CHAPTER 6 - GREEN BUILDINGS FOR A RESOURCE EFFICIENT FUTURE

"The Urban Best Practice Area of the Shanghai World Expo not only presented original and valuable practices designed to improve the quality of urban life, but also acted as a platform for cities to share experiences in green urban construction and development"[1]

1. ISSUES AND CHALLENGES[2]

As an urban leader you know that investments in the built infrastructure, whether through new construction or refurbishment, can have some of the most long term impacts on the competitiveness of your city. An upfront investment of only 2 per cent in green building design, on average, can result in life cycle savings of 20 per cent of the total construction costs – more than ten times the initial investment. [3] In comparison to the average commercial building,[4] the cost benefits of green buildings[5] are appreciable and include 8-9 per cent decreased operating costs, 7.5 per cent increase in building value, 6.6 per cent improvement on return on investment, a 3.5 per cent increase in occupancy ratio, and a 3 per cent increase in rent ratio.

Apart from the economic benefits, there is a growing body of evidence that green building occupants are more productive. Improvements in indoor environments are estimated to save $17-48 billion in total health related gains and $20-160 billion in worker performance. [6] So from this perspective, city leaders should strive to build green infrastructure just to obtain the significant productivity benefits. Yet it should also be noted that zero net energy buildings are technologically feasible. Moreover through proper design, energy efficient features, and with integrated renewable energy applications, buildings can be net energy producers. Finally cities challenged by water scarcity, either now or in the future, should strive for buildings with reduced water footprint.

1.1. URBAN MANAGEMENT ISSUES

Political will and strong leadership at the top levels of city government are needed if we are to transform the built sector. To encourage such leadership we may sometimes need to educate city

[1] http://en.expo2010.cn/sr/node2282/gallery2/more.htm

[2] This chapter was authored by Mohan Peck with valuable input and contributions from Yang Jiemian and Yu Hongyuan.

[3] Kats, G. (2003). The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force

[4] GSA Public Buildings Service (2008). Assessing Green Building Performance: A Post Occupancy Evaluation of 12 GSA Buildings

[5] McGraw Hill Construction, Green Building SmartMarket Report, 2006

[6] Fisk, W. (2000) Health and productivity gains from better indoor environments and their relationship with building energy efficiency. Annual Review of Energy and the Environment: 25, 537-66

leaders to strengthen their conceptual understanding about sustainability and its long-term, systemic benefits to the economic vitality of a city. Strong executive leadership has been the key driver for the successful transition to green building and sustainable development in cities like New York, Curitiba and Sydney.

City operating budgets are always tight and allow little tolerance for investing in building upgrades, even when they have a good payback and return on investment. A city's limited capital budget generally skews decisions based on first cost rather than life cycle cost. Lack of interdepartmental communication often prevents collaborative decision-making that would justify the investment in green building for the best long-term interests of the city.

1.2. ISSUES IN THE BUILDING SECTOR

Another important measure to promote development of more green buildings is to increase incentives for builders and developers to build green. The benefits of green buildings, especially in energy savings and worker productivity, accrue over the long term. While green buildings are more cost-effective, the benefits accrue to the final owners and users of the building, and not to the builder. Additional construction costs for green buildings, generally 2-5 per cent, cannot be easily passed on to owners and therefore are often a financial disincentive to builders. The challenge is to create a mechanism that allows some of the value of the long-term benefits to be transferred to the builder to offset first-time costs (see section 2.2 below).

Another barrier is lack of information and sourcing for green building products. Architects and builders lament the scarce and poorly accessible information available on green products and high-performance building systems. The lack of information about performance and cost attributes of building elements can force projects to depend on specialized consultants. Alternatively, builders and contractors risk costly call-backs to remedy green products that don't perform well. Another consequence of limited product information is skepticism from municipal building and safety departments. Green products can only deliver their air quality and energy conservation benefits if regulators allow them to be used. The challenge is to get the information and to educate the marketplace.

As the regulation of building design and construction becomes increasingly complex, developers and clients have difficulty assessing the costs and requirements of complying with regulations. Improved communication of local building codes and their implications for green process and product choices would allow developers and clients to make choices among efficiency, aesthetics, product choice, and cost that would satisfy regulators without costly delays and changes.

This leads us to characterize the general objectives for green buildings. High performance and sustainable buildings should:

- Maximize natural resource efficiency and human health benefits throughout the life-cycle of a building – from siting through design, specification, construction, operation, maintenance, renovation, and demolition
- Employ integrated design
- Optimize energy performance
- Protect and conserve water
- Enhance indoor environmental quality
- Reduce environmental impact of materials

2. POLICY OPTIONS TO PROMOTE GREEN BUILDINGS

2.1. EXECUTIVE LEADERSHIP

As Mayor, you might consider establishing, empowering, and staffing a cabinet level position focused on Sustainability. City employees should be empowered through a value system that rewards decisions which make the city green and sustainable. City officials can lead by example, implementing green strategies and proven technologies on city facilities before asking the private sector to make the necessary investments. They may consider: a) auditing city facilities for energy and water performance; b) using the audits as benchmarks to develop an environmental "accounting" and set goals for improvement; and c) holding the departments accountable for achievement of their goals. A validation and rewards programme could be launched for city employees who take initiative in advancing green building and sustainable development initiatives. Instituting a course of professional development focused on sustainability for the city's engineers, architects, and code officials could also be useful, engaging the NGO community as educational providers.

As Mayor, you may consider implementing policies and requiring training for departments in the use of life cycle evaluation, consideration of long term operating costs, and assessment of environmental impacts as criteria for their decision-making. The leadership of all departments associated with the City's built environment, including those responsible for operations and the funding of operations, must collaborate to develop policies that are both fiscally and environmentally sound. An example would be Finance and Water working together to establish a requirement for permeable parking lots and sidewalks that absorb rain water as a step to help avoid the need for massive stormwater infrastructure investment. The city budgeting process could be changed so that every city facility and department is responsible for paying its own utilities from their respective operating budgets. Savings (or some portion thereof) should accrue to the facility or department rather than to the general fund, to reward responsible behavior.

Green building demonstration at the Shanghai Expo

The Shanghai Expo was a platform for the demonstration of green building applications, including new energy technologies, active and passive architectural designs, and a host of energy saving measures. The Expo pointed the way to a major green legacy for future urban development.

Solar power was used extensively in the Expo Park. It was incorporated into the Theme pavilions, the Expo Center, the China pavilion, the Nanshi electric power plant, and several other pavilions. The total solar power generation capacity of the Park reached 4.5 megawatts.

Heat pumps tapping geothermal and river water sources provided energy for air conditioning in a number of pavilions, in the Expo Axis, the Expo Center and the Expo Performance Center.

The Expo Park contains four large green spaces covering a total of 1 million square meters. A wetland system and other water recovery technologies were used for Houtan Park and the water system of Bailianjing.

As per the Planning and Design Guidelines for the Park, LED lighting is used for all landscape lighting at night in the Park, the lakeside areas and the Urban Best Practices Area. This significantly reduced energy-use for lighting.

There were numerous other green building features in the pavilions within the Park. These included siting for natural ventilation, maximizing daylighting, installing green roofs, green walls and shades for natural cooling, use of green building materials, permeable pavement, rain water recycling and water-saving equipment.

2.2. MEASURES TO CATALYZE INVESTMENTS IN GREEN BUILDINGS

City leaders may wish to establish green building labeling schemes as these can provide more information to potential buyers on the benefits of green buildings, and at the same time it provides builders with a new marketing tool.

Favourable tax policies can incentivize construction of new green buildings. The difference in cost for green construction is 2-5 per cent more than business as usual. [7] Fiscal measures can help reduce that difference. The same is true for favourable interest rate financing policy, which when combined with favorable tax policies can further encourage green building construction. Special funding for financing energy-efficient retrofits of existing buildings is important. Such retrofits often pay for themselves in a relatively short period of time, but without special funding they may not occur.

Energy price reform can accelerate the realization of energy savings by making the case for renewable energy applications and energy efficiency measures more economically feasible.

[7] McGraw-Hill Construction (2007) Greening of Corporate America SmartMarket Report.

Shanghai Eco-Building

Within the Shanghai Expo Urban Best Practices Area, the city of Shanghai constructed an environmentally friendly building featuring traditional shikumen-style natural ventilation systems and a geothermal heating system. Modeled on an eco-friendly office building in the Xinzhuang area of Shanghai, it was remodeled into a residential structure in the Expo Park to demonstrate energy efficiency concepts. The building aims to achieve zero energy consumption. Plants help cool the building and skylights filter the sun and help make rooms airy. The house taps solar and wind power for its energy needs. Rainwater is collected for building use and light-emitting diode (LED) technology was adopted for lighting. The four-story structure containing eight apartments comprises around 3,000 square meters and the residence will be piloted in new construction within the city after the Expo.

Transforming the marketplace requires overcoming the barriers to widespread adoption of renewable energy technologies. In addition to the high—though declining—up-front cost of installing renewable energy systems, obstacles include confusing rules about permitting and connecting systems to the grid, a lack of consumer understanding of technologies and financing options, and a dearth of trained installers and inspectors.

Mayors and other local government officials are in a unique position to remove many of these barriers, clearing the way for the renewable energy industry to flourish. Local governments, residents, business owners, advocacy groups, and other stakeholders can take a multifaceted approach to promoting renewable energy by purchasing renewable energy systems directly, streamlining local regulations, and developing programmes that make clean energy options more accessible and affordable for consumers. By investing in renewable energy, local governments can boost the local economy in addition to enhancing national energy security and improving the environment.

Many in the real estate finance and investment community are finding their efforts hobbled by anecdotal data, lack of precedents, perception of higher costs, and inadequate underwriting, valuation and risk management protocols. More awareness-raising is needed to help overcome these barriers and facilitate the flow of debt and equity investment among all stakeholders (investors, lenders, developers, technology experts, building owners and managers, and risk managers) to share experiences, best practices, and new paradigms and to confront novel challenges. Cities can overcome these challenges by undertaking some mix of the following policy options and incentive programmes.

Create Direct Incentives: Up-front cash incentives encourage customers to install renewable energy technologies by helping reduce high equipment costs. Although production-based incentives don't reduce up-front costs, they do generate revenue that can help secure financing and offset financing costs. Direct incentives are useful to a broad range of consumers, especially those who can't take full advantage of other incentives such as tax credits. With direct cash incentives, programme administrators can track programme participation and installed capacity, along with any problems encountered and their solutions

Adopt Feed-In Tariffs: Feed-in tariffs are intended to increase the adoption of renewable energy technologies and encourage the development of the renewable energy industry, but they also bring significant ancillary benefits to the table, including enhanced economic development and environmental improvements. For cities that want to assure investors about future revenue, drive more capital to the market, and get more renewable energy applications integrated into new green buildings, a feed-in tariff can be a useful policy. See also Chapter 3 - Transforming the Urban Economy, for a case study of feed-in tariff application.

Offer Loans and Fiscal Measures for Energy Efficiency and Renewable Energy Systems: State, utility, and local government loan programmes encourage customers to implement energy efficiency measures or to install renewable energy systems by allowing consumers to spread up-front equipment costs over the life of a loan. These loan programmes offer lower interest rates, better terms, and lower transaction costs relative to private lenders. Loan programmes may be more politically viable than cash incentives, and they can even become self-sustaining through a revolving fund mechanism. Governments can also provide tax write-offs for energy efficiency and renewable energy investments to encourage their uptake.

Create a Property Assessed Clean Energy Financing Programme: This approach to financing offers a number of benefits to renewable energy system owners including a long-term, fixed-cost financing option; a loan tied to the property (instead of the system owner's credit standing); a repayment obligation that transfers with the sale of the property; and the potential to deduct the loan interest from federal taxable income as part of the local property tax deduction. For local governments the benefits are also clear. This financial model can help local governments meet climate and energy goals with little to no liability or exposure to a municipality's general fund. These programmes do have administrative costs, but those costs can be included in the bond issuance and be repaid by programme participants. Because the programme can be structured to fully leverage private investment, a municipality or county can implement a property assessed clean energy programme with almost zero budget impact.

Develop or Improve Renewable Energy Access Laws: Solar access laws encourage more widespread adoption of solar energy by increasing the likelihood that properties will receive sunlight suitable for solar energy production, protecting the rights of property owners to install solar systems and reducing the risk that systems will be shaded and compromised once installed.

Streamline and Improve Renewable Energy Permitting Processes: Simplifying permitting requirements and processes can increase the likelihood of successful renewable energy installations and save a significant amount of time and money. Creating consistent permitting processes across a state or region benefits renewable energy installers by providing a standard set of operating procedures, reducing uncertainty, and allowing them to produce more accurate estimates.

Promote Installer Licensing and Certification: Consumers, local governments, and the industry should all benefit from an energy efficiency and renewable energy market that encourages high-quality installations through licensing and certification. Consumers benefit when contractors are

essentially "pre-screened" according to government standards. The expectation is that encouraging licensing and certification will result in baseline standards being met, which will in turn lead to higher consumer confidence and satisfaction (and therefore fewer contract disagreements). Licensed and certified installers benefit from possessing credentials that demonstrate their proficiency and experience with installing clean energy technologies. Licensing and certification benefits local governments by promoting high-quality installations and building a skilled workforce. Using nationally recognized programmes relieves municipalities of the need to create their own certification standards.

Improve Building Energy Efficiency Codes: Improving building energy codes for public and private buildings helps achieve community-wide energy-reduction, environmental, and sustainability goals, and results in significant near- and long-term energy cost-savings. Building codes that mandate certain levels of energy efficiency help ensure that renewable energy systems will be used most cost-effectively.

Engage the Utility: Work with the electrical utility to promote energy efficiency. Many utilities will cover the costs of basic energy audits and even some efficiency measures, such as replacing incandescent light bulbs with CFLs. Government can lead the way by requiring energy audits of all government buildings and investing in energy efficiency improvements.

Improve net-metering rules. Net metering encourages customer investment in renewable energy by allowing customers who install such systems to receive credit for excess electricity generation, which improves their return on investment. Utilities benefit from net metering if customer-sited generation is located in an area that allows a utility to avoid distribution and transmission system upgrades. Utilities also benefit when they own renewable energy credits associated with net-metered generation and can use those credits to meet national renewable energy requirements.

Optimize rate structures for renewable energies. Working with your utility to create rate structures optimized for renewable energy technologies will improve the economics of renewable energy in your community.

Rhône -Alpes Eco-Building

This eco-building in the Urban Best Practice Area of the Shanghai Expo is based on a building in Valence in the Rhône-Alpes region of France. It showcases economic innovations and a sustainable environment, and is widely reputed for its high quality of work/life balance.

The building's design incorporates state of the art energy-efficient equipment for heating, ventilation and air conditioning, as well as environment-friendly materials to reduce energy consumption and improve indoor air quality, making it a standard for eco-building in the Rhône-Alpes region.

The pavilion is built with innovative natural building materials made from recyclable calcined clay. This helps to keep energy consumption to a minimum while providing a comfortable environment in terms of temperature, humidity, light and sound effects. A planted rooftop functions to purify the air, regulate temperature, add coolness in summer, and ensure quick drainage during rainstorms.

2.3. POLICY MEASURES FOR REDUCED WATER USE

Use Low Impact Development. Capturing and reusing storm water runoff can greatly reduce the consumption of imported, potable water, as well as the energy usage and CO2 emissions associated with importing water. When runoff is diverted and captured before it flows into surface waters, it can be used onsite either to replenish groundwater supplies through infiltration or for graywater uses, like landscape irrigation and toilet flushing. These techniques are known as low-impact development, the central objective of which is to maintain individual sites' pre-development hydrology. Low impact development uses common sense and simple technology— landscaping with native plants, rain barrels, "green roofs," porous surfaces for sidewalks, parking lots and roads, and other measures—to retain rainfall onsite or to help rainfall soak into the ground, rather than flowing into and perhaps polluting the nearest body of water. In effect, low impact development mimics nature's own filtration systems. In addition to reducing water and energy use, the result is less water pollution from contaminated runoff, less flooding, replenished water supplies, and often more natural-looking, aesthetically pleasing cityscapes.

Recycle and Reuse Wastewater. Because water suitable for reuse is often a by-product of existing wastewater treatment processes, this type of water recycling is a low-energy source of water supply. This is especially true in areas where enormous amounts of energy may be required to import water. Recycled water can be delivered to users, usually at less cost than non-recycled water, for anything from irrigating golf courses, parks, and crops, to mixing concrete, to firefighting.

Promote and expand water regulations in building codes. A number of countries now label products that meet water-efficiency performance criteria. Typical labeling programmes set specifications for the labeling of products that are at least 20 per cent more efficient than the current standards while performing as well or better than their less-efficient counterparts. All water savings realized through the use of labeled products and services also often have a corresponding reduction in energy consumption. The US Environmental Protection Agency estimates that if just one out of every 100 American homes were retrofitted with water-efficient fixtures, about 100 million kilowatt-hours of electricity per year would be saved each year. Local governments can expand and promote such programmes by: i) offering rebates for the purchase of labeled water-efficient products; ii) offering tax credits for purchasing such labeled products; iii) requiring labeled water-efficient products in new construction and in government buildings through appropriate building codes.

2.4. POLICIES FOR IMPROVED INTERNAL ENVIRONMENT AND AIR QUALITY

Strengthen building codes and planning requirements. Building codes can mandate that the construction industry choose only better building materials and interior finish products with zero or low emissions to improve indoor air quality. Building codes can also require more daylighting, better quality lighting products, as well as enhanced ventilation and air filtration.

The Benefits of Daylighting

Higher occupant productivity and satisfaction are likely to result from the better visual quality that is provided by good daylighting design. Daylight provides the truest and most vivid color rendition of all available light sources. There is also evidence that the high concentration of blue wavelengths in daylight help the eye to see more detail with greatest precision, especially at lower light levels. Mental stimulation is perhaps the biggest benefit of natural light. Daylight reinforces natural circadian rhythms and the production of neural transmitters, such as seratonin. Higher illumination levels have been associated with greater mental acuity and the simple variability of daylight may be key to mental stimulation. Students with the most daylighting in their classrooms progressed 20 per cent faster on math tests and 26 per cent faster on reading tests in one year than those with less daylighting.[8]

Carnegie Melon University's Intelligent Workplace design studio found that daylighting improves worker productivity by 5 per cent to 25 per cent. In one case study it found that an extra up-front cost of $370,000 saved almost $700,000 in energy and operating costs for a typical workplace. However, the resulting gains in productivity were worth as much as $14 million. Here's why: In a typical building, energy costs average $1.50 to $2.50 per square foot, while salaries exceed $200 per square foot. Cutting energy use in half typically saves $1 per square foot per year, while boosting productivity just 5 per cent saves more than $10 per square foot.[9]

3. CASE STUDIES

3.1. MADRID BAMBOO ECO-BUILDING

Like many cities, Madrid has a housing shortage. Providing new affordable public housing in a sustainable manner is not an easy task. But a recently developed award winning design is attracting much attention. As a result, Spain's capital city Madrid contributed a highly ecological exhibition to the World Expo 2010 Shanghai -- a bamboo building. The 18-meter high building of bamboo originated from a residential block in southern Madrid. The architecture received an award from the respected Royal Institute of British Architects.

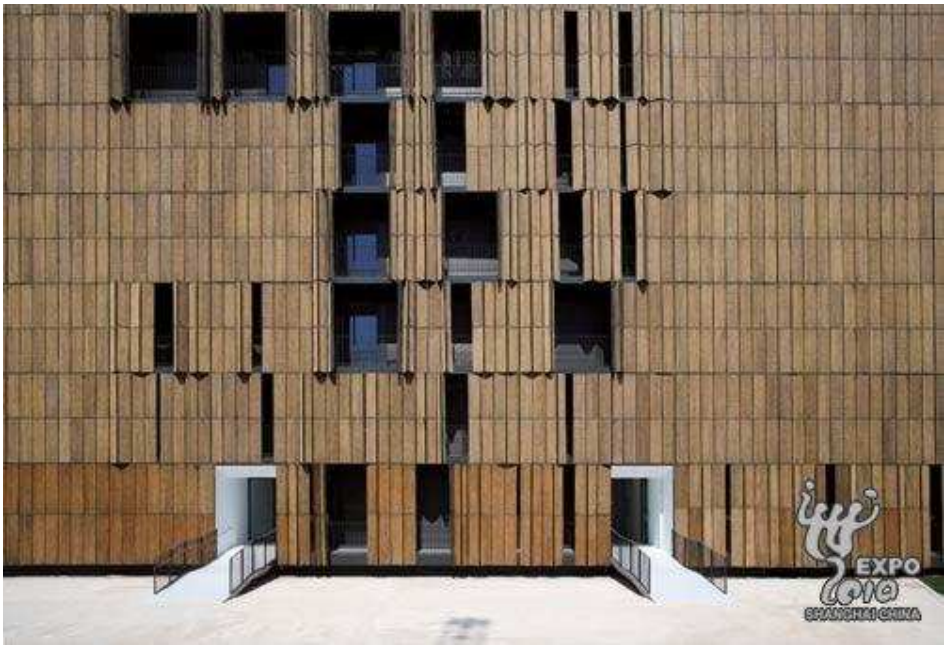
The building, which was displayed in the Urban Best Practices Area of Shanghai Expo 2010, is highly energy efficient and represents an advanced model for urban living through the use of renewable energies and green building products. Energy-saving glass, which can help absorb light, is installed in part of the building to adjust to the climate of Shanghai and minimize the effect of greenhouse emissions.

Water, wind power and solar energy are transformed into electricity inside the building, which is fully self-sufficient in terms of energy generation and produces zero CO_2 emissions.

[8] Heschong Mahone Group (1999). Daylighting in Schools: An Investigation into the Relationship Between Daylighting and Human Performance

[9] http://www.cool-companies.org/profits/

The pavilion is based on the leading role that some architects are giving bamboo in their latest housing schemes in Spain. There are two main reasons for doing so -- it's eco-friendly and it's low cost. The Bamboo Housing area is a rent-control project founded and operated by the municipal government of Madrid. Currently, it is home to 88 families.



The Madrid Bamboo Eco-building at the Urban Best Practices Area of the Shanghai Expo.

Photo courtesy of Shanghai Expo.

Bamboo louvers mounted on folding frames cover the façades of the building in Madrid's Carabanchel public housing development in the city's southern suburbs. The basic parallelogram block contains units of different shapes and sizes which, thanks to their interior design, all have a dual east-west orientation as well as access to a private garden on the eastern side. The louvers, or shutters on folding frames, provide various functions. They help control temperatures and reduce noise; they form an attractive façade; they provide shade to the extensive veranda areas forming part of the living space inside each apartment; they are a sustainable material; and they also allow the living space to be opened completely to the outside world to let in light and air during pleasant weather.

A further green aspect is the use of solar water-heating panels on the roof, plus wind chimneys to ventilate internal bathrooms and kitchens. These elements on the rooftop are not visible from below, as the bamboo-clad facades are extended upwards on steel frames to conceal it. The bamboo is treated to last, fireproofed, and can easily be replaced over time.

Lessons learned:

Local governments should actively encourage innovation in the design of public housing projects. When free to experiment, architects can make more creative use of new materials and renewable energy technologies. Innovative designs can enhance livability while at the same time reduce building operation and maintenance costs.

3.2. HAFENCITY ECO-BUILDING

“HafenCity" is one of the largest urban renovation projects in Europe in which old facilities are being renovated into commercial and residential eco-buildings. At the Shanghai Expo, an example of a HafenCity eco-building was constructed as an urban best practice pavilion. The structure incorporates a district heating system, intelligent ventilation system, and many other sophisticated technologies to create a quality eco-building. It is certified as a "passive-house", which means an ultra-low energy building that requires little energy consumption for heating or cooling. Solar, wind and geothermal energy are used as additional energy sources for cooling, heating and power supply. A special brick wall is applied on three exterior sides to maintain warmth in winter and cool in summer; the rest of the exterior is a glass curtain wall that allows natural light into interior spaces. The building consumes only 50 kilowatt-hours of energy per square meter each year, a fourth of what is normally required.

The urban best practice pavilion is based on the community of Haften City in Hamburg, Germany. This is a new community development in the heart of the city’s industrial port where leading-edge standards are being put into place. Ecological sustainability is inherent in the design of many of the new buildings, but the underlying concept of HafenCity itself is founded on the sensible use of resources.

The development will provide homes and workplaces, cultural and recreational opportunities, as well as high-quality public spaces. Hamburg is no longer growing on its periphery. Instead old areas of the port are being upgraded – expanding the usable area of the city by 40 per cent. Overall, HafenCity is being densely built. This density yields an efficient utilization of land that is made more livable by its waterside location.

In some former industrial sites, contaminated soil had to be removed; thus enhancing the ecological value of the old industrial area. Plazas, promenades and parks are now taking shape on a total area of approximately 27 hectares. HafenCity will not have a single parking garage above ground – except for the Elbphilharmonie Concert Hall. Generous space is provided in underground parking garages in the basements of buildings, but parking above ground is strictly limited.

Because the HafenCity development is in the heart of the port city, it can be reached very easily without a car. Two subway stops guarantee excellent connections to local public transport services. Cyclists and pedestrians can cover the route between the new city district and city center in minutes.

Within HafenCity, mixed use development of commercial, retail, restaurants, and residential buildings ensures short distances to almost everywhere. Through a close-knit network of foot and bicycle paths, pedestrians have two and a half times as many kilometers of pathway at their disposal as motorists. Seventy per cent of foot and cycling paths are separated from motorized traffic on promenades, piers and squares, and 30 per cent are adjacent to the water. Since HafenCity has few extended blocks of buildings, pedestrians and cyclists seldom have to take a long way round. Thoroughfares exist between many free-standing buildings with guaranteed public rights of way.

Publicly available bicycles are ready for use, supplied by the new Hamburg city bike rental system. Low car ownership is also being promoted in eastern HafenCity. This means that residents of a building will agree to go without a car of their own, and instead participate in a car-sharing system.

Supply of heat to the new district is provided by innovative means. An upper emission limit value of 175 grams of carbon dioxide per kilowatt hour (g/kWh) will not be exceeded. Compared with gas-powered heating units in individual buildings, this amounts to a reduction of 27 per cent. All buildings in western HafenCity are connected to district heating networks for this purpose. In combination with decentralized heat generated by fuel-cell technology and solar thermal energy, this produces a very efficient blend of energy. Geothermal plants are also used in individual buildings.

Heat supply for HafenCity's eastern section will see CO_2 emission limits reduced even more significantly to just 89 g/kWh. The concept incorporates a local energy supply network, fed by various power units both within and outside HafenCity. A woody biomass-fired combustor, a biomethane fuel cell and a heat pump – almost all renewable energy sources – will be deployed. Because of its decentralized structure, the system can grow with the new neighborhood. Flexibility was a crucial factor, since development of HafenCity will continue into the 2020s, and future energy demand cannot be accurately estimated.

Sustainability is also being pioneered in the implementation of individual construction projects. Since 2007, HafenCity has been awarding gold and silver Ecolabels for special achievements in developing sustainable buildings. The award is designed to motivate private and public developers to handle resources responsibly. In addition to the ecological factors, the label also evaluates economic and social sustainability.

Initially the Ecolabel applied to residential and office space construction. But since increasing numbers of buildings with retail or hotel uses and multi-uses are going up in central and eastern HafenCity, these building types are also being certified as of 2010. The aim is to reach a level of 30 per cent gold certification throughout central and eastern HafenCity, although the actual level achieved is expected to be a lot higher. In the future, buildings which include residential uses will only be able to be built if they comply with the gold standard Ecolabel.

Lessons learned:

Urban redevelopment projects that convert brownfields to greenfields can capture the imagination of a city and help recast the image of the city as an innovative, creative and livable space.

Integrated approaches to rethinking a community can solve multiple urban challenges related to land use, housing shortages, energy supply, transportation and access to cultural services.

3.3. US GREEN BUSINESS COUNCIL'S LEED PROGRAMME

LEED is an internationally recognized green building certification system It provides third-party verification that a building or community was designed and built using strategies aimed at improving performance across a number of important metrics. Those metrics include: energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.

Developed by the U.S. Green Building Council, LEED provides building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

LEED is a flexible framework that can be applied to all building types – commercial as well as residential. It works throughout the building lifecycle – design and construction, operations and maintenance, and significant retrofit.

LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. Architects, real estate professionals, facility managers, engineers, interior designers, landscape architects, construction managers, lenders and government officials all use LEED to help transform the built environment to sustainability. State and local governments across the country are adopting LEED for public-owned and public-funded buildings. Apart from the U.S., the LEED scheme is being applied to projects in Canada, Brazil, Mexico and India.

LEED rating systems are developed through an open, consensus-based process led by LEED committees. Each volunteer committee is composed of a diverse group of practitioners and experts representing a cross-section of the building and construction industry. The key elements of the consensus process include a balanced and transparent committee structure, technical advisory groups that ensure scientific consistency and rigor, opportunities for stakeholder comment and review, and a fair and open appeals process.

LEED points are awarded on a 100-point scale, and credits are weighted to reflect their potential environmental impacts. A project must satisfy all prerequisites and earn a minimum number of points to be certified. Basic certification requires 40-49 points, Silver requires 50-59 points, Gold requires 60-79 points, and Platinum requires 80 or more points.

The Green Building Certification Institute assumes administration of LEED certification for all commercial and institutional projects registered under any LEED Rating System.

Lessons learned:

Building standards with measurable criteria have proven to be a good basis around which communities of practitioners can come together to design and build more sustainable buildings. A framework should allow enough flexibility for its application across all manner of residential and commercial buildings. Different levels of certification allow builders to pursue certification levels commensurate with their level of available financing.

3.4. GREEN BUILDING CONSTRUCTION IN A HOT CLIMATE -- MASDAR CITY, UNITED ARAB EMIRATES

Illustration of the Masdar Headquarters building and its innovative green architecture.
Image credit: Adrian Smith + Gordon Gill Architecture

Masdar City is being designed and developed in an integrated way following sustainable development principles. It will be a carbon-neutral, zero-waste city for 40,000 inhabitants powered entirely by renewable energy. Building performance indicators are divided between design, construction, and operation. The specifications cover performance requirements for buildings, building structure, components, systems, materials, finishes and supply chains. A restricted materials list specifies materials with negative environmental impacts whose use should be avoided.

The Masdar Headquarters building is meant to set an example for future development in the city. This example will reduce energy use and waste production in each building to a level that can be handled by the city's renewable energy systems and its waste-to-energy plants. This building is set to become the world's first mixed-use, positive-energy building. The building is designed to produce more energy than it consumes, produce zero solid and liquid wastes, and reduce its water needs by 70 per cent.

The design of Masdar HQ is dominated by adaptations of traditional wind towers which draw hot air upwards during the day. At night, the wind cones reverse roles acting as inlet wind towers drawing cool night air downwards to cool the building structure.

The building's form shades the entire building structure to reduce its solar heat gain. A seven-acre large canopy with a substantial overhang dominates the building's roof and is structurally integrated with the cones that support it to create a superstructure around which the building spaces and functions are arranged. In addition to its role in shading, the roof canopy also incorporates one of the world's largest photovoltaic and solar thermal arrays, simultaneously producing electricity from solar photovoltaics and providing thermal energy for solar cooling.

In addition to these form-giving passive strategies, the building also features many passive strategies that are less obvious to the casual observer. One example is the use of high-thermal-mass exterior glass cladding to reduce heat gain while keeping transparency to preserve views and increase daylighting. Under the building, earth ducts are used to reduce the building temperature through contact with the almost constant temperature of the earth below. The ducts also act as underground pedestrian passages that connect the building with the proposed mass transit system. The building's walls are constructed of heavy masonry with a 30 per cent glazing ratio to achieve a high thermal mass and reduce the indoor heat gain.

The building also has a number of active systems to cool and ventilate the building, including ground source cooling, an efficient underfloor air distribution system integrated into office furniture, and the world's largest solar thermal driven cooling and dehumidification system. The design also features the use of integrated renewable energy generation, such as wind turbines and the above-mentioned photovoltaic systems. The installation of these renewables will help make the building a net energy producer, generating 3 per cent more energy than it consumes.

Water scarcity in the Gulf States makes it necessary to implement water conservation strategies. At Masdar the plan is to save 70 per cent of the building's water use compared to business as usual. This

in turn will reduce the city's energy demand, since most of the water supply comes from desalination plants. Rainwater and condensation are collected, stored, and used -together with grey water from showers, laundries, and lavatories- to irrigate the shaded roof garden. Grey water is also used to flush toilets.

Masdar HQ's plans to reduce the building's environmental footprint also address the energy embodied in the materials used to construct it. Recycled materials and rapidly renewable materials were specified wherever possible. Flexible, modular, prefabricated materials and furniture were also specified to make the process of recycling them easier.

Passive solar design strategies alone are estimated to contribute 52 per cent of energy savings. The remaining portion of the 103 per cent in energy savings (including the 3 per cent of positive energy generation) is achieved through efficient active systems (20 per cent) and renewable energy generation (31 per cent).

Lessons learned:

In many green buildings in Europe and the United States, the role of passive design strategies is overshadowed by that of efficient energy systems. This is partly due to the climatic conditions in their cities where buildings have considerably greater heating loads than cities in tropical regions. This resulted in the preeminence of engineering concerns over the architectural designs of the architect.

In tropical regions, with much of the sustainable design process geared towards blocking heat away rather than generating it efficiently, the contribution of passive strategies in overall energy savings in green buildings is larger.

3.5 WATER EFFICIENCY IN GREEN BUILDINGS AND GREEN SPACES

George Washington University (GWU) wanted to convert Square 80, an underutilized parking space and trash collection area, into an urban, multi-functional, sustainable plaza. Completed in 2010, it now serves as an urban plaza with a central open space and an outdoor classroom for the university's Sustainable Landscapes programmes. Square 80 harvests 100 per cent of on-site rainwater for irrigation, maintenance and other amenities. It fits well with the University's Sustainable Vision: "The GWU community is building a greener campus, providing research and intellectual discourse on policies and pathways to sustainable systems, and equipping students with the skills and knowledge to contribute to a sustainable future."

The project was part of the Sustainable Sites Initiative, a partnership of the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin, and the United States Botanic Garden. The programme's objective is to transform land development practices with the first national rating system for sustainable landscapes. Square 80 is one of about

150 projects within the initiative's pilot programme. The U.S. Green Building Council, a stakeholder in the initiative, anticipates incorporating these guidelines into future iterations of the LEED Green Building Rating System.

Key elements of the project included rainwater harvesting, use of native plants, installation of porous paving, roof water collection, cisterns, biofiltration planters, a raingarden and a bioswale.

Rainwater Harvesting - The plaza design implements numerous low impact development practices in order to clean, store and reuse the harvested rainwater. These practices maintain and enhance the pre-development hydrology of urban watersheds.

Native Plants - The majority of the plants used at Square 80 are native species. The remaining plants, with the exception of the lawn, are non-invasive, adaptive species that tolerate regional soils and climate. After they were established, the trees, shrubs, grasses and groundcover no longer required supplemental irrigation, so harvested rainwater could be completely allocated to the open lawn.

Pervious Paving - Conventional impervious paving causes water to quickly sheet flow over the surface and into gutters and storm drains, often causing flooding during a heavy rain event. Pervious paving allows water to move vertically through the paving material to slowly infiltrate and recharge groundwater. Water flows through the joints between pavers, filters through the gravel subbase, percolates into the native subgrade and ultimately recharges the groundwater. At Square 80, excess water that does not infiltrate the soil below is collected into a pervious PVC underdrain and channeled to the underground cistern for storage and reuse on site. Including pervious paving in any urban setting creates a cleaner environment and can save on costly stormwater infrastructure and filtration systems.

Roof Water Collection - Utilizing existing gutter and downspout systems, rainwater can be re-routed to rain barrels and cisterns. These components allow the reuse of water that would otherwise flow into storm drains. At Square 80, overflow from the rain barrel is piped to the underground cistern, while water in the 300-gallon rain barrel is used for routine maintenance.

Cisterns - Using cisterns for rainwater harvesting makes it possible to eliminate reliance on potable water. In the plaza, all stormwater collection systems convey water to three underground cisterns with 8,000, 10,000, and 15,000-gallon capacities, respectively. Rainwater from the buildings' roof downspouts, the drain inlets and trench drains, the pervious paving, and the overflows from the biofiltration tree planters, rain garden and bioswale are all collected and stored in the underground cisterns. Prior to the water reaching the cisterns, it is flushed by the vortex fine filter separators, which remove small debris. The stored water is redistributed to either the irrigation system or the rainwater fountain feature at the center of the plaza.

Biofiltration Planter - At the plaza, runoff from the paved sidewalk flows toward the linear trench drains at the edge of the walkway. The trench drains act as a water runnel, conveying water to a series

of biofiltration tree planters. The soil is depressed below the paved surface to retain stormwater while it slowly infiltrates the soil into the native subgrade. These planters are designed to hold six inches of standing water. Native Willow Oak trees and native grasses are planted at Square 80.

Biofiltration Planters and Rainwater Garden at the George Washington University Square 80 green space.

Rain Garden and Bioswale - A rain garden is a shallow planting bed depressed six to eight inches that collects water runoff from impervious surfaces like sidewalks, roads, compacted lawns and roof downspouts. A bioswale is a rain garden with a slight gradient. It captures surface water during a rain event, and allows the water to flow slowly and infiltrate the enriched soil into the native subgrade. In Square 80's rain garden, Blue Flag Iris is planted with a Sweet Bay Magnolia, while the bioswale has a diverse planting of native grasses and groundcovers.

Rainwater Irrigation Pump - Square 80 is irrigated using filtered rainwater from on-site collection. Water lines are gravity fed from underground storage cisterns to the irrigation pump, which then distributes it to the planting beds organized in zones. Ninety per cent of the irrigation system is designed as drip irrigation, the most efficient way of delivering water to plants by supplying slow, steady and precise quantities of water.

Rainwater for Fountain - The rainwater fountain sources 100 per cent of its water from on-site rainwater harvesting. A designated cistern collects and stores approximately 600 gallons of water beneath the plaza surface. In addition to the pump, the fountain system is equipped with a UV filtration unit that helps clean the rainwater by removing bacteria, algae and protozoa, making it safe for human interaction. The use of this UV filtration process reduces the amount of chemicals needed for water treatment.

4. Policy Options on Green Buildings for Better City, Better Life

Strategy 1: Executive leadership on green buildings

POLICY OPTIONS	
option 1	Establish a city cabinet-level position focused on Sustainability.
option 2	Lead by example, implementing green strategies and proven technologies on city facilities before asking the private sector to do the same; audit city facilities for energy and water performance to establish a baseline and set goals for improvement; hold departments accountable for achievement of their goals.
option 3	Require training for departments responsible for physical infrastructure in the use of life cycle evaluation, consideration of long term operating costs, and assessment of environmental impacts as criteria for decision-making.
option 4	Foster interdepartmental communication to enable collaborative decision-making that would justify the investment in green building for the long-term interests of the city.
option 5	Change city budgeting process so that each department is responsible for paying for utilities from its own operating budget. Savings should accrue to the department to reward responsible behavior.

Strategy 2: Catalyze investments in green buildings

POLICY OPTIONS	
option 1	Establish green building labeling schemes to provide information to potential buyers and to provide builders with a new marketing tool.
option 2	Create favourable tax policies to incentivize construction of new green buildings by making up the 2-5 per cent higher cost for green construction.
option 3	Create favourable interest rate financing policy to further encourage green building construction.
option 4	Establish special funding for financing energy-efficient retrofits of existing buildings. Without special funding, such retrofits may not occur.
option 5	Reform energy price schemes (taxes, subsidies) to accelerate the realization of energy savings by making the case for renewable energy applications and energy efficiency measures more economically feasible.

Strategy 3: Promote renewable energy applications and energy efficiency in the built sector

POLICY OPTIONS	
option 1	Accelerate demand for renewable energy applications through provision of direct cash incentives to customers.
option 2	Adopt feed-in tariffs to assure investors about future revenue, drive more capital to the market, and get more renewable energy applications integrated into new green buildings.
option 3	Offer soft loans (lower interest rates, better terms, lower transaction costs) for renewable energy systems.
option 4	Create a property assessed clean energy financing programme. Because these programmes can be structured to fully leverage private investment, a city can implement such a programme with almost zero budget impact.
option 5	Develop or improve renewable energy access laws. These will protect the rights of property owners to install solar systems and reduce the risk that systems will be shaded and compromised once installed.
option 6	Improving building energy efficiency codes for public and private buildings to achieve city-wide energy reduction that will result in significant near- and long-term energy cost-savings.
option 7	Streamline and improve renewable energy permitting processes to encourage RE installations, save time and money, and benefit installers by providing a standard set of operating procedures.
option 8	Strengthen installer licensing and certification programmes. Consumers, local governments, and the industry should all benefit from a renewable energy market that encourages high-quality installations.
option 9	Improve utility net-metering rules. This will encourage customer investment in renewable energy by allowing customers who install such systems to receive credit for excess electricity generation, which improves their return on investment. Utilities benefit by gaining new generation that supports distribution in that area.
option 10	Optimize rate structures for renewable energies: Working with your utility to create rate structures optimized for renewable energy technologies will improve the economics of renewable energy in your community.

Strategy 4: Policy measures for reduced water use

	POLICY OPTIONS
option 1	Promote low impact development by capturing and reusing stormwater runoff instead of polluting nearby waterways. Stormwater can be used onsite either to replenish groundwater supplies or for graywater uses, like landscape irrigation and toilet flushing.
option 2	Encourage recycling and reuse of wastewater. This is a low-energy type of water supply as reusable water is often a by-product of existing wastewater treatment processes.
option 3	Fix leaking drinking water pipes. Water treatment processes use large quantities of energy to treat and distribute water to customers. Yet many drinking water systems lose as much as 20 per cent of water each year due to leaks in their pipe networks. Improving this infrastructure would save water and energy.
option 4	Promote and expand the water regulations in building codes. Local governments can expand and promote such programmes by: i) offering rebates for the purchase of labeled water-efficient products; ii) offering tax credits for purchasing such labeled products; iii) requiring labeled water-efficient products in new construction and in government buildings
option 5	Require and provide incentives for agricultural water-use efficiency. Since cities often compete with regional farming for water supply, it is important to include agriculture in regional water planning. Even modest water use efficiency measures have the potential to vastly improve water use efficiency.

Strategy 5: Policies for improved internal air quality

	POLICY OPTIONS
option 1	Strengthen building codes to mandate that the construction industry choose only better building materials and interior finish products with zero or low emissions to improve indoor air quality. Building codes can also require more daylighting, better quality lighting products, as well as enhanced ventilation and air filtration.

5. LINKS FOR FURTHER INFORMATION

- www.buildup.eu/home : energy solutions for better buildings.

- www.ecoarchwiki.net : Building case studies, good energy-oriented work
- www. intendesign.com : Integrated energy design in public buildings:
- www.esprojects.net/en/energyefficiency/
- California Integrated Waste Management Board Green Building Web site: http://www.calrecycle.ca.gov/GreenBuilding/. Includes the manual Designing With Vision: A Technical Manual For Material Choices In Sustainable Construction (Pub. #431-99-009), http://www.sustainable.doe.gov/freshstart/articles/ptipub.htm
- A Guide to Irrigation Water Needs of Landscape Plants in California: www.dpla.water.ca.gov/urban/conservation/landscape/wucols/
- Department of Health Services, Indoor Air Quality Web site: www.cal-iaq.org
- U.S. Department of Energy Web site: www.sustainable.doe.gov/buildings/gbintro.shtml
- Environmental Building News: www.buildinggreen.com/
- U.S. Green Building Council Web site: www.usgbc.org
- Building Green: overcoming barriers in Philadelphia
- http://www.pecpa.org/sites/pecpa.org/files/downloads/2-27-08_BuildingGreen_FINAL.pdf
- IEA (2008) Energy Efficiency Requirements In Building Codes, Energy Efficiency Policies For New Buildings
- Sustainable Building Practices for Low Cost Housing, UN Habitat, 2010