2009

Sustainable Construction Handbook

CLIMATE CHANGE AND SUSTAINABLE CONSTRUCTION WORKSHOP

Seychelles Institute of Technology

7/23/2009

TABLE OF CONTENTS

WORKSHOP OVERVIEW

Climate change workshops for professionals in the construction sector

As a small island developing state, Seychelles is extremely vulnerable to the impacts of climate change. It is critical now that the population of Seychelles becomes more aware and pro-active in terms of how they can both mitigate and adapt to the effects of climate change. Professionals in the construction industry need to be made aware of the causes and impacts of climate change, to help them adopt new practices in their professional fields in response to climate change. Sustainability for Seychelles (a local NGO) has secured funding from LUNGOS to hold two one day workshops for the construction industry: one for construction students at the SIT, and the second for construction professionals. These workshops are being organised by Sustainability for Seychelles in collaboration with its partners the Sea Level Rise Foundation (SLRF), the Department of Risk and Disaster Management (DRDM), Seychelles Bureau of Standards (SBS) and Seychelles Institute of Technology (SIT).

Workshop objectives:

1) To increase construction professionals awareness of climate change and its expected impacts on Seychelles and on the construction industry
2) To introduce examples of construction design and materials that reduce Seychelles' contribution to global warming, and help us prepare for and adapt to the expected impacts of climate change.
3) To engage participants in a hands-on exercise to apply knowledge of design and materials in construction projects.
4) To inspire workshop participants to apply what they have learned to their work in the construction industry.

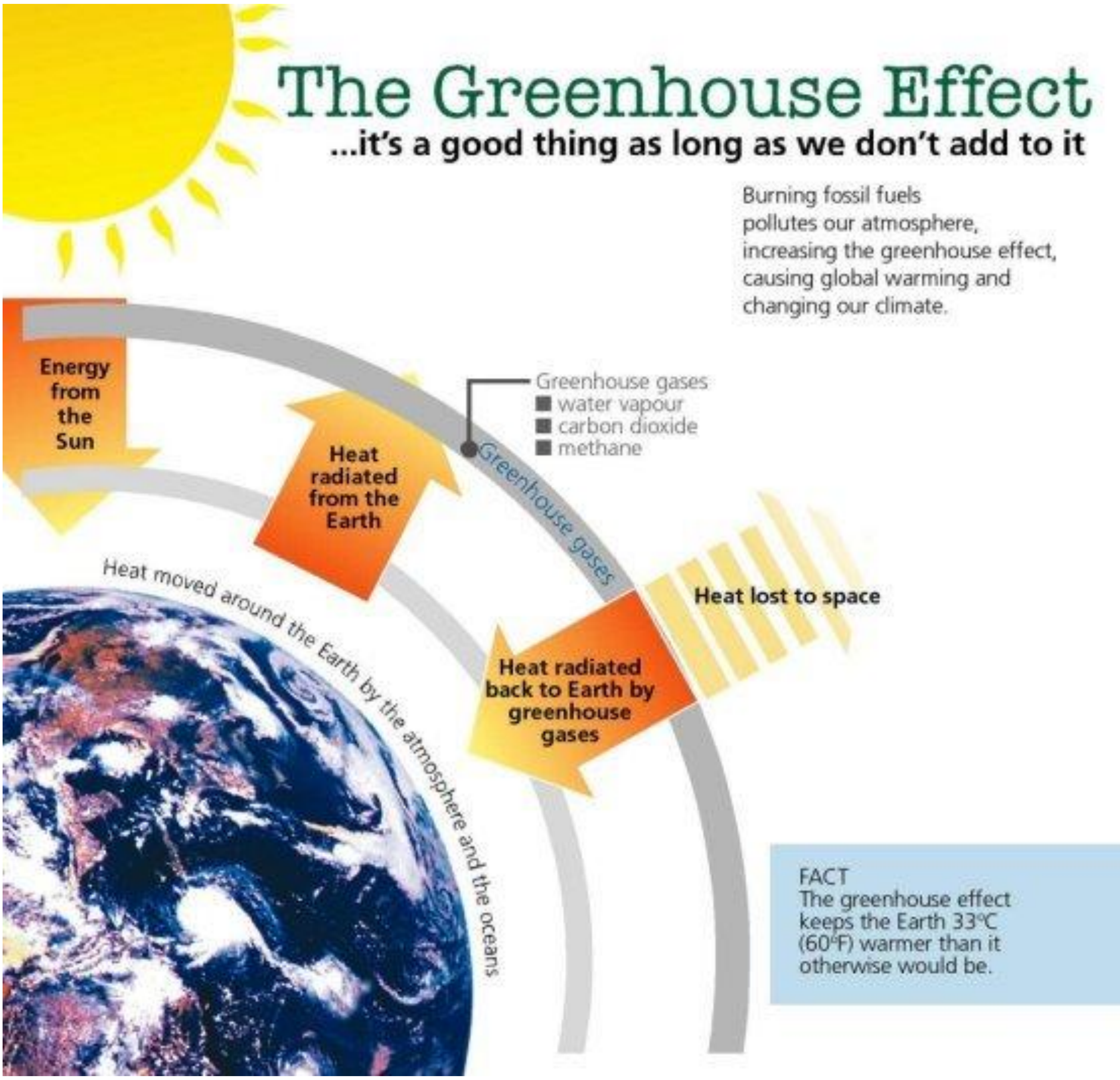
Workshop Facilitators from Sustainability for Seychelles:
Iris Carolus tel.511292 carolusiris@yahoo.co.uk
Michele Martin tel.525794 sustain@intelvision.net

WORKSHOP AGENDA (CONSTRUCTION PROFESSIONALS)

Thursday, July 23rd, 2009 at the SIT, Providence

9:00 – 9:15	Registration	
9:15 - 9:30	Welcome and Opening	SIT Director, LUNGOS, S4S Chair
9:30 – 9:40	Icebreaker Game	S4S
9:40 – 10:10	Introduction to Climate Change	SLRF: Film and PPT
10:10 – 10:30	BREAK	
10:30 – 11:00	Risk, Building Disasters & Disaster Mitigation in Construction	DRDM: PPT
11:00 – 11:30	Sustainable Building Design	S4S:PPT
11:30 – 11:40	Building Code Response to Climate Change	Planning Authority: PPT
11:40 – 12:10	Site Visit: Materials testing at SBS	SBS / SIT / S4S
12:15 – 1:15	LUNCH	SIT Canteen
1:15 – 2.00	Task: Designing a house/building for climate change	SIT/S4S
2.00 – 3.00	Group presentations and discussion	S4S
3.00 – 3:15	Workshop conclusion and evaluation	S4S
3.15	BREAK	

INTRODUCTION TO CLIMATE CHANGE



Source: http://studentsagainstclimatechange.blogspot.com

Sustainable (Green) Building Basics

Source: http://www.ciwmb.ca.gov/GREENBUILDING/Basics.htm

Buildings account for one-sixth of the world's fresh water withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows (Roodman and Lenssen, 1995). Building "green" is an opportunity to use our resources efficiently while creating healthier buildings that improve human health, build a better environment, and provide cost savings.

What Makes a Building Green?

A green building, also known as a sustainable building, is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment.

What Are the Economic Benefits of Green Buildings?

A green building may cost more up front, but saves through lower operating costs over the life of the building. The green building approach applies a project life cycle cost analysis for determining the appropriate up-front expenditure. This analytical method calculates costs over the useful life of the asset.

These and other cost savings can only be fully realized when they are incorporated at the project's conceptual design phase with the assistance of an integrated team of professionals. The integrated systems approach ensures that the building is designed as one system rather than a collection of stand-alone systems.

Some benefits, such as improving occupant health, comfort, productivity, reducing pollution and landfill waste are not easily quantified. Consequently, they are not adequately considered in cost analysis. For this reason, consider setting aside a small portion of the building budget to cover differential costs associated with less tangible green building benefits or to cover the cost of researching and analyzing green building options.

Even with a tight budget, many green building measures can be incorporated with minimal or zero increased up-front costs and they can yield enormous savings (Environmental Building News, 1999).

Elements of Green Buildings

Siting

- Start by selecting a site well suited to take advantage of mass transit.
- Protect and retain existing landscaping and natural features. Select plants that have low water and pesticide needs, and generate minimum plant trimmings. Use compost and mulches. This will save water and time.
- Recycled content paving materials, furnishings, and mulches help close the recycling loop.

Energy Efficiency

Most buildings can reach energy efficiency levels far beyond California Title 24 standards, yet most only strive to meet the standard. It is reasonable to strive for 40 percent less energy than Title 24 standards. The following strategies contribute to this goal.

- Passive design strategies can dramatically affect building energy performance. These measures include building shape and orientation, passive solar design, and the use of natural lighting.
- Develop strategies to provide natural lighting. Studies have shown that it has a positive impact on productivity and well being.
- Install high-efficiency lighting systems with advanced lighting controls. Include motion sensors tied to dimmable lighting controls. Task lighting reduces general overhead light levels.
- Use a properly sized and energy-efficient heat/cooling system in conjunction with a thermally efficient building shell. Maximize light colors for roofing and wall finish materials; install high R-value wall and ceiling insulation; and use minimal glass on east and west exposures.
- Minimize the electric loads from lighting, equipment, and appliances.
- Consider alternative energy sources such as photovoltaics and fuel cells that are now available in new products and applications. Renewable energy sources provide a great symbol of emerging technologies for the future.
- Computer modeling is an extremely useful tool in optimizing design of electrical and mechanical systems and the building shell.

Materials Efficiency

- Select sustainable construction materials and products by evaluating several characteristics such as reused and recycled content, zero or low off gassing of harmful air emissions, zero or low toxicity, sustainably harvested materials, high recyclability, durability, longevity, and local production. Such products promote resource conservation and efficiency. Using recycled-content products also helps develop markets for recycled materials that are being diverted from California's landfills, as mandated by the Integrated Waste Management Act.
- Use dimensional planning and other material efficiency strategies. These strategies reduce the amount of building materials needed and cut construction costs. For example, design rooms on 4-foot multiples to conform to standard-sized wallboard and plywood sheets.

- Reuse and recycle construction and demolition materials. For example, using inert demolition materials as a base course for a parking lot keeps materials out of landfills and costs less.
- Require plans for managing materials through deconstruction, demolition, and construction.
- Design with adequate space to facilitate recycling collection and to incorporate a solid waste management program that prevents waste generation.

Water Efficiency

- Design for dual plumbing to use recycled water for toilet flushing or a gray water system that recovers rainwater or other nonpotable water for site irrigation.
- Minimize wastewater by using ultra low-flush toilets, low-flow shower heads, and other water conserving fixtures.
- Use recirculating systems for centralized hot water distribution.
- Install point-of-use hot water heating systems for more distant locations.
- Use a water budget approach that schedules irrigation using the California Irrigation Management Information System data for landscaping.
- Meter the landscape separately from buildings. Use micro-irrigation (which excludes sprinklers and high-pressure sprayers) to supply water in nonturf areas.
- Use state-of-the-art irrigation controllers and self-closing nozzles on hoses.

Occupant Health and Safety

Recent studies reveal that buildings with good overall environmental quality can reduce the rate of respiratory disease, allergy, asthma, sick building symptoms, and enhance worker performance. The potential financial benefits of improving indoor environments exceed costs by a factor of 8 and 14 (Fisk and Rosenfeld, 1998).

Choose construction materials and interior finish products with zero or low emissions to improve indoor air quality. Many building materials and cleaning/maintenance products emit toxic gases, such as volatile organic compounds (VOC) and formaldehyde. These gases can have a detrimental impact on occupants' health and productivity.

Provide adequate ventilation and a high-efficiency, in-duct filtration system. Heating and cooling systems that ensure adequate ventilation and proper filtration can have a dramatic and positive impact on indoor air quality.

Prevent indoor microbial contamination through selection of materials resistant to microbial growth, provide effective drainage from the roof and surrounding landscape, install adequate ventilation in bathrooms, allow proper drainage of air-conditioning coils, and design other building systems to control humidity.

Building Operation and Maintenance

Green building measures cannot achieve their goals unless they work as intended. Building commissioning includes testing and adjusting the mechanical, electrical, and plumbing systems to ensure that all equipment meets design criteria. It also includes instructing the staff on the operation and maintenance of equipment.

Over time, building performance can be assured through measurement, adjustment, and upgrading. Proper maintenance ensures that a building continues to perform as designed and commissioned.

Steps to Ensure Success

- Establish a vision that embraces sustainable principles and an integrated design approach.
- Develop a clear statement of the project's vision, goals, design criteria, and priorities.
- Develop a project budget that covers green building measures. Allocate contingencies for additional research and analysis of specific options. Seek sponsorship or grant opportunities.
- Seek advice of a design professional with green building experience.
- Select a design and construction team that is committed to the project vision. Modify the RFQ/RFP selection process to ensure the contractors have appropriate qualifications to identify, select, and implement an integrated system of green building measures.
- Develop a project schedule that allows for systems testing and commissioning.
- Develop contract plans and specifications to ensure that the building design is at a suitable level of building performance.
- Create effective incentives and oversight.

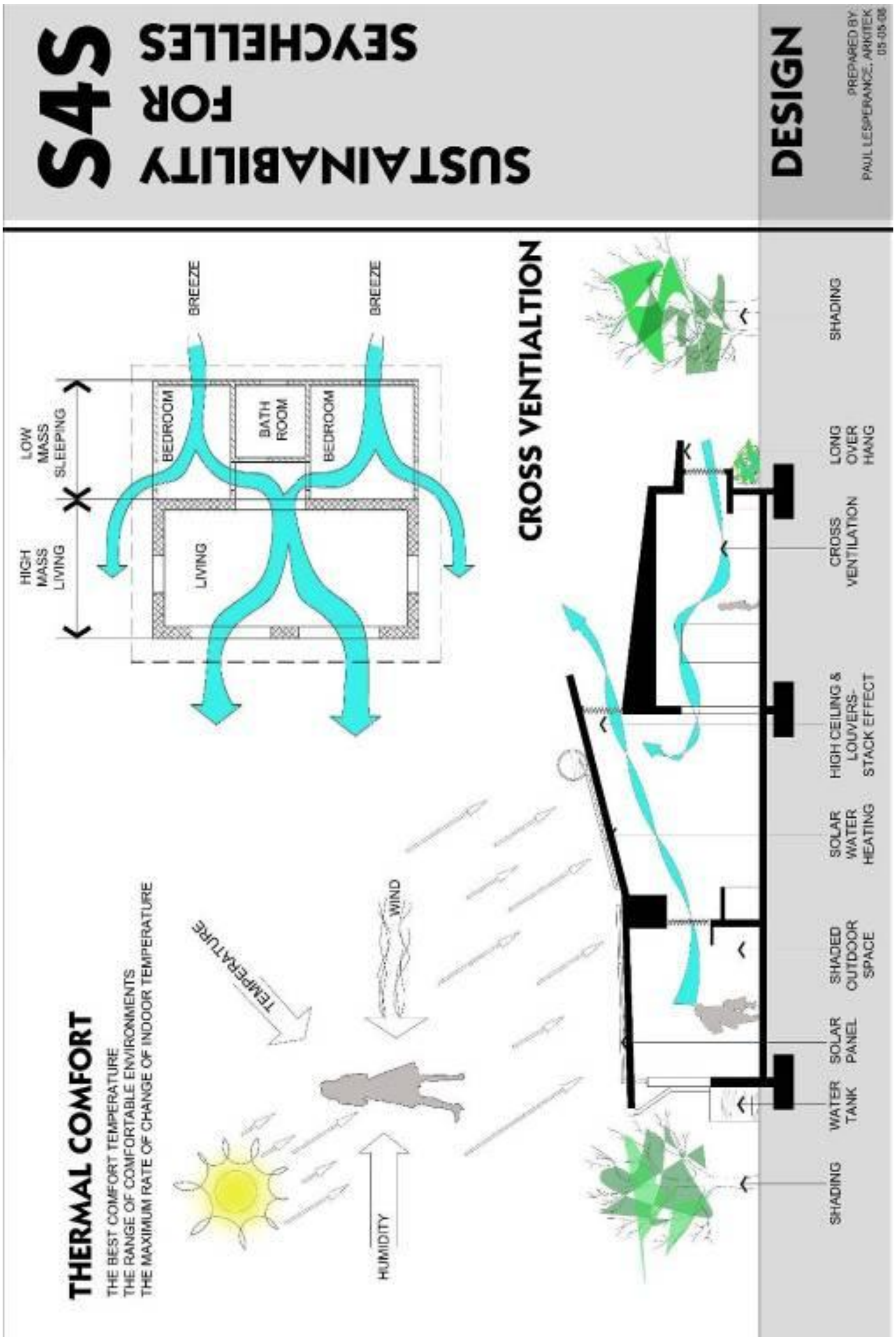
For More Information

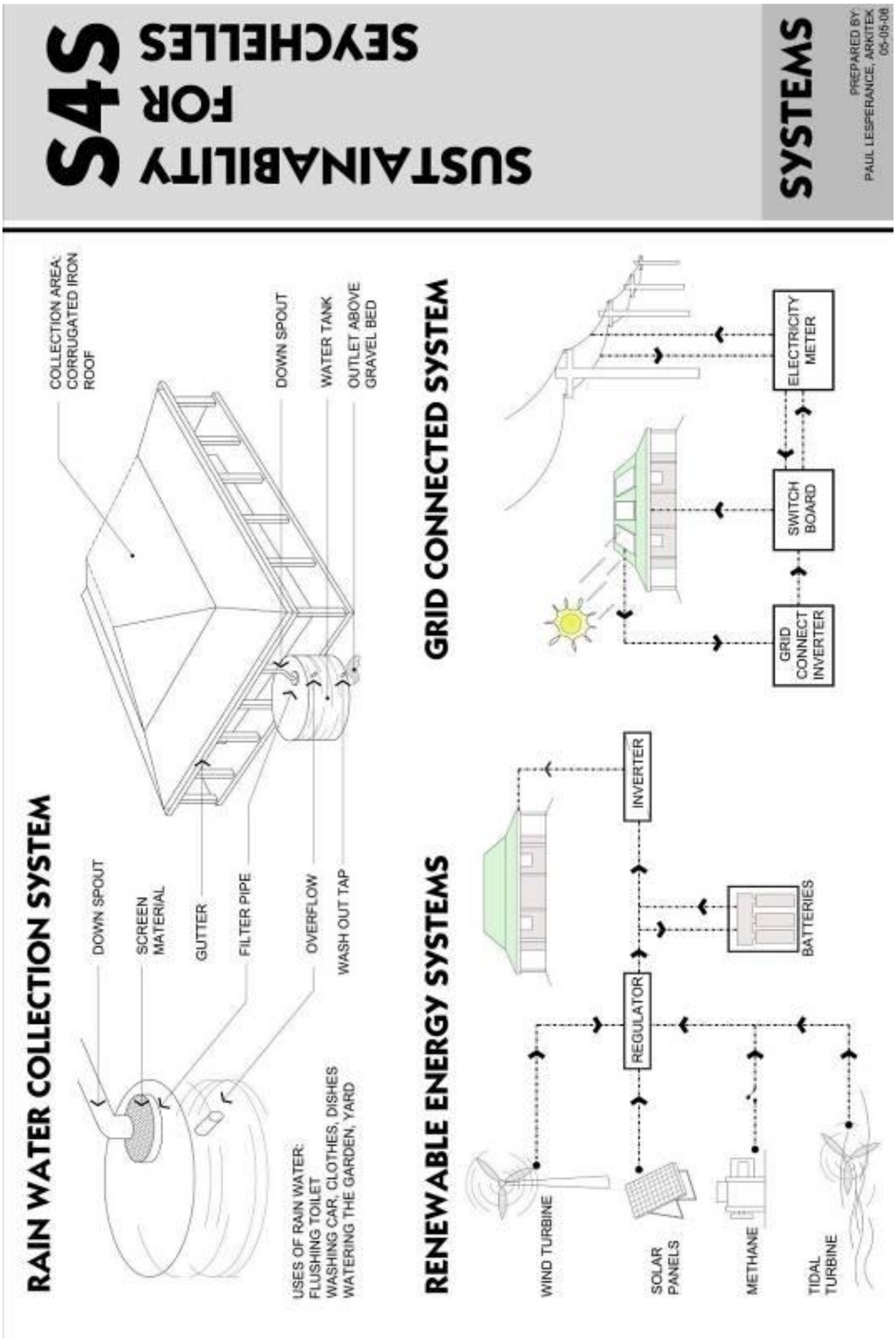
- California Integrated Waste Management Board Green Building Web site (this site): www.ciwmb.ca.gov/GreenBuilding/. Includes the manual *Designing With Vision: A Technical Manual For Material Choices In Sustainable Construction* (Pub. #431-99-009). Hard copies are available from the publications clearinghouse at 1-800-CA-WASTE.
- *Sustainable Building Technical Manual*, 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

References

1. D.M Roodman and N. Lenssen, A Building Revolution: How Ecology and Health Concerns are Transforming Construction, Worldwatch Paper 124, Worldwatch Institute, Washington, DC, March 1995, p. 5.
2. Environmental Building News, Building Green on a Budget, Vol 8, No. 5, May 1999, www.ebuild.com/Archives/Features/ Low_Cost/Low_Cost.html#General William Fisk and Arthur Rosenfeld, Potential Nationwide Improvements in Productivity and Health From Better Indoor Environments, Lawrence Berkeley National Laboratory, May 1998.
3. Gottfried Technology, excerpt from Web site, www.buildingfutures.com/p3.htm, Feb. 9, 1999.

DIAGRAMS BY PAUL LESPERANCE, SEYCHELLOIS ARCHITECT




S4S
SUSTAINABILITY
FOR
SEYCHELLES
SYSTEMS
PREPARED BY:
PAUL LESPERANCE, ARKITEK
05-05-08
RAIN WATER COLLECTION SYSTEM
DOWN SPOUT
SCREEN MATERIAL
GUTTER
FILTER PIPE
OVERFLOW
WASH OUT TAP
COLLECTION AREA: CORRUGATED IRON ROOF
DOWN SPOUT
WATER TANK
OUTLET ABOVE GRAVEL BED
USES OF RAIN WATER:
FLUSHING TOILET
WASHING CAR, CLOTHES, DISHES
WATERING THE GARDEN, YARD
RENEWABLE ENERGY SYSTEMS
WIND TURBINE
SOLAR PANELS
METHANE
TIDAL TURBINE
REGULATOR
BATTERIES
INVERTER
GRID CONNECTED SYSTEM
GRID CONNECT INVERTER
SWITCH BOARD
ELECTRICITY METER

An introduction to sustainable design in tropical climates

Source: www.gleearchitects.com/sustainablefaqtropic1.htm

The practice of sustainable/ environmentally friendly design tends to have captured the imagination of most people living in developed nations. For the most part, countries with moderate climates or those that have four seasons. Most sustainable design methods and bioclimatic data have been developed, are mature and fairly easily accessible within these countries in general. However this does not mean that sustainable or green design is not applicable within developing nations or in the tropics. The purpose of this specific guide or FAQ being written is due to the interest we have experienced first hand in South East Asian countries like Malaysia and Singapore.

Sustainability in the tropics: Issues of comfort and climate

The issues that concern human comfort within buildings in a tropical or subtropical climate are those of heat and humidity. In other words to limit heat build up or remove it and to reduce humidity. Anyone who has ever had to walk through a tropical city beneath the afternoon sun will relate to this. Since this isn't meant to be a scientific paper on the environmental factors affecting human comfort within tropical or subtropical climates and the sustainable design solutions that respond to them, please bear with our attempt to simplify and to present things in a general way or in layman terms. *(Obviously we would be happy to work with researchers on real world application of systems.)*

If you simplify matters and look at bioclimatic charts, you will find that for the most part, temperatures tend to stay consistent throughout the day and in the evenings. Roughly temperatures in the high 80s to low 90s with humidity around the 80% range. Somebody coming from a moderate climate will feel hot and uncomfortable throughout the

day and the night without the aid of mechanical systems to help them achieve comfort levels. However a person living within this climate will feel that while it is hot during the day, there is relief during the evenings and nights when the sun goes down and some would feel cold in the mornings. It is a matter of acclimatization and perception. For countries nearer the equator, the sun tends to be high in the sky, therefore most solar heat gain tends to be from the east and west orientations. The hottest part of the day being the afternoon.

Back to index

Sustainability in the tropics: Current Construction methodology -base model

We begin by looking at typical construction methods that are practised in general. While newer modern construction methods are obviously in place within developing countries (i.e Petronas Towers in Kuala Lumpur and the new Singapore National Library), a percentage of building construction methods still follow methods that tend to be labor intensive and utilize materials that lead to waste.

So as a case study, the typical construction method for housing developments and light commercial structures:

We can use this as a base model against which to compare sustainable design strategies or alternative construction methods.

A structural framework of reinforced concrete for both exterior and interior walls/ partitions. These are then in-filled with masonry/ bricks before a layer of stucco/ plaster is applied as a finish layer. No insulation is used within walls. The roofs tend to be simple wood trusses with roof sheathing, wood battens and a clay or concrete tile roof over. As we stated, a general description that has several variations throughout the South East Asian region.

This is a relatively inexpensive method of building construction in Asia and relies on cheap labor.

If we break it down, to the way most of these countries are living today, it becomes an energy inefficient and a resource wasteful method of construction. The same could be said of the traditional 2x6 wood stud or metal stud construction methods utilized within the United States. Ergo, the move for alternative construction methods to limit or stop the waste.

But let's look at this system before we look at other approaches. Technically clay bricks are actually a rather decent "green" material because it's natural resource is clay, sand, straw etc. (depending on the methods used in each country to manufacture it). All from the earth and resources that are fairly plentiful. It requires some skill to lay a straight wall but labor for now is somewhat affordable. However without really going in depth on the socio economic factors, we should note that many of the developing nations in South East Asia use immigrant labor in construction. As countries develop and salaries increase, so does the cost of labor.

Now let's look at concrete. The concrete itself is not so much an issue *(but like many products requires energy to be expanded in the creation of cement. The high use of fossil fuels in both manufacturing and transportation of cement/ concrete produces substantial pollution)* but the way it is used or formed during construction. Formwork made from wood panels or plywood are used to hold concrete in place while it sets. Most of these panels are discarded after the concrete beams or columns have achieved sufficient strength. Considering that these panels are made from tropical hardwoods that can take hundreds of years to mature, it is obviously not a very good use for such a valuable resource. Tropical hardwoods cannot be compared to fast growing coniferous/ softwood trees like Douglas Fir. So it's not really feasible for reforestation programs to use tropical hardwoods to maintain new growth for the future. So you tend to see growths of coniferous trees in some tropical countries. Not a good sign for the natural ecosystem. It's doubly ironic that most tropical hardwoods are not priced higher than softwoods.

Obviously there are easy ways to remedy the waste by utilizing reusable formwork for column and beams. Standardizing the systems used for the structural framework without taking away from the design. There is no such thing as an ultimate sustainable building system. Each project, each site, each building must be approached on an individual basis. In other words, a holistic approach that looks at all the factors that impact a site, the occupants, it's region, climate, culture and resources before a strategy is employed. Any design solution used to solve climatic concerns also needs to look at how each society has adjusted life patterns to suit new technologies as they become easier to acquire.

Sustainability in the tropics: Design methodology

Many different designers approach sustainability from many viewpoints. At GLA we tend to see at as solving the baseline model using passive energy design methods and progressing from there. That is to try to achieve a comfortable living environment before applying other methods. Notice we didn't say energy efficient.

Passive energy methods can be employed by using lessons learned from the past. Using indigenous or vernacular architecture as a basis is an often used "green' design method within the tropics and in other parts of the world. The traditional Malay house or the long houses by the Ibans are good examples of vernacular and indigenous architecture that have evolved with the climate of their regions over time. Both are wood structures set on post with steep roofs and high ceilings. These designs enabled good ventilation and cooling of the interior spaces. Being up on post allowed for good ventilation beneath the buildings, has the added bonus of keeping the living spaces above the flood line and limits the possibility of invasion by predators. The materials used tend to be lightweight and therefore do not retain heat for long periods of time (low thermal mass). These traditional designs have been reinterpreted in more contemporary designs that utilized passive energy methods/ strategies.

From what we can see above and learning from the past, simple design strategies that can be employed would be to minimize solar heat gain from the sun by having sufficient shelter from the sun. That is decent roof overhangs, limiting the exposure of windows or glazing on the east and west side of a building, whenever possible and trying to orient the building so that east and western wall or building exposure is limited. To allow for decent ventilation and to use wide verandahs to achieve more shading and to encourage ventilation and cooling from prevailing winds.

Problem is these ideas are not unknown but other factors like the desire to just build multiple structures cheaply and easily tend to have a negative impact on these easily achieved design strategies. We haven't even addressed large scale grading of hills to build cookie cutter houses on flat lots. While these are often driven by developers, their architects could do better by educating clients on better ways of achieving what they want in a sustainable fashion. Building sustainable communities does not mean lower profits. On the contrary, time and time again, sustainable design actually tends to lead to communities that are more livable, healthier and comfortable. Pleasant environments that usually have the added cache of a unique or interesting architecture. These communities tend to sell well and above expectations. Freeing up a developer's capitol quickly to progress onto other sustainable communities.

Non-Sustainable Design Flaws

As with most developing nations, as new technologies are introduced and people get progressively wealthier, the drive for mechanical methods to achieve human comfort increases. Therein lies the problem. Air conditioning is now a widely used and accepted way of life, however buildings built using the methods outlined above are not really designed to use air conditioning effectively. The few concessions being installing casement or sliding windows in replacement of the old style jalousie or louvered windows. Yet the buildings themselves are not insulated, windows and doors do not have proper seals to prevent the heat from the exterior penetrating the structure. You end up with a building or home that is bleeding money through wasted energy from an air conditioner struggling to keep a building cool against all odds. What happens in these buildings the moment you turn off the air conditioner? They get stifling hot within minutes. So you have buildings not designed to work with the climate and have technology that is inefficient. Since buildings use 50% of a country's energy, you can see why for a developing nation, sustainability should be a priority.

Using a single family residence and a terrace house or row house as case studies, let's look at the repercussions of the present construction methods and design strategies as it affects energy consumption and you. Terrace houses or row houses are prevalent throughout South East Asia. Many tend to be single storey though with rising prosperity, a drive for bigger homes and multiple storey's. Using the construction methods outlined above, consider the terrace home. Masonry or brick are not good conductors or heat. That is they do not transfer heat easily through the material itself. However energy will travel through a wall made from these materials as by themselves they are not good insulators, in other words heat is going to flow from one side of a brick wall to the other. Think of a thermos or your picnic cooler and the insulating materials that limit the loss of heat or cooling tends to be entrapped air. A solid brick wall has no entrapped air to stop the flow of heat, it slowly conducts it from one side to the other. In a brick terrace home, if one unit has their cooling system on, they are losing cooling to the walls facing the exterior, as well as to the unit besides them. So if the unit does not have their cooling system on, your unit is expanding energy cooling theirs and the great big world beyond. There's nothing to stop the loss or to slow it down.

In a single family home or bungalow as they are referred to in the tropics, you are continuously losing cooling to the exterior without any form of insulation installed in the building. You are losing even more through the glazing or glass in your windows or doors. You may feel cool and not think too much about it but you are wasting both valuable hard earned income and resources through your walls, roofs, windows and doors. In other words, your home or building is energy inefficient.

Summary of Building Design Problems in Tropical Climates.

What we have here is a classic case of countries developing and implementing all the latest comforts of home. Unfortunately the construction or building industry is not evolving or developing fast enough to factor in these new must have technologies. Compound this with the need to follow architectural trends set by developing nations without really understanding why certain movements or "styles" are adopted, and you have a major aesthetique and environmental problem. A good example of this is the widespread implementation of the "modern" movement in commercial structures throughout these countries through the 70s and 80s. Bleak buildings with flush windows and little or no ornamentation. Bland flat facades with aluminum windows all looking like ice cube trays (except ice cube trays have more variety). Topped of with the application of suitcase size air conditioning units attached like pimples to the exterior skin of the buildings.

Now add both the tropical sun and rain on buildings with no protection and you get moss, lichen and larger saprophytes literally growing on the buildings. No, not the romantic image of ancient temples in sweltering jungles but dirty buildings becoming eyesores in these thriving cities. It's not the modern aesthetique that is the problem, but the poor implementation of its core values. The good news is that there are architects like Ken Yeang who design modern tropical buildings with "green" design strategies. These buildings tend to be innovative, interesting and good performers. *(At GLA, we obviously would like to be your architect on sustainable tropical buildings.)*

It is not difficult to imagine that implementing passive energy methods to a building can help a building perform better in any environment or climate. We will look at some sustainable/ "green" strategies possible for tropical buildings in our next chapter. Suffice to say for now, that a building that has adequate protection from the sun will have a lower level of heat gain. Before even implementing measures like insulation, it is logical to realize that if such a building had an air conditioning system, at least it would not have to work as hard to cool the interior.

As we said before, sustainable design should be approached from a holistic standpoint, where after understanding the unique problems facing a particular site, we find the appropriate solution instead of tacking on systems just because they are called "green".

Sustainability in the tropics: Design Theories

LEED has developed a tropical climate building model by which they form their basis and approach towards sustainability in tropical countries. The model was developed in Jamaica and has applicability within most tropical countries. This LEED model has the same basic approaches outlined in our last chapter outlining passive energy design

methods. That being said, the model does not look at it's applicability within developing countries like Malaysia, Singapore or Thailand and how cultural or social mores may affect the effectiveness of their case study or model. It calls for the use of lightweight building materials for construction as opposed to materials that have a lot of thermal mass like concrete or masonry. The theory being that lightweight materials tend to cool down faster than heavy mass materials that retain the heat for long periods of time. As we have stated before it doesn't help to just point to a design solution and state that this is the best approach. Everything needs to be considered and researched very carefully before making judgments as to the best applicability of a design approach. What are these lightweight materials called for in the report?
Assuming it means wood, what types of wood or species are they specifying? Tropical hardwoods as we have noted before tend to be very slow maturing trees. Deforestation is definitely an ongoing problem within the countries of South East Asia. Therefore it's important to use timber harvested using ISO 14000 standards or Forest Stewardship Council (FSC) certified wood timber. That being said, there are other materials available to satisfy the criteria for lightweight low thermal mass. Composition boards or panels have been developed from rubber wood and cement, and insulation panels from old rubber tyres combined with rice straw. These represent new construction technologies that recycle waste materials and are able to be installed using relatively simple methods. Sustainable design is not just the application of "green" design strategies to a building but an overall holistic approach to how the building impacts the environment before and after construction. In other words to limit any negative impact and to promote positive overall results to the environment. Properly executed, a good sustainable building can actually give back to the environment.

Sustainability in the tropics: Thermal mass and evaporative cooling concepts.
From the basic climatic data listed previously and using text book approaches, you would assume that since there are no large variations between the high (80-90F)and low temperatures and with a humidity level hovering in the high 80 or 90 percentiles that using passive systems like evaporative cooling or thermal mass would be ineffective.
Evaporative cooling working on the concept of using differences in humidity levels to cause water to evaporate. The process of evaporating water then tends to have a cooling effect. (Again we apologize for over simplifying the process). Anyone who has ever splashed water on their faces on a hot day knows the effect of evaporative cooling. Evaporative cooling tends to work really well in hot dry climates. It is relatively less efficient in humid climates because the air tends to be saturated with water thereby making it less likely for more water to evaporate. The process by which water evaporates requires energy and the ability of the air to accommodate the moisture. This in turn means that in high humidity climates the air is saturated with moisture and has limited capacity to absorb anymore moisture, but if you have ever walked down a street in Kuala Lumpur or Singapore on a balmy sunny afternoon and just happen to pass beneath one of those big fans that are blowing a mist of water, you'll understand that while not exactly cold, it adds a degree of cooling and comfort.

Thermal mass for cooling works on the principle that a large mass tends to take a long time to heat up or cool down. Materials like stone or concrete which are slow conductors of heat, tend to be really good materials for the application of thermal mass in both heating or cooling circumstances. Again if you have ever laid flat on a concrete floor on a hot day and felt the coolness of the floor, you'll grasp the concept really well. These systems tend to rely on significant differences in temperature or humidity to work. But as we have pointed out above, it's a matter of perception. Passive solar homes in moderate or cold climates utilized thick walls of masonry or concrete or floors behind windows that have good sun exposure (south in the northern hemisphere and north in the southern hemisphere). During the day, the sun heats up the mass very slowly. But when night falls, the mass which has been storing all that thermal energy now slowly releases it to the space it is in. These properties are what help masonry/ stone or concrete feel cool to the touch during a hot day. A good example of using thermal mass for cooling is to visit an old colonial building in the tropics with those thick stone walls. The strategy here is to shade the thermal mass from the sun, let it absorb the heat from your space and then use the cool of the night to expel that heat build up.

Sustainability in the tropics: Sustainable Design Implementation

Let us stress again that the design strategies espoused within these pages are meant as starting points from which an overall holistic approach towards design begins. They are not perfect nor do they claim to be perfect. Most ideas have flaws but what's important is to gain the most out of it's implementation.
We touch on thermal mass above because recent housing trends in Asia tend to be vertically oriented. In other words, the high rise residential or condominium building. While these are starting to gain in popularity within major urban centers in Malaysia, Indonesia and Thailand, no where else in South East Asia are they as dominant a housing form as in the island republic of Singapore. The limited amount of available land tends to be the driving force that makes high rise residential construction a necessity within this country.

In Malaysia, Indonesia and Thailand which have more land, housing units tend to have more variety. Regardless of the number of stories, the residential units tend to be row/ terrace houses, semi detach (duplexes), bungalows (single family residence) or as is becoming more prevalent, high rise condominiums. Construction of these building types, tend to be similar to the high rise residential towers and as outlined in the last chapter.

High Rise Residential Towers-Sustainable concepts.

Therefore let's start by looking at Singapore. Most housing is government sponsored and erected by the Housing Development Board. All these buildings tend to be vertically oriented residential units or "HDB flats" as they are commonly referred to. Concrete structures with masonry infill or precast concrete panels for the walls and no insulation. Many of these buildings are clumped together and for the most part seem to have very little variety in form or heights.
A general solution, would be to ensure that proper site analysis/ studies are carried out before designs for any building is started. Understanding how wind and sun works on a particular site, can be the driving force of how these high rise buildings are formed and oriented. The unit plans of the flats could be arranged in a way to block solar heat gain from the western sun and to maximize cooling from prevailing winds. Buildings could be oriented to funnel winds through them and not block it. Additionally, instead of trying to maximize units within these buildings it may help to change the heights of the buildings to create daylight and wind corridors. While it is efficient to have all the units the same size because it easier to construct, sometimes having variations can provide variety to a buildings facade and help with passive energy design. Taking a page from commercial office towers like the Kommertzbank or Menara Mesiniaga, roof top gardens or mid level gardens that step through a building or open up atriums within the core of the building, can help create a "green" belt within the buildings themselves. Imagine if you would, buildings that have natural daylight, ventilation biodiversity through landscaping and evaporative cooling available through waterscapes in these roof

gardens. These high rise residential buildings could use their building forms and orientation to take advantage of the sun to generate enough power to sustain themselves from an energy standpoint. The trick of course is to design the photo voltaic panels into the form of the buildings in a way that is both innovative and visually pleasant. It's not just about sticking panels to the roof or walls of a building.

Residential Tower alternative construction.

Many sustainable advocates will point out that both concrete and steel have high embodied energy in their manufacturing process. This includes the direct and indirect energy used for their production but also for their extraction, transportation and installation. All that burning of fossil fuels tends to result in pollution. Therefore for some, these materials are not seen as being environmentally friendly, however until new technologies for building high rise buildings come about, concrete and steel will still remain the structural framework for these buildings. It should also be noted that some forms of waste materials from manufacturing and industry like fly ash can be incorporated into concrete as admixtures. A great way to recycle environmental waste. In addition much of the steel used in construction tends to be recycled steel. If construction methods were approached from a sustainable viewpoint, with long term planning taken into consideration, it would make sense that using light weight panels or materials would lessen the loads on the structure of these buildings. A lighter load in turn requires less structure to support it. Less structure in turn means less materials, resources, labor and pollution for its construction.

There's a reason why the mantra for LEED is, **"Build green. Everybody profits."**

Lightweight Construction Methods.

While the focus has been on high rise buildings, these construction methodologies can be applied to most housing types within the developing countries of South East Asia.

Option 1: Insulated prefabricated panels. Prefabricated panels assembled in a factory, then installed in the field. Nothing new here and it has been done before. Exterior sheathing materials assembled against a frame work of wood or steel. The cavity between panels is filled with some form of insulation. Using new systems like these have certain advantages and disadvantages. Prefab panels will be lighter than brick or masonry infill, resulting in the lighter structure we have talked about. Beams and columns maybe smaller. We have simplified things overly much but you get the idea.

Option 2: Utilization of insulated masonry units. Terracotta/ Concrete masonry units with insulated cores. This enables the present workforce to build as they are used to but with energy efficient materials.

Option 3: Rain screen with steel stud construction with insulated wall cavities. Using systems similar to those in the United States. This requires the construction work force to adapt to a new way of building. However the overall structural framework remains the same.

Option 4: Researching and discovering alternative construction methods for a particular region's needs.

Option 5: Use the present construction method but apply insulation to the exterior and party walls. I.e. EPS rigid insulation panels applied on the interior face with sheathing panels over. Note that this is a retrofit of existing methods.

Insulation materials can be in the form of:

- Rigid insulation (expanded polystyrene containing no CFCs or formaldehyde. Can be termite resistant)
- Spray in expanding insulation like Icynene which has no CFCs in it and works really well as a vapor barrier.
- There are many agricultural resources in the tropics that can be researched to identify waste products that can be successfully used as building materials or insulation.

There are many different types of insulation materials available to the building industry. Fiberglass batt insulation being the most widely used. Fiberglass batts tend to lose efficiency when saturated with moisture, so it may not be a good option for tropical climates. Additionally, they are not a "green" product. Insulation that does not entrap moisture will tend to perform better. Utilizing waste products from agriculture would be a good option, however tropical climates are known for the myriad flora and fauna that thrive within their ecosystems. Before wholesale application of any organic material, it needs to be carefully researched to ensure mold or insects or other pest do not infest it. That is one of the reasons cellulose was not listed as an insulating material. Rice straw used for straw bale construction tends to come from species developed in California. They are not cultivated in paddy fields as in Asia and have high silica content, low moisture and very little nutritional value within the straw itself. The bales are compacted and because of the construction methods used have been proven to last for many years (over a hundred years in some notable instances). While some of these represent new and different ways of construction from the present, there are potentially many advantages beyond the sustainability of the buildings. New industries can be created resulting in new jobs. Construction costs can be lowered and reliance on unskilled imported labor can be reduced.

Things to consider:
Cradle to grave. A movement that looks at how all materials selected for a building impacts the environment. From it's creation to the end of it's useful life span. In other words, a lifecycle process and implementation. Just because an end product is labeled "green" when installed does not necessarily mean that the process used to create it was green or environmentally friendly. This can be weight against the idea that anything green is good and better than taking no action whatsoever and the good needs to be balanced with the bad.

Summary
While the focus seems to have been on high rise residential towers, the sustainable and passive energy design strategies apply to all the housing types described previously. Proper orientation for day lighting, ventilation and cooling should always be the baseline approach to design. Alternative construction methods should be a process that is developed specifically for each region/ country using the available resources. Architects with good knowledge of sustainable design and awareness of socioeconomic, cultural and climatic factors can serve as the engine for building construction innovation. Gerard Lee Architects believes in sustainable design and would be willing to participate with developers, builders, research facilities, universities and governments in these regions to help formulate new sustainable building systems, materials and construction methods.

Sustainability in design can create new industries, save resources and energy while creating better communities.

ARTICLE ON CLIMATE-PROOFING BUILDINGS

Climate-proofing: Severe weather defence is still low priority

By Sarah Murray
Published: April 24 2009 15:41
Retrieved July 14, 2009 from: http://www.ft.com/cms/s/0/df8cd68e-305f-11de-88e3-00144feabdc0.html

A couple of decades ago, suggestions that weather experts at the UK's Met Office would become consultants to architects and developers might not have been taken very seriously. However, as evidence emerges that buildings will need to stand up to increasingly frequent severe weather events, the weathermen are finding a new audience.

The Met Office now advises businesses on everything from how a building's energy consumption relates to the weather to what wind speeds construction cranes can withstand.

Even so, much of the attention regarding buildings and climate change is still focused on the impact – through energy and water consumption – buildings can have on the environment, rather than the impact climate is likely to have on buildings.

Construction companies and property developers do factor in the need to refurbish a building in the future, but do not always take into account the fact that during the lifetime of that building the climate will change, says John Firth, chief executive and co-founder of Acclimatise, a risk management company with expertise in climate risks.

"This will mean the building itself will deteriorate quicker than expected," says Mr Firth. "And there are occupier issues such as the fact that the building will get warmer and will need more cooling, and this will clearly be a determinant in terms of the rental value."

Of course, it is not always easy to cool buildings in a way that does not create more greenhouse gases – usually by running air-conditioning units. This is particularly true of existing buildings where the structure may not allow for ventilation of fresh air or other natural cooling methods. Nevertheless, features that can help reduce the heat in a building include the addition of thermal mass or natural shading through the planting of trees around a building.

As well as prompting a need for mechanisms that help buildings withstand rising temperatures, climate change will also drive the introduction of features such as sturdier roofs, and stronger windows that protect buildings against more severe rainstorms and high winds.

One feature that is a means of reducing energy consumption is also a useful tool for managing extreme climate events: the green roof. While planted roofs cool the floors below them they can also, during severe storms, act as giant sponges, soaking up water and delaying the high-volume run-off that can create problems for sewerage and drainage systems.

Many businesses have yet to take action however. More than 40 per cent of companies in the construction and building materials sector expressed little or no concern about their exposure to the risks posed by a changing climate, according to "The adaptation tipping point", a report by Acclimatise, the UK Climate Impacts Programme and the Carbon Disclosure Project.

The study also found that almost 90 per cent of respondents in the real estate sector expressed little or no concern about their exposure to changes to the structural integrity of buildings or the increased vulnerability of the external fabric, internal environment and service infrastructure that could be brought about by climate change.

“The whole issue of climate adaptation is one that’s been ignored [in the buildings sector] to a surprising and worrisome degree,” says Andrew Logan, insurance programme director at Ceres, a US-based coalition of investors and environmental groups.

Mr Logan also points out that green buildings are not necessarily climate-resilient structures. “You can have the greenest building, but if it’s built on the beach in a hurricane zone, it’s hard to make that building resilient,” he says.

Some action will be prompted by government legislation. In the UK, for example, building regulations have tightened in response to the growing likelihood of flooding. “[In the UK] we don’t have a maximum workplace temperature, particularly in offices. But it’s an area people are asking questions about,” says Mr Firth. “And the implications of having a maximum office temperature could be significant in terms of increasing cost.”

Another pressure on builders to respond to climate change is coming from the insurance sector. “What’s beginning to happen is that insurers are focusing on the overlap between features that make a building more environmentally-friendly but also make it more resilient to loss,” says Mr Logan.

However, the day-to-day impact of changing temperatures could also provide a strong business case for building owners and occupiers to address the climate resilience of their facilities.

“There’s behavioural research that talks about ideal conditions for employee productivity,” says Mr Firth.

“And one thing is clear – as temperatures increase and people get hot in offices, their productivity drops.”

FURTHER READING

Green building - Wikipedia

www.en.wikipedia.org/wiki/Green_building

Sustainable Design, Green Building, LEED Projects: GreenSource

Sustainable design, green building, LEED projects, green & sustainable products, case ... International Green Construction Code (IGCC)
www.greensource.construction.com

Green Construction Inc. - Home

www.greenconstruction.us

Community Home | Green Construction | Reed Construction Data

In-depth resources for those seeking to incorporate green features into structures they are designing, specifying or constructing.
www.reedconstructiondata.com/green-construction

Green Construction Restoration Home Page

www.green-construction.com

Oikos: Green Building News

Features news and resources for sustainable and green construction.
www.oikos.com -

Go Green Construction

Go Green Construction is Los Angeles_ leading green builder/ general contractor.
www.gogreencalifornia.com -

Climate-proofing: A risk based approach to adaptation
http://www.adb.org/Documents/Reports/Climate-Proofing/

Grontmij company's climate proof and sustainable approach to construction
http://www.grontmij.com/highlights/Water/Documents/Our%20climate%20proof%20and%20sustainable%20approach.pdf

http://www.gleearchitects.com
Gerard Lee Architects website (based in California). Contains info on green/ sustainable architecture

NOTES

This handbook was compiled by Sustainability for Seychelles, a locally registered NGO which aims to promote sustainable living in Seychelles. For more information or to become a member contact us: sustain@intelvision.net tel.713985, PO Box 900, Victoria, Mahe, Seychelles