incorporated in many parts of the globe. The two systems discussed here have been occurring in human's lives for as long as humans have needed water, though with the rise of new technologies, these systems are becoming more efficient all the time. One of these systems will be used for generating fresh water - aside from what is taken from wells - and the other is used to reuse water. Indeed these systems are being made mandatory in residential and commercial buildings in places like India and Australia, where shortages of water are of a dire concern.

#### Gray Water Systems

The first and most important system for conserving water is the use of a gray water system. Gray water consists of used water from automatic clothes washers, dish washers, bath tubs and showers, sinks (including kitchen) and swimming pools. Essentially, this is any water that does not come directly from the toilet (termed "black water" because of the higher amounts of contaminants.)

Uses of gray water will be determined based on where it is coming from and how much it will be treated. Treated gray water can be used for irrigating food supplies, but unless it is treated heavily (and probably with too much cost to be efficient enough), it is not good enough for drinking.

Untreated gray water has several uses, though: non-food gardening, landscaping, toilets and wash basins. One of the best ways to reuse gray water is by installing a small reservoir under a sink in your bathroom. The small reservoir under the sink will be used to flush the toilet and thus water in the bathroom is used twice. Surely, one can imagine a sophisticated dual-plumbing system in a high-rise building that could reuse the gray water quite easily. (Malgrave, 2007)

#### Rainwater Harvesting

The second system that will be used is a rainwater harvesting system. Essentially, rainwater will be collected from rooftops, and drained through a series of gutters and filters in to a large holding tank that will act as a reservoir for holding and potentially cleaning the rain water. This rainwater, once minimally cleaned, can be used in sinks and showers (along with the regular plumbing system.) Of course, if large amounts of vegetation are directly surrounding the building, some of the rainwater could be diverted in to gravity-enabled showers, which can act as a sprinkler system for the surrounding plant-life. More often, this rainwater will be kept in a reservoir where it can be maintained until it is needed.

A rainwater system could also be incorporated in to the building's gray water system through the rooftop gutter system which could feed the rain water in to the gray water's plumbing system. This would allow for more water to be used in the plumbing system (without having to incorporate other means of fresh water production), while treating both as one body of water.

Using the specifications for the high-rise residential building designed for Pearl City and Shanghai rainfall data, we can calculate the average amount of rainfall that could be collected by the rainwater harvesting system from the roof top.

A simple equation can be used to calculate the amount of rain that can be harvested from a rooftop catchment:  $\text{Rainfall (mm)} \times \text{Area of Catchment} \times \text{Runoff Coefficient}$ . The runoff coefficient is the ratio of the volume of water that runs off a surface to the volume of rainfall that falls on the surface. So, if we take average monthly rainfall in Shanghai to be 93.64 mm/month, a rooftop catchment of 6400 sq. m., and a runoff coefficient of .8 for a corrugated sheet metal rooftop, we can determine that our buildings have the potential to collect, on average, 479,436 cubic meters in rainfall each month. Though, much of this water will not be held in tanks because of the sheer amount of it, the plumbing could be helped by this system, and the potential for other uses is amazing.

#### Water Conservation

Of course, using less water initially is always the best way to maximize the conservation of water. There are several ways to conserve your water usage, including: low-flush toilets, waterless urinals, low-flow showerheads, and reduced water pressure faucets. Each of these technologies is being widely incorporated today and is a cheap and efficient way to develop a new building. (Malgrave, 2007, pp. 149-155)



# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

Waste Management | Water Management



# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA

### Waste Management | Solid Waste Management

The policies that exist in Chongming County for solid waste management provide a unique opportunity to implement comprehensive solid waste management criteria that serve to not only solve the solid waste problems, but also provide energy and fertilizers for the community. In developing countries, the waste that is put into landfills is primarily organic waste, as opposed to developed countries' mostly post consumer landfills. This opens the door to using a bioreactor landfill and utilizing a methane capture procedure within the landfill. The bioreactor landfill has many benefits, including :

- Decomposition and biological stabilization in years vs. decades in "dry tombs"
- Lower waste toxicity and mobility due to both aerobic and anaerobic conditions
- Creation of usable nutrient rich soil by-product from composting of left over materials
- A 15 to 30 percent gain in landfill space due to an increase in density of waste mass
- Significant increased LFG generation that, when captured, can be used for energy use onsite or sold
- Reduced post-closure care

[http://www.methanemarkets.org/resources/landfills/docs/usa\\_lf\\_profile.pdf](http://www.methanemarkets.org/resources/landfills/docs/usa_lf_profile.pdf)

Among the many benefits that a bioreactor landfill has, the most promising aspect from a sustainability standpoint is the production of LFG (land fill gas) that can then be used for :

- Electricity Generation
  - o This electricity can be used on site, or sold to local power companies
- Direct-Use
  - o The LFG can be used to power facilities on site associated with the waste treatment
- Cogeneration and Alternate Fuels
  - o Once collected and processed, the LFG can be used as a fuel source that could be sold to generate electricity outside of the facility or for use as a fuel for municipal vehicles

A comprehensive solution to the solid waste treatment within Pearl Lake city will allow the city to move closer to sustainability and can also serve as a model of integration of all of the latest technologies available for waste treatment.

The combination of both a bioreactor and a methane capture system will allow Pearl Lake city to not only reduce the land area necessary for the solid waste treatment, but also to extract from the waste useful byproducts that can help to power the infrastructure of the city.



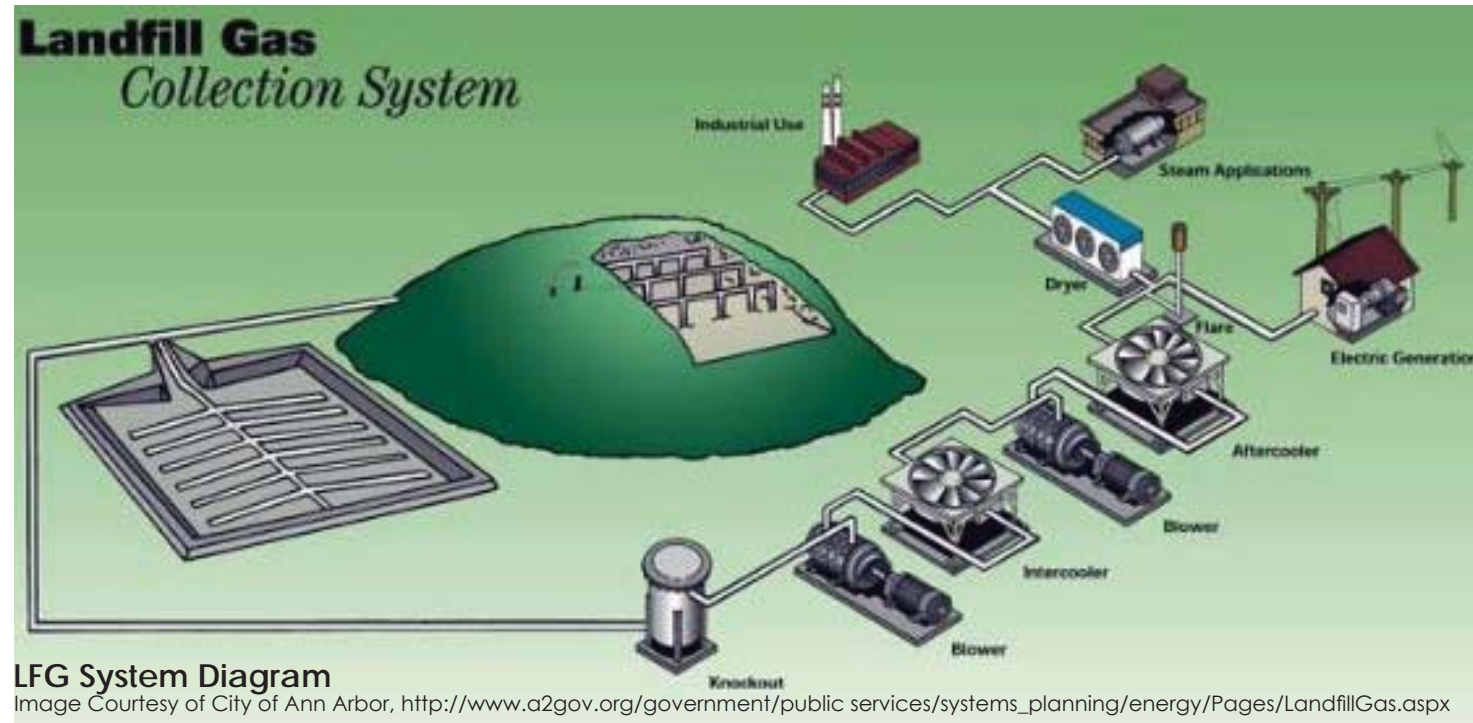
LANDFILL GAS ENGINES IN ONTARIO USA  
Image Courtesy <http://www.global-greenhouse-warming.com/landfill-gas.html>



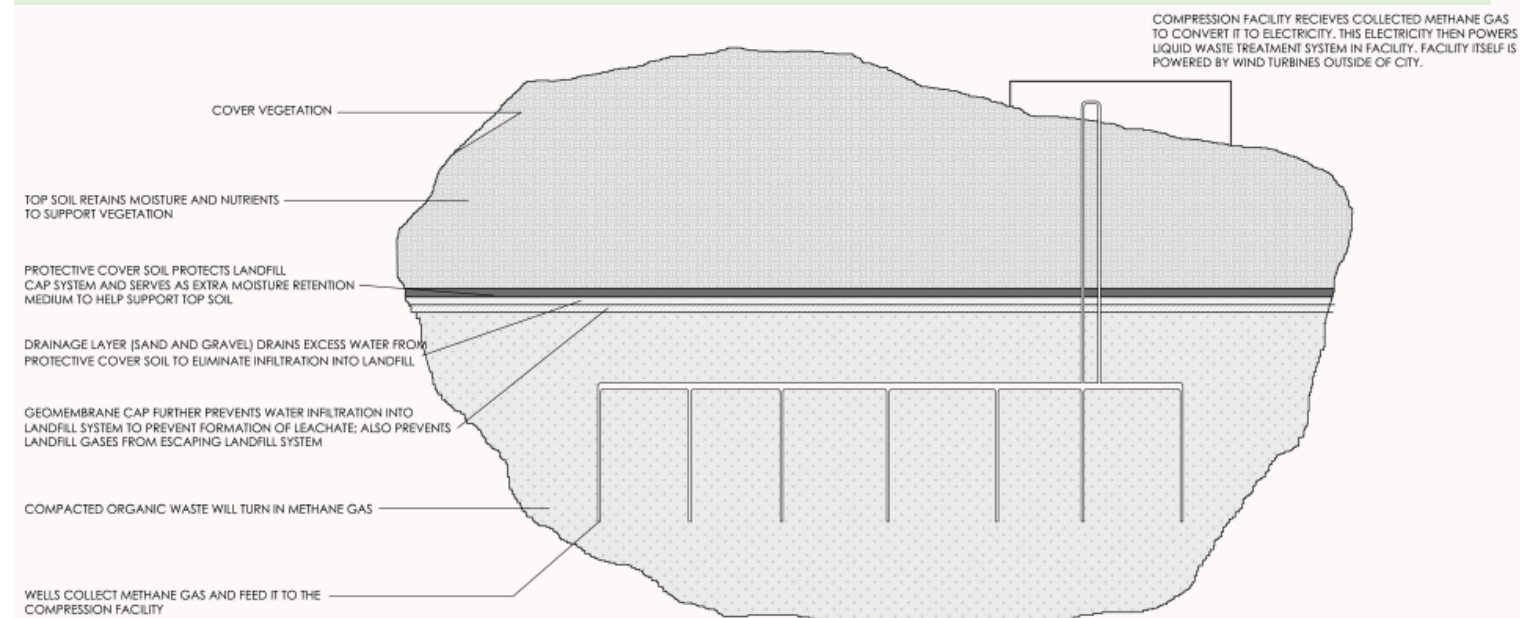
Image Courtesy United States Environment Protection Agency  
<http://www.epa.gov/lmop/news/fall07.htm>

# DESIGN OF A SUSTAINABLE CITY IN CHINA CHONGMING ISLAND, CHINA

Waste Management | Solid Waste Cogeneration



**LFG Gas Flares**  
Image Courtesy of MRW Technologies, [http://www.mrw-tech.com/landfill\\_gas\\_flares.html](http://www.mrw-tech.com/landfill_gas_flares.html)



**LFG Collection Diagram**

# DESIGN OF A SUSTAINABLE CITY IN CHINA

## CHONGMING ISLAND, CHINA



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