

e c o  
p r e f a b  
e n e r g y  
independent  
**Green Houses**



faculty \_      Arquitectura \_ **master work**\_ 2007/2008

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## sustainability

**“The human action is now the major cause of climate change, and that this trend is increasingly and alarmingly negatively impacting the quality of life for all living things, then we urge you to consider this: we—as individuals, communities, and nations—must consciously change the way we live to reduce our ecological impact. Choosing to reduce emissions, consumption of finite resources and waste is often described as living in a way that's more "sustainable." Sustainability calls for a change of worldview that embraces contemporary science and pragmatic solutions to the challenges face in every area of our lives. “- (1)**

### architecture\_

**zero\_energy\_** home produces all the energy it consumes, to make every home as self-sufficient as possible, to reduce the demand for energy, while installing technologies that produce the majority (or all) of the power it needs.

**reduce\_reclaim\_reuse\_** to design homes that capture or reuse all the water you need for your landscaping, landscaping consumes 15% of all water used, garden will grow with grey and reclaimed water.

For outdoor irrigation needs, ideally we would take no city water, only using captured or reused water for irrigation.

*For areas with low rainfall, we reduce demand by planting native, drought-tolerant species. Water from baths and sinks — called "grey water" — is reclaimed and reused. Filtering grey water through sun and soil helps control pollution when home reuses it to water the plants in garden and on living roof.*

*Rainwater is captured and reclaimed by collecting it in gallon cistern for later use.*

*Reharvesting water in this manner prevents it from running off untreated, polluting nearby bodies of water (the ocean, river, or lakes). So in addition to reducing, reclaiming and reusing water, your home helps keep your local swimming(2)*

**renewable materials\_** Bamboo, because it grows so fast and easily, is a wonderful renewable material and one we use for flooring, to use sustainably harvested materials such as FSC certified wood, green walls, etc. ..

*The bamboo plant is considered as the fastest growing woody plant. It reaches full maturity in five to six years depending on the climate. In comparison, other hardwoods used for flooring can take upwards of 50 years to regenerate. Bamboo offers about 25 times the yield of hardwood and it is more sustainable and renewable. The bamboo plant is harvested and replenished with virtually no impact on the environment. It constantly regenerates its self by sending runners that result in new canes. Bamboo wood floors typically expand and contract approximately 50% less than other hardwood floors. Bamboo is considered incredibly durable. Its favorable characteristics, allows bamboo floors to be installed in homes with climates where high humidity and temperature variations exists and other forms of hardwood are simply impractical.(3)*

**reduce waste and use less\_** Modular technology allows for 50% to 75% less waste during construction.

**long-lasting and low maintenance\_** Materials such as cement siding with integrated color never require repainting and are relatively maintenance free. They are strong and reliable materials with long lives.

**efficient envelope\_** foam insulation, green roofs, and triple-pane/ low-E windows to help homes trap heat in the cold and cool air when it's hot out.

**efficient cooling system\_** Features such as ceiling fans, house fans, and cool roof systems serve as energy efficient means for keeping homes cool in hot weather.

**sun shading\_** The elements into houses provide sun shading in order to help keep them cool. Low tech sliding wood sunshades, and screens all play a role in keeping energy use for cooling down.

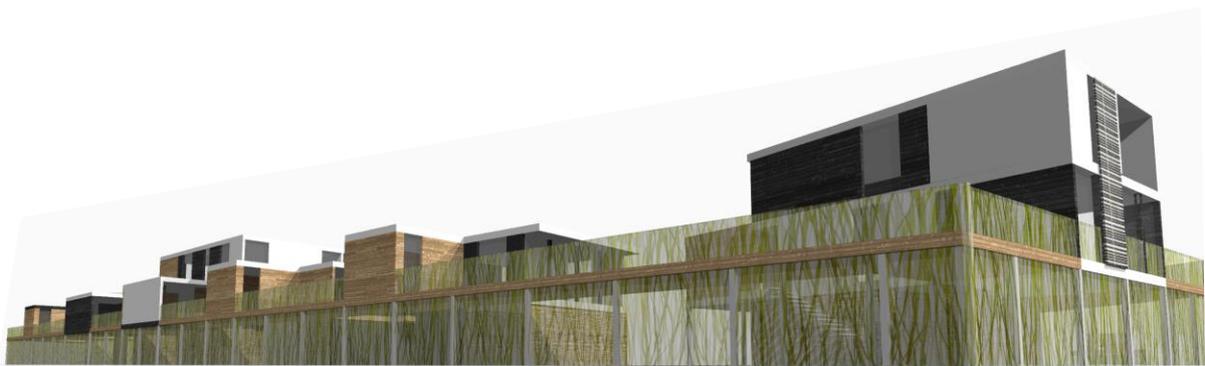
**alternative energy sources\_** designed to rely mostly on alternative energy sources including solar, wind generation, and geo-thermal power.

**site waste management & minimizing storm water run-off\_** Solutions such as green "living" roof systems, and the use of permeable materials for walkways and driveways allow homes to maximum the absorption of rainwater and its utility.

**non-off-gassing materials\_** use only formaldehyde-free materials..

# e c o p r e f a b e n e r g y independent Green Houses

**My aim was to construct an urban single-family homes that are ecological, socially regenerative, and self-sustaining. Homes are as healthy as possible, and minimize their "ecological footprint" with respect to the resources they use for their construction, operation and eventual decommission. Combining healthy materials and efficient systems with resource-saving, modular fabrication process, contribute to cleaner air, water, and soil. Homes and all community become better places for people to live, learn, work and play.**



## concept\_

Project is composed of different types of single family houses. Every of them are connected by one platform and green transparent gate, which surround all buildings. The gate is open and in esthetical way not disturb the environment. It's a part of the green brief redesign. The platform is used as a green space (green roof, terrace). Under the platform exist an interior road for the inhabitants. Inside there is a half common half public garden, which include small wind turbines to produce common electricity. Each building is different in shape, contrary to the typical anonymous architecture. All buildings are part and parcel of one community organism, with integral energy grids, which balance needs and access capacity.

## typology dependes of\_

### **\_size of the building**

Modular construction allow to produce higher quality and mobile homes, every type of building can exist in different size, from house for 1 person to big family houses, all of the buildings have the same basement which consist of 2 modules, one as a technical room, and second as a garage for one car, other modules have different use (dining, bedroom, living room, common room, office, bathroom, kitchen, etc. ...)

there are two types of modules, 3,5m x 3,5m and 3,5m x 7m modular construction results in saving of time, materials and cost.

Modular buildings are built to a higher level of quality than stick-built (site built) structures, in part because they must be able to withstand the stresses of transport. Joints are tighter, fasteners more accurately applied and material is cut with more exactness. The modular building process decreases construction time, a modular houses can be built in no more than six months, and factory construction leverages specialized construction teams, equipment and facilities. As a result, prefabrication saves money. With a modular home-building process, only about two percent of materials (on average) end up as waste.

It can be built as independent home or as carriage house on large properties. Depending on number of occupants and requirements it can be used without structural adaptation. With a few changes of the furniture the house can even be adapted to handicapped persons. Also the enlargement is possible with one or more modules so the house is permanently inhabitable for more than 2 people. For Families there is also the possibility to add on another floor.

### **\_the orientation**

Relationally to the sun: project consist of 3 types of orientation ,

direct gain involves using the positioning windows, skylights and shutter to control the amount of direct solar radiation reaching the interior space themselves, and to warm the air and surfaces within the buildings maximizing natural daylighting reduces the need for artificial light, thus reducing energy consumption and utility bills, dwellings that have good natural daylighting are also pleasant for the residents

Bathrooms and bedrooms are located on the north side without a lot of apertures. The living and dining spaces are located on the south side with big windows shaded by the roof and bamboo louvers.

## flexibility

Over time, most homeowners will make additions (to) or remodel their dwelling. This is one of the largest growing economies within the building industry. Most of the buildings are not systematically designed to be adaptable; huge expenses are incurred to make changes. Oftentimes, "fighting" with the existing structure in order to install the new work, is one of the major costs. Open building system is a concept that promotes a design philosophy that systematically allows for change and adaptability. "Pre-fabricated plug-in" modules, plug-in porches, and surface mounted wiring, etc., are an integral part of this design.

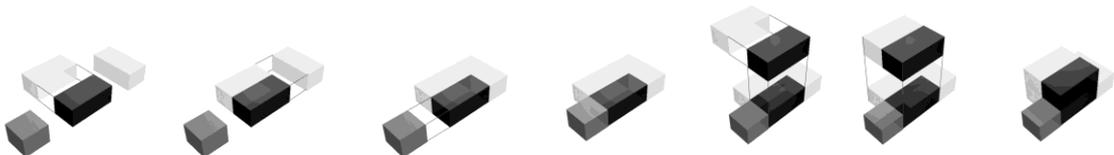
## materials

All building materials will undergo a sustainability and life-cycle analysis which addresses (but is not limited to) the following: local, regional supplies of raw material and manufacturing (using local economy, looking carefully at the wood industry, stewardship of natural resources, long term durability)

## structure

The structure of is made from timber. Wood, because of sustainable forestry, is a very environmentally friendly material with low energy costs for its production. The feel of the surface of wood fits quite well design concept of a comfortable home.

The main structure of houses consists of different amount of modules(typology). Individually, these modules are well reinforced, but the house is strongest as a whole. Essentially all of the house's structural and live forces are supported by the core and the studs at the module joints. The construction of each house include module for technical installations. The ceilings and roof overhead are both flat.



## **appliances and mechanical systems**

All appliances and mechanical systems will undergo a life-cycle analysis which addresses (but is not limited to) the following:

- 1-Energy Star ratings for all appliances;
- 2-using natural systems as much as possible in conjunction w/ mechanical systems;
- 3-composting toilets/ wetland sanitary;
- 4-solar hot water pre-heat;
- 5-photovoltaics for daytime use
- 6-ceiling fans; and exhaust fans which supplement natural air flows (such as 'flushing' hot air out during night-time daily cycles;
- 7-rainwater harvesting (for all gray water needs (and possible potable water);
- 8- geothermal heating and cooling system
- 9-electric lighting (only needed at night) to be compact fluorescent.

## **photovoltaic (PV or solar) cells\_**

*are made of semiconducting material which directly convert sunlight into electricity. The simplest system of photovoltaic cells power small devices such as watches and calculators. More complex systems can light houses and provide power to the electrical grid.*

*Crystalline silicon (c-Si) is the leading commercial material used for solar panels. The forms it is used in are:*

- *Monocrystalline*
- *Polycrystalline*
- *Ribbon*
- *Sheet*
- *Thin-layer silicon*

*When light is absorbed by a semiconductor such as silicon, the electrons within the material increase in energy. This increase in energy causes the electrons to move within the material. However, there must be charge carriers in order for the electrons to move in a preferred direction to generate an electrical current. Charge carriers are created by doping the semiconductor, which is to say adding small amounts of impurities to change the material's electrical properties.*

*Silicon is an element with four valence electrons. This means that when a silicon atom bonds with other silicon atoms, they complete their valence shells by sharing all four electrons. Doping silicon involves adding small amounts of a material with three valence electrons or a material with five valence electrons. By adding a small amount of aluminum, for example, an atom with three valence electrons, covalent bonding of the aluminum to silicon creates 'holes'. A 'hole' is the absence of an electron where there would normally be one if there was no impurity bonded to silicon, which results in a p (positive) -type silicon semiconductor. Adding a small amount of an atom with five valence electrons, such as antimony, causes an opposite effect. Once antimony is bonded to other silicon atoms, there will be an extra electron that is loosely bound to antimony, which will result in a n (negative) -type silicon semiconductor. Introduction of a voltage to either type of semiconductor causes current to move in a preferred direction.*

*A solar panel uses a layer of p-type silicon and a layer of n-type silicon. This way, when light is absorbed and the electrons in the n-type layer increase in energy, the electrons will be able to travel from the n-type layer to the 'holes' in the p-type layer. This electrical current is what allows solar panel technology to convert light energy into electricity.*

*Silicon based solar panels are not the only type of solar cells. Other types include solar panels that use conductive polymers or light absorbing dyes.(4)*

## **green roofs \_**

*Involve growing plants on rooftops, thus replacing the vegetated footprint that was destroyed when the building was constructed.*

*As our forests and agricultural lands are replaced with impervious surfaces due to urban development, the necessity to recover green space is becoming increasingly critical for the health of our environment as well as our well-being. Vegetated or green roofs are one potential remedy for this problem. Establishing plant material on rooftops provide numerous ecological and economic benefits including stormwater management, energy conservation, mitigation of the urban heat island effect, increased longevity of roofing membranes, as well as providing a more aesthetically pleasing environment to work and live. The mitigation of stormwater runoff is considered by many to be the primary benefit because of the prevalence of impervious surfaces in urban areas. The rapid runoff from roof surfaces can exacerbate flooding, increase erosion, and may result in raw sewage that is discharged directly into our rivers. The larger amount of runoff also results in a greater quantity of water that must be treated before it is potable. A major benefit of green roofs is their ability to absorb stormwater and release it slowly over a period of several hours. Green roof systems have been shown to retain 60-100% of the stormwater they receive. In addition, green roofs have a longer life-span than standard roofs because they are protected from ultraviolet radiation and the extreme fluctuations in temperature that cause roof membranes to deteriorate. Furthermore, the construction and maintenance of green roofs provide business opportunities for nurseries, landscape contractors, irrigation specialists, and other green industry members while addressing the issues of environmental stewardship.(5)*

## **rain water harvesting\_**

*Rainwater harvesting is the process of collecting, filtering and storing water from roof tops, paved and unpaved areas for multiple uses. The harvested water can also be used for potable purposes after testing and treatment. The surplus water after usage can be used for recharging ground water aquifer through artificial recharge techniques. This can also result in improving the quality of the ground water e.g. lower fluoride content in ground water. Rainwater harvesting mechanisms are designed after assessing the site conditions such as incident rainfall, subsurface strata and their storage characteristics, infiltration test and by building suitable structures to collect and store rainwater.*

*Rainwater harvesting system provides a source of soft, high quality water, reduce dependence on wells and other sources, and, in many contexts, are cost effective. Rainwater harvesting system can range in size from a simple PVC tank to a contractor designed and built sump - costing thousand of rupees. Rainwater system are inherently simple in form. Harvesting rainwater is not only water conserving, it is also energy saving since the energy input required to operate a centralized water system can be bypassed.*

*A range of filters for different filtration rates have also been designed using different filter media.*

### **Benefit**

- *To harness good quality water resource now being wasted*
- *To prevent groundwater depletion*
- *To augment the expensive piped water supply*
- *To save expenditure on water*
- *To prevent soil erosion and urban flooding*
- *Inexpensive and simple technology*
- *Aids ecological conservation*

### **Components of Rainwater Harvesting System**

- *Catchment area*
- *Conveyance system*
- *First rain separator*
- *Filter unit*
- *Storage*
- *Delivery system*
- *Usage*
- *Recharge(6)*

## geothermal heating and cooling system\_

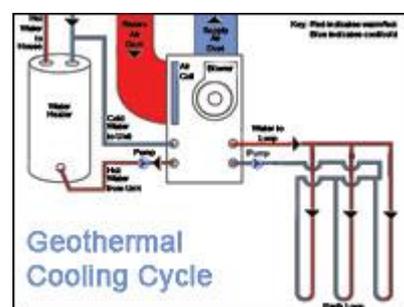
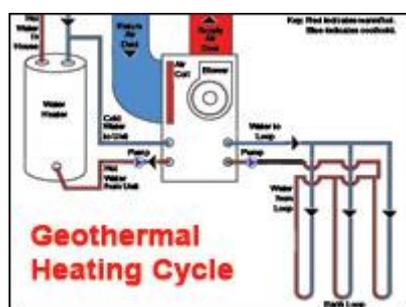
*Our own backyard has the potential to be an energy source for heating and cooling comfort. Outdoor air temperatures fluctuate throughout the year with the changing seasons. In contrast, ground temperatures about four to six feet below the Earth's surface remain relatively moderate and constant all year. That's because the Earth absorbs 47% of all the heat energy that reaches its surface from the sun. A geothermal system circulates a water-based solution through a buried loop system to take advantage of these constant temperatures. A single piece of equipment has the ability to heat and cool your home, while providing some or all of your home's hot water as well. Geothermal systems can save you 30% to 70% on your monthly utility bills.*

### **Heating Cycle**

*During the heating cycle, the fluid circulates through the loop extracting heat from the ground. The heat energy is transferred to the geothermal unit. The unit compresses the extracted heat to a high temperature and delivers it to your home through a normal duct system or radiant heat system.*

### **Cooling Cycle**

*For cooling, the process is simply reversed. Because the earth is much cooler than the air temperatures on a hot day, the geothermal system removes heat from the home and deposits it into the ground. The fluid is cooled by the ground temperatures and returned to the unit for cooling your home.(7)*



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