

# Low Carbon Green Growth Roadmap for Asia and the Pacific

[Background Policy Paper]

## Buildings:

Policy recommendations for the development  
of eco-efficient infrastructure



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Policy recommendations for the development  
of eco-efficient infrastructure

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## Glossary of Terms and Abbreviations

|                  |   |
|------------------|---|
| <b>ADB</b>       | Asian Development Bank  |
| <b>ASHRAE</b>    | American Society of Heating, Refrigeration and Air Conditioning Engineers     |
| <b>BCA</b>       | Building Construction Authority (Singapore)                                   |
| <b>BESC</b>      | Building Energy Standards and Codes   |
| <b>BREEAM</b>    | Building Research Establishment Environmental Assessment Method (UK)          |
| <b>CASBEE</b>    | Comprehensive Assessment System for Building Environmental Efficiency (Japan) |
| <b>CDM</b>       | Clean Development Mechanism   |
| <b>CII</b>       | Confederation of Indian Industry  |
| <b>CLASP</b>     | Collaborative Labelling and Appliance Standards Program                       |
| <b>CO2</b>       | Carbon dioxide  |
| <b>CSEB</b>      | Compressed Stabilized Earth Block   |
| <b>ECBC</b>      | Energy Conservation Building Code   |
| <b>ECBCS</b>     | Energy Conservation in Building and Community Systems                         |
| <b>ECCJ</b>      | Energy Conservation Center, Japan   |
| <b>EEO</b>       | Energy Efficiency Office  |
| <b>EES&amp;L</b> | Energy Efficiency Standards and Labelling                                     |
| <b>EPBD</b>      | Energy Performance of buildings Directive (European Union)                    |
| <b>ESCO</b>      | Energy Service Company  |
| <b>FEMP</b>      | Federal Energy Management Program (USA)                                       |
| <b>GBCA</b>      | Green Building Council of Australia   |
| <b>GDP</b>       | Gross Domestic Product  |
| <b>GHG</b>       | Greenhouse Gases  |
| <b>GHLC</b>      | Government Housing Loan Corporation (Japan)                                   |
| <b>GRIHA</b>     | Green Rating for Integrated Habitat Assessment (India)                        |
| <b>HQE</b>       | High Environmental Quality (France)   |
| <b>HVAC</b>      | Heating, Ventilation and Air Conditioning                                     |
| <b>ICC</b>       | International Code Council  |
| <b>ICLEI</b>     | International Council for Local Environmental Initiatives                     |
| <b>IEA</b>       | International Energy Agency   |
| <b>IECC</b>      | International Energy Conservation Code  |
| <b>IESNA</b>     | Illuminating Energy Society of North America                                  |
| <b>IGBC</b>      | Indian Green Building Council   |
| <b>IgCC</b>      | International Green Construction Code   |
| <b>IPCC</b>      | Intergovernmental Panel for Climate Change                                    |
| <b>IPEEC</b>     | International Partnership for Energy Efficient Countries                      |
| <b>KEMCO</b>     | Korea Energy Management Corporation   |
| <b>LCA</b>       | Life Cycle Assessment   |
| <b>LEED</b>      | Leadership in Energy and Environment Design                                   |
| <b>LEO</b>       | Low Energy Office   |
| <b>MDG</b>       | Millennium Development Goal   |
| <b>MEPS</b>      | Minimum Energy Performance Standard   |
| <b>MNRE</b>      | Ministry of New and Renewable Energy (India)                                  |
| <b>MOUD</b>      | Ministry of Urban Development (India)   |
| <b>MRET</b>      | Mandatory Renewable Energy Target   |

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|--------------|--|
| <b>SBS</b>   | Sick Building Syndrome                             |
| <b>SEAD</b>  | Super Efficient Appliance Deployment               |
| <b>SLP</b>   | Standards and Labelling Programme                  |
| <b>TERI</b>  | The Environment and Resources Institute            |
| <b>UNEP</b>  | United Nations Environment Programme               |
| <b>USEPA</b> | United States Environmental Protection Agency      |
| <b>USGBC</b> | United States Green Building Council               |
| <b>WBCSD</b> | World Business Council for Sustainable Development |
| <b>WTO</b>   | World Tourism Organization                         |
| <b>ZEO</b>   | Zero Energy Office                                 |

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## 1. Introduction

### 1.1. GREEN GROWTH: TRANSFORMING A VICIOUS INTO A VIRTUOUS CYCLE

Countries of Asia and the Pacific region are facing unprecedented financial and environmental challenges in their pursuit of achieving rapid growth and the Millennium Development Goals (MDGs). The combined effect of the business model of “growing at any cost” adopted by them and the erratic price fluctuations of natural resources during the last decade have resulted in deterioration of their economic security as well as the environment, manifested in the forms of depleting eco-systems and increasing climate vulnerability. There is growing realization of the urgency to move away from the current economic paradigm of maximizing the Gross Domestic Product (GDP) towards a new development paradigm of maximizing the economic, social and ecological quality of growth that focuses on employment generation, economic resilience, improved quality of life, and ecological sustainability.

The lower and middle income countries in Asia and the Pacific may be in different stages of development but they are all urbanizing rapidly and feel the pressure to create adequate infrastructure in order to cope with the growing demand for housing, industries, transportation and other services. The traditional approach to infrastructure development locks into patterns of production and consumption for decades. Choices made in infrastructure development today will determine the competitiveness, quality of life and sustainability of countries for decades to come. A well-conceived infrastructure development strategy is more likely to meet the set goals of improved standard of living and quality of life without depriving the future generations of their due share of natural resources and ecological space.

#### **Box 1. Building Virtual Power Plants**

*Many governments are presently pursuing a vicious cycle of development that undervalues our natural resources such as raw materials, energy, water, etc. Such pattern of development neither favors the adoption of resource-efficient infrastructure, nor encourages the population to adopt a resource-frugal life style that is respectful of the ecosystems and the environment.*

*Consider the policy adopted by many Asian developing countries to keep the energy prices low in order to sustain economic growth. Billions of Dollars are spent to subsidize energy prices. As a result, users are dissuaded from adopting leapfrogging technologies that can drastically lower the energy intensity or the demand for energy without compromising the productivity or the quality of service rendered. While the economic growth is meant to benefit the population, the demand for energy keeps rising incessantly and governments find it increasingly difficult to mobilize financial resources needed to create or enlarge the energy infrastructure.*

*A common example of the perverse effect of low electricity price is the disincentive to substitute energy-inefficient incandescent lamps by the more efficient alternatives such as the compact fluorescent lamps or light emitting diodes. While this technology substitution can help in dividing the electricity demand by at least a factor of four, the incremental investment for such a technology leapfrogging represents only about one-tenth the incremental investment for creating the infrastructure to supply the electricity needed for the lamps. Furthermore, expansion of the power generation capacity requires several hundred times the investment needed to build the infrastructure for manufacturing compact fluorescent lamps, or the so-called virtual power plants. It also takes much longer to recover the capital invested in a power plant than the lamp-manufacturing unit. One should not overlook the fact that while the power plant creates employment opportunity for only a handful of people, many more jobs can be created through the manufacturing, distribution and commercialization of energy-efficient lamps.*

\* During the 5th Ministerial Conference in Seoul, Republic of Korea, in 2005, the concept of Green Growth was adopted by 52 Member States of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) as a common path for achieving environmentally sustainable economic growth. For further information, see: <http://www.greengrowth.org/>



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Box 1 shows the relevance of adopting energy-efficient infrastructure in order to reduce the pressure on energy supply and how to create virtual power plants that eliminate the need for huge quantities of energy forever, thus avoiding the need to depend on highly polluting fossil-fuel based power plants. A report of a recent WBCSD study that included the building stocks of 6 of the largest economic regions, including China, India and Japan from Asia, concluded that at energy prices proportionate to oil at US\$ 60 per barrel and depending on the local context, building energy-efficiency investments totalling US\$ 150 billion annually would reduce related energy use and corresponding carbon footprints in the range of 40 per cent, with five-year discounted paybacks for the owners. A further US\$ 150 billion with paybacks between 5 and 10 years adds 12 percentage points and brings the total reduction to slightly more than half (WBCSD 2009).

## 1.2. INFRASTRUCTURE FAVORING GREEN GROWTH: FOCUS ON BUILDINGS

Chapter 1.1 highlighted the importance of designing eco-efficient infrastructure that guarantees the provision of all forms of services to ensure societal well-being without putting undue pressure on the earth's carrying capacity. Among all infrastructures, buildings play an important role as they form part of the three essential needs of a human being: food, clothing and shelter.

The world's urban population has now reached 3.2 billion people, the growth being much higher in less-developed countries. The global population is expected to further by 2.7 billion or 42 per cent by 2050 (WBCSD 2009). In Asia, the urban population grew from 231 million in 1950 to about 1.22 billion by 2000, a 5-fold increase in 5 decades (Hugo 2003). Asian cities are home to more people than all the urban dwellers in the rest of the world. As peasants become urban, they expect the same life style and comfort as the other city-dwellers. In China, for example, urbanites use almost double the energy per capita as the national average (IEA 2008). In India, one-third of the population lives in cities, accounting for the use of 87 percent of the nation's electricity (Starke 2007).

The rate at which people in developing countries are moving in urban centres is five times the rate at which new housing stock is constructed. The pressure for constructing housing for those deprived of it is thus very high. The building stock in China is estimated to be 35 billion m<sup>2</sup> (WBCSD 2011). Moreover, nearly 2 billion m<sup>2</sup> of floor space are likely to be added every year by 2020, representing almost half of the global total (McKinsey & Company 2009).

Much of the new building stock in Asia consists of large commercial office buildings and mixed-use developments that represent high embodied energy and embrace design features such as glass facades and centralized air conditioning which lead to high energy consumption and costs. China is reported to have 3.5 billion m<sup>2</sup> of office space, accounting for about one-third of the commercial building stock; offices are expected to grow by over 70%, adding over 2.5 billion m<sup>2</sup> by 2020 (WBCSD 2009). These resource-intensive buildings will be around for at least next 30-40 years. On the other hand, the rate of renewal of outdated and obsolete buildings is very slow.

Three major factors influence the growth of energy use in buildings: demographic evolution (population growth), socio-cultural changes (nuclear families, lifestyle changes), and design of building and equipment (energy use per unit building area). In industrialized countries, appliances accounted for only 16 per cent of the household energy in 1990, but their share had jumped to 21 per cent by 2005, despite of the increased appliance efficiency (IEA 2008).

There is growing realization that current ways of living, made possible mainly because of cheap and abundant fossil fuels, are not sustainable in the long term. Investments on buildings to reduce long-term demand on resources such as raw materials, energy and water through green approaches and features will enhance resources security by lowering the dependence on such resources, and abate greenhouse gases (GHG) emissions without affecting the scale of construction activities. Moreover, lower operational costs will free up financial resources to improve and extend building services, in addition to yielding local co-benefits such as job creation through higher local investments.

### 1.3. DRIVERS FOR GREEN BUILDINGS

Buildings are estimated to be worth US\$7.5 trillion per year, contributing to around 10 percent of global GDP (Betts and Farrell 2009). Drivers for sustainable buildings are highlighted in Box 2. Buildings create direct employment for over 111 million people around the world, with 75 percent in developing countries and 90 percent in micro firms having less than 10 employees (UNEP 2007). Buildings are also important consumers of natural resources such as raw materials, energy and water, and produce considerable amount of waste in solid, liquid and gaseous forms.

#### Box.2 Drivers for Sustainable Buildings

- Increasing scarcity of natural resources
- Population growth
- Extreme weather phenomena
- Growing awareness of environmental issues
- Legislation on environmental issues in building codes
- Increasing interest in human health and wellbeing aspects
- Rapid and continuous urbanization – an opportunity
- Aging population in industrialized countries
- Rise of living standards in developing countries
- Rapid development of ICT solutions

Source: International Energy Agency, ECBCS

Energy plays a vital role over the life cycle of a building, hence sustainable buildings and energy refurbishments in buildings hold enormous potential for energy saving and reduction of greenhouse gas emissions. Almost 2/3rd to 4/5th of energy is used directly during the operation of the building, the remaining accounting for the indirect form of energy such as the energy needed to manufacture building materials and components as well as the energy needed to transport raw materials to the construction site, and construction and demolition of the building (see Box 3).

#### Box 3. The role of energy in a building's life cycle

*Energy plays a vital role in the life cycle of a building, spanning over 5 distinct phases:*

**Phase 1.** Embodied energy needed to manufacture building materials and components. The more complex the material is, higher would be the quantity of energy consumed. Aluminium, steel and concrete are among the materials with the highest embodied energy and their manufacturing is responsible for large quantity of CO<sub>2</sub> emissions.

**Phase 2.** Grey energy for transporting from production site to building site. In earlier times, materials for building construction were sourced locally but with the development of technology and transportation, this is no longer the case today.

**Phase 3.** Induced energy needed for construction of the building. Due to the population density in urban zones, high-rise buildings are favoured to avoid urban sprawl, thus the energy needed for building construction has increased.

**Phase 4.** Operation energy consumed for the functioning of the building over its life time. This represents by far the highest share of energy use in buildings because energy is required to provide comfort and various services in buildings that have a long life time. In the United Kingdom, for example, buildings are estimated to consume around 50 percent of the total commercial energy available in the country. In China, buildings account for 42 percent of the total energy use. End-use energy consumption in the building sector for the year 2005 shows that

heating, ventilation and air conditioning accounts for 45 percent, followed by water heating (19 percent), appliances (14 percent), lighting (10 percent).

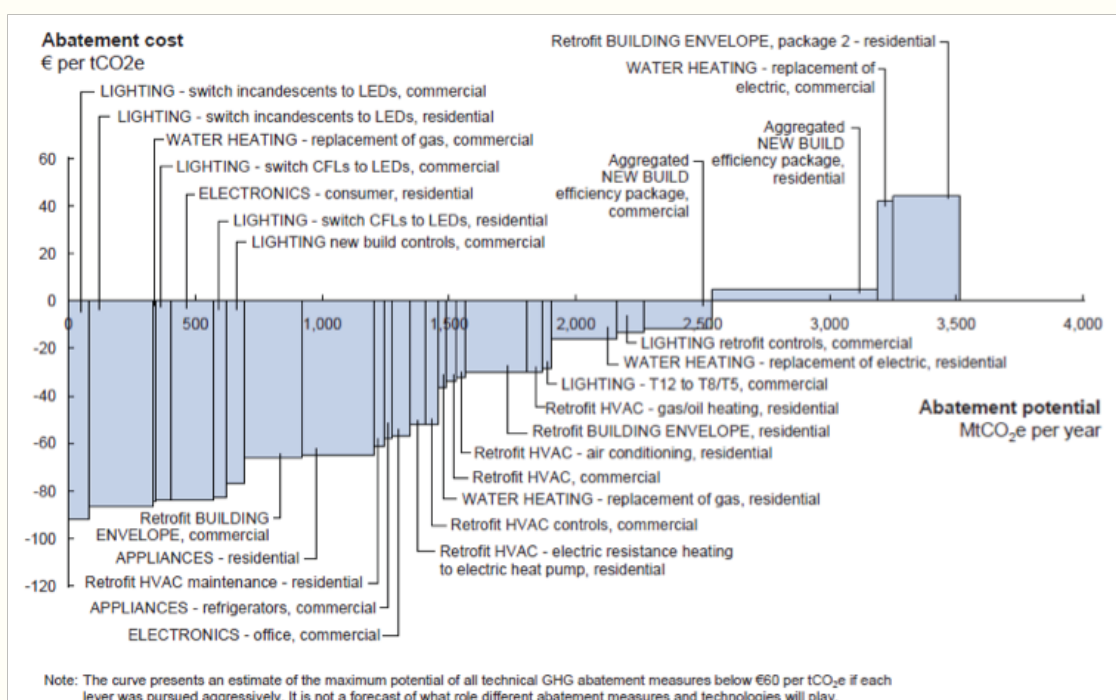
**Phase 5.** Demolition energy required to pull the building down at the end of its life. Further, some parts from the demolition of existing buildings can be reused or recycled by using only a fraction of energy that would have been required to mobilize new materials.

Oil and natural gas prices are rising incessantly and are quite unstable due to the uncertain supplies associated with geopolitical factors. Climate change and CO<sub>2</sub> emissions are a major challenge because a wide range of predicted environmental changes associated with climate change will have direct or indirect impact on the building industry. Directly, the building industry will incur higher operational costs associated with rising energy, water and management costs. Along with the building operating costs, construction and demolition costs will also increase due to rising oil prices and transportation costs, as well as increasing landfill charges. Buildings can however play a major proactive role in our fight against climate change. Green buildings have the potential to not only reduce pressure on infrastructure and CO<sub>2</sub> emissions but also contribute to the improvement of the air quality, social welfare and enhanced energy security.

Conclusions of the research work conducted for the Intergovernmental Panel on Climate Change (IPCC 2007) estimated that around 30 percent of the baseline CO<sub>2</sub> emissions in buildings projected for 2020 could be avoided cost-effectively by the use of various technological options, resulting in a number of co-benefits such as decreased air pollution, better health and reduced mortality, improved social welfare and energy security (Koeppel and Urge-Vorsatz 2007).

Sustainable buildings hold some of the most profitable means of abating climate change. According to McKinsey, an international consulting firm, carbon emissions in the building sector can be reduced substantially, either with net economic benefits or at low cost, using a range of proven technologies aimed at demand reduction and energy efficiency. The Global greenhouse gas abatement cost curve for the building sector shows that changes in building design and construction could offset up to 6 billion tonnes of carbon emissions annually through measures with a zero or negative net life-cycle cost (see also the global GHG abatement cost curve in Figure 1). In other words, green buildings have the potential to save money and carbon emissions at the same time through effective insulation, glazing, water heating, air conditioning, lighting, and other energy-efficiency measures.

**Figure 1. Global GHG abatement curve for the building sector (scenario perspective 2030)**  
(Source: McKinsey & Company 2009)



The worldwide concerns for the impending resources crunch and the dangers of global warming, and the understanding of the role that buildings can play to contribute positively to the economy, energy security, human health and the environment have led to a quiet and green building revolution around the globe over the last decade. Both government and private initiatives have resulted in an expanded stock of green buildings, though the focus has been much greater on commercial and institutional buildings.

**Figure 2. Leading real estate investment markets around the world (Source: Nelson 2008)**

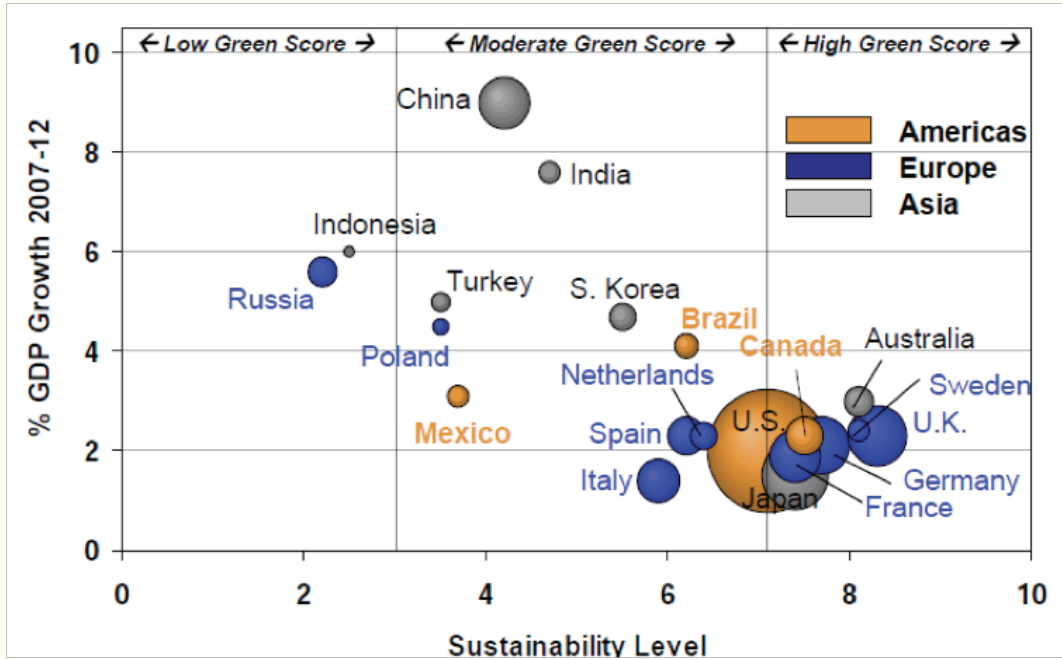


Figure 2 shows the leading real estate investment markets around the world. As one can note, green buildings have the largest potential market in faster growing emerging economies in Asia (e.g. China, India and Indonesia) though the green building movement is still at an early stage, at levels below 5 in the sustainable scale of 1 to 10.

Faced with the challenge of the tight energy supply-demand situation, several countries have taken initiatives by adopting policies and strategies favourable to the growth of energy-efficient buildings. A number of large green buildings commissioned lately in countries like China, India, Japan, Singapore and Republic of Korea have been certified against either international or national green building rating systems to differentiate themselves and demonstrate environmental credentials. Investors, developers, buyers and tenants are increasingly showing a preference for buildings that incorporate environment-friendly features.

#### 1.4. ECONOMIC, ENVIRONMENTAL AND HEALTH IMPACTS OF BUILDINGS

While buildings provide countless benefits to society, they also have significant economic, environmental and health impacts.

Buildings are estimated to account for more than a third of the world's resources in construction, 40 percent of global energy (including embodied energy), 12 percent of fresh water use, and generate 40 percent of greenhouse gas (GHG) emissions and make up 40 percent of waste to landfill. IPCC projections show that buildings will account for around one-third of total CO<sub>2</sub> emissions by 2030, with the largest share coming from developing countries, including developing Asia (IPCC 2007).

Most buildings are designed and constructed inefficiently. In order to keep the costs down and minimize the time for construction, there is a strong tendency to adopt fast parallel design and focus on speed and yield. Due to

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the inefficiency of design and construction, and the adoption of inappropriate but easily available construction materials, buildings incur higher operation and maintenance costs. For instance, there is higher heat gain in poorly designed air conditioned buildings in tropical climate, resulting in increased cooling load (or higher heat losses in cold climates, leading to greater heating load). Moreover, such buildings are highly vulnerable to future energy price hikes.

Buildings are large entities and have huge impacts on the environment in various ways. With the present-day methods of design, construction, use and maintenance, large quantities of resources such as materials, energy and money are consumed. In the phases of construction, occupancy and demolition, large quantities of waste and potentially harmful atmospheric emissions are generated, resulting in adverse effects such as loss of amenity and biodiversity. A study carried out on the life cycle analysis of dwellings in Sweden concluded that 70-90 percent of the environmental impact occurs during the phase when the building is used (ISO14042, 2006).

In addition to the greenhouse gases (GHG) emission, inefficient design and construction of buildings contributes largely to the generation of municipal solid waste and wastewater. In California, nearly 60 percent of the waste generated in the state comes from the commercial buildings. Local authorities in many cities spend a sizeable share of their budget to create the infrastructure, transport water from hinterland and treat it before supplying to buildings for human consumption. However, most buildings are not equipped to harvest rainwater or minimize water consumption by adopting measures such as the use of water-efficient faucets and showerheads, recycling of bathwater and washbasin water for flushing toilets and watering plants.

The potentially negative health effects of poor indoor environment in buildings are of major concern as people spend 85-95 percent of their time indoors. People are exposed to problems such as high radon gas concentrations and suffer from allergies due to poor indoor air quality associated with inefficient and defective heating or cooling systems. In low-income countries, traditional fuels used for heating and cooking contribute to chronic obstructive pulmonary disease in adults and acute respiratory infections in young children. Paints, varnishes, solvents and preservatives commonly used in buildings generate volatile organic compounds (VOCs) that have been proven to be public health hazards. Furthermore, when structure of a building begins to deteriorate, there are possibilities of exposure to asbestos which may be an important risk factor for the chronic respiratory disease mesothelioma. These poor indoor qualities attributed to the buildings lead to the notion of Sick Building Syndrome (SBS); occupants of affected buildings often describe a complex range of vague and often subjective health complaints.

Other than health aspects, there is also the problem of urban warming, or the so-called "heat island effect". Roofing and walls used for construction of buildings capture and retain the solar heat and radiate to the surrounding. Air conditioners used to cool the building by evacuating heat from within the building reject it outside. Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality. Relevant studies have demonstrated that greening approaches are the most inexpensive solutions to alleviate the urban heat island effect and to provide tangible benefits in terms of optimizing the energy use in buildings.



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## 1.5. BENEFITS OF GREEN BUILDINGS

Green building design is rooted in an understanding of natural systems and the behaviour of eco-systems, facilitating and preserving the interrelationship between nature and buildings. It encompasses the whole process of planning and design (pre-building phase), construction, use and maintenance (building phase), and demolition/disposal (post-building phase), spanning over the whole life cycle of the building. It strives to make judicious use of the surrounding resources in order to create a harmonious environment and excellent living space for the dwellers, while minimizing the environmental impacts and ecological footprints.

Green building practices strive for integral quality in a very broad way, including economic, social and environmental performance. Rational use of resources and appropriate management of building stocks contributes to saving scarce resources, reducing energy consumption and improving the environmental quality. In summary, there are two complimentary approaches to consider for green buildings:

- Adoption of nature-driven technology (solar/wind protection, daylight, thermal envelope, renewable resources, reuse and air quality control).
- Adoption of technology-driven strategy (site selection, building materials, heating, cooling, recycling, HVAC control, etc.).

Thanks to the integration of design features that are site-specific and well suited to the local climate, and the adoption of innovative and environment-friendly technologies and durable materials with high recyclable content, sustainable buildings have the potential to cut down the energy/water use and cost by over 50 percent as compared to conventional buildings, boosting the property values considerably. While sustainable buildings can achieve cost reductions because of the lower need for lighting, ventilation, heating and cooling, they may incur slightly higher capital costs because of the additional features and systems incorporated in these buildings, such as on-site energy generation, rainwater harvesting or wastewater recycling, etc. However, the marginally higher investments guarantee the generation of several-fold higher life-cycle savings. Further benefits can be in the form of better thermal, visual and acoustic comfort, improved air quality and human health, enhanced performance and productivity. Sustainable landscaping and adoption of bioclimatic features can help the buildings to improve urban microclimate and air quality. On the whole, green buildings have considerable potential benefits for their owners, users, the environment, and the society in general.

According to UNEP, greening of buildings can be part of the strategies to improve access to basic services, reduce vulnerability, and contribute to better living conditions of the poor residing in informal settlements or overcrowded housing estates that are associated with the lack of access to electricity, fresh water, health-care and effective waste management (UNEP 2011).

Based on the several thousands of green buildings designed, built and operated over the last couple of decades, there is increasing evidence around the world that while green buildings generally incur a small green premium above the cost of standard construction, they deliver a suite of economic, social and environmental benefits that conventional buildings do not. Buildings have the potential to reduce energy consumption by 75 percent, contributing to 20 percent reduction in the world's total energy needs, improving the quality of life, creating over a million jobs and reducing pressure on energy prices worth billions of Dollars (Rockwool Company 2010).

There are a number of stakeholders involved in the building sector, including owners, developers, investors, facility managers, tenants, etc. Therefore the benefits can also be perceived differently by each stakeholder.

Most building developers with short-term views opt to build, sell and move on to the next project. Those who have made efforts to create green buildings have found their clients appreciating well the improved living and working environment. Developers can greatly influence the development of green buildings by adopting the right policy, mobilizing the required expertise, and allocating the budget according to the needs. In return, they can reap higher benefits thanks to a number of opportunities offered by green buildings. Table 1 presents the wide-ranging benefits of green buildings for potential developers, each of which is further described below.

**Table 1. Wide-ranging benefits of green buildings for developers**

|   | Typical benefits for potential developers |
|---|---|
| 1 | Capital cost savings                      |
| 2 | Operational cost savings                  |
| 3 | Reduced construction time schedule        |
| 4 | Improved marketability and enhanced value |
| 5 | Higher future value of property           |
| 6 | Reduced advertising costs                 |
| 7 | Reduced liability and risk                |

**1. Capital cost savings:** Green building design necessitates the adoption of a system's approach that helps in substantial cost saving. For example, architectural design that is well suited to the local climate can cut down the need for heating/cooling substantially, thus helping to downsize the heating, ventilation and air conditioning (HVAC) system, including the bulky mechanical equipment and ductwork; the space saved can be sold or leased to earn additional revenue. The TaiGe serviced apartments in Shenzhen is the first LEED-certified commercial building in China, developed in 2004, which saves 75 percent of lighting power and 50 percent of air conditioning power consumption while providing the same visual and thermal comfort. Though the building cost more to build, it rents at a premium (Wen Hong et al 2007).

**2. Operational cost savings:** Bioclimatic architecture combined with judicious use of insulation, and high efficiency equipment and appliances will guarantee sizeable operational cost savings (e.g. typically 30 to 50 percent lower energy and water bill and waste disposal costs, along with reduced carbon footprint from energy savings). This is particularly relevant in the context of high fossil fuel prices which are unlikely to come down in the future. Developers can use this argument to market the building to their prospective clients or tenants.

**3. Reduced construction time schedule:** Green buildings require an integrated and teamwork approach to designing, resulting in minimized conflicts during the construction phase, allowing the project to be commissioned ahead of schedule. Time saved on the project allows the builder to lower the cost and gain higher benefit.

**4. Improved marketability and enhanced value:** Green buildings can be considered as distinct products that can be used for marketing purposes, attracting and retaining employees, and building corporate image. As such buildings are conceived to provide an improved indoor environment and increased productivity of employees, thus the scope for selling or renting them is enhanced.

**5. Higher future value of property:** Green buildings guarantee lower operating costs, rendering them more competitive for sale or to be leased at a premium. According to American and British studies, the asset value of a building can increase by 6-15 percent if it is covered by trees (Callaghan 1999). Moreover, clients see better future prospects of selling the acquired properties.

**6. Reduced advertising costs:** Because of their superior design and ecological contribution, green buildings attract media attention and get free publicity, thus helping them to cut down the expenditure on promotional advertising.

**7. Reduced liability and risk:** As insurance companies get better aware of the positive contribution of green buildings in terms of lower operating costs and better indoor environment, they are likely to link lower insurance premium to green buildings.

LEED stands for Leadership in Energy and Environment Design, initiated by the US Green Building Council. There are two very good Asian examples of high energy savings in green buildings. The headquarter building of the Ministry of Science and Technology in China consumes around 70 percent less energy than comparable buildings. The CII-Godrej Green Business Centre Building in India consumes 55 percent less energy and has achieved 88 percent reduction in lighting energy consumption.

Green buildings find easy acceptance among owners and facilities managers who seek to minimize their operating costs and risk liability in order to secure tenants more quickly and enjoy lower tenant turnover, achieve higher returns on assets, and increase their property value. Following the same arguments, they are also willing to renovate older buildings to include as many green features as possible so as to lower their operation and maintenance costs thanks to reduced energy, water and waste disposal costs, and better indoor environment.

Some of the benefits from green buildings for owners and facility managers are summarized in Table 2.

**Table 2. Some of the benefits of green buildings for owners and facilities managers**

|   | Typical benefits for owners and facilities managers                         |
|---|---|
| 1 | Savings in energy and water costs   |
| 2 | Lower maintenance costs and better performance                              |
| 3 | More competitive real estate holdings                                       |
| 4 | Improved employee productivity  |
| 5 | Healthier indoor environment and reduced absenteeism                        |
| 6 | Faster leasing and sales  |
| 7 | Demonstration of commitment to sustainability and environmental stewardship |

In Hong Kong, China, an energy-efficiency retrofit of the Swire Group's office building achieved an annual electricity savings of around HK\$1 million, and is expected to recover the investment made for the retrofit in around 3 years. Similarly, the Sydney Harbour Foreshore Authority (SHFA) retrofitted the first heritage-listed building in Australia to achieve a 5-Star green rating for office design at approximately 5 percent over the premium rate; the building is expected to recover the additional investment through higher rents and full tenancy before the full completion of the building refurbishment.

Office workers spend a third to a quarter of their life in commercial buildings, and expect building owners and facility managers to maintain good indoor environment quality. Several Asian countries in the process of development are vulnerable to grid failures in the form electricity brown-outs and black-outs or water shortages. It makes sense to incorporate green features such as daylighting and natural ventilation, solar power generation and rainwater harvesting to make buildings less reliant on external grids.

Tenants are increasingly aware of the benefits of green buildings. They look for the most-effective and comfortable space to rent in order to suit their residential or business needs. In commercial buildings where salaries of employees represent the largest share of costs, worker productivity is more important than the savings from the utilities such as energy, water, etc. A study conducted in California concluded that four of the green building design features that led to increased productivity are increased ventilation control, temperature control, lighting control and daylighting. For example, glare from windows decreased performance by 15-21 percent whereas an increase in ventilation was associated with 4-17 percent performance improvements, and from 9 to 50 percent reduction in sickness.

Companies opting for green buildings could attract and retain a committed workforce (Heschong 2003). The headquarters of ING Bank in Amsterdam where all desks are located within 23 feet of a window for daylighting, reported a 15 percent reduction in employee absenteeism due to improved comfort. Boeing, the aircraft manufacturer participated in a programme to promote energy-efficient lighting and reduced the lighting electricity use by up to 90 percent in some of its plants; with the new lighting, the workers' ability to detect imperfections in the shop improved by 20 percent (Romm and Browning 1998).



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## 1.6. ARE GREEN BUILDINGS AFFORDABLE?

There is general perception that buildings designed to be sustainable are likely to be more expensive than the traditional ones and have to look different with technology-laden rooftops. This can be major hindrance for the mainstreaming of green building practices because of the general aversion to make additional investments in order to achieve lower energy costs. It is crucial to design buildings that are genuinely environment-friendly, accessible and do not require additional budget. For this, there has to be more emphasis on adopting the right building science and depending less on high-cost building technologies. A better scientific understanding of the way buildings work can help in avoiding high technological sophistication or the “technical fix”. In short, the challenge is to do more with less.

A report by the World Business Council for Sustainable Development pointed out that despite the increasing knowledge and understanding about green buildings, key decision makers still overestimate the cost. A 1,400-person survey found that the average guess for the additional cost of building green was 17 percent, when the actual amount is closer to 5 percent. A 2003 report by the U.S. Green Building Council put the increase at as little as 2 percent. Other more conservative estimates for the most energy-efficient buildings are around 10 percent. These additional costs, although sometimes initially high, are paid back over 2–7 years. After the initial payback period, they become a negative cost, as the savings over time are greater than the initial increase in investment (UNEP/ILO/IOE/ITUC 2008).

A report submitted to California's sustainable Building Task Force in 2003 provided the first comprehensive analysis of the actual costs and financial benefits of green buildings (Kats 2003). Examining 33 green buildings across the USA, the report also undertook a comparison of the real constructed cost with the estimates based on similar non-green building design. The report concluded: *“The benefits of building green include cost savings from reduced energy, water, and waste; lower operations and maintenance costs; and enhanced occupant productivity and health. An analysis of these areas indicates that **total financial benefits of green buildings are over ten times the average initial investment required to design and construct a green building.** Energy savings alone exceed the average increased cost associated with building green. Additionally, the relatively large impact of productivity and health gains reflects the fact that the direct and indirect cost of employees is far larger than the cost of construction or energy. Consequently, even small changes in productivity and health translate into large financial benefits”*.

The report further indicated that the average construction cost premium for green buildings is almost 2 per cent, or about US\$4/ft<sup>2</sup> – substantially less than it is generally perceived. The findings of this report point to a clear conclusion: building green is cost-effective and makes financial sense today.

The Davis Langdon report published in 2004 analyzed the construction costs of 138 existing buildings across the USA (Langdon 2004). Forty five of these buildings were certified as green by the North American Green Building Rating Tool ‘LEED’ (Leadership in Energy and Environment Design) and the remaining 93 buildings were defined as ‘conventional’. While there was a high variation in the construction costs within both green and non-green categories, the report concluded that there was no statistically significant difference between the capital costs of green and conventional buildings. An analysis of initial budgets concluded that *“the cost per square foot for buildings seeking LEED certification falls into the existing range of costs for buildings of similar program type and many projects can achieve sustainable design within their initial budget or with a very small supplementary funding”*.

Similar study conducted by the Indian Green Building Council (IGBC) concluded that LEED rated green buildings in India consumed 30-50 per cent less energy compared to a conventional building at an incremental cost of 5-8 per cent that was paid back within 3 to 5 years, which is short compared to the typical life span of a building of at least 50 years. The incremental cost depends on the extent of eco-friendly features that have already been considered during the design process. Moreover, working in environment with access to daylight and views has a positive impact on human psychology. Studies have shown that people having access to daylight and view generally contribute to 12-15 per cent higher productivity. Three “LEED Platinum” rated buildings were monitored over 3 years by IGBC and the cost-benefits of energy savings achieved are summarized below:

| Building           | Built-up area (ft <sup>2</sup> ) | Increase in cost (per cent) | Energy reduction (per cent) | Payback time (years) |
|--------------------|----------------------------------|-----------------------------|-----------------------------|----------------------|
| Wipro Technologies | 175,000                          | 8                           | 40                          | 5                    |
| ITC Green Centre   | 170,000                          | 15                          | 45                          | 6                    |
| CII Godrej GBC     | 20,000                           | 18                          | 63                          | 7                    |

According to IGBC, with the rapid market transformation taking place in India, the incremental costs are likely to go down as well, further lowering the time needed to recover the additional investment.

The ING Bank office building completed in 1997 at Amsterdam is considered to be one of the pioneer sustainable buildings. A very important feature of this building is the absence of air conditioning system. The office building was designed using massive 18" interior concrete walls to act as insulator and the building was flushed with the cooler night air. According to a report of the Rocky Mountain Institute, the building used less than a tenth of energy of its predecessor and a fifth that of a conventional new office building in Amsterdam. Annual energy cost savings were evaluated as US\$2.9 million. While the additional features increased the building construction cost by around US\$700,000, they were paid back in only 3 months. The building was one of the first to report the productivity gains of a green building, such as lower absenteeism (Room and Browning 1998).

The first well-publicized green office building in Australia was the 60L (60-66 Leicester Street, Carlton, Victoria) project which was considered as an example from which the property industry could learn that minimizing a building's impact on the environment could be commercially viable. According to the owners of 60L, energy efficiency measures result in power savings of 65 per cent compared to a conventional office building. 60L also pioneered the use of green lease which is negotiated between owners/managers/developers and tenants, and which obliges both parties to cut their environmental impacts over the whole life span of the building (GBCA 2006).

Governments have a major influence in promoting sustainable buildings because of the vast amount of space they occupy and own, as well as through regulation, policy, incentive programs and leadership. The Malaysian government took up initiative to set up the first low-energy and zero-energy office buildings to lead the way and set good example for others to emulate. The low-energy building of the Malaysian Ministry of Energy was reported to have cost around 10 per cent more than a conventional building but the energy consumption index of the building was brought down by less than 50 per cent, to 100 kWh/m<sup>2</sup>.year as compared to the typical 250-275 kWh/m<sup>2</sup>.year for traditional air-conditioned office buildings in the country. The additional investment was to be recovered from the energy cost savings within 5 years. Based on the experience gained, a so-called "zero-energy" office building was constructed for the use of Malaysian Energy Centre. This building included features that allowed to reduce the energy consumption of the building to about 35 kWh/m<sup>2</sup>.year and roof-top solar photovoltaic systems were expected to meet this low energy demand of the building by interacting with the national grid to supply excess electricity during the utility peak period and purchasing the deficit during the off-peak.

In 2005, the South Australian Government announced that all new offices built or leased by the government must achieve 5 Star Green Star – Office Design Certified Rating and all new government offices must achieve a 5 Star Green Star – Office Interiors Certified Rating. In Sydney, Lend Lease's new headquarters is a nine storey building, with a design that ensures 30 per cent lower greenhouse gas emissions than a typical office building. Pre- and post occupancy evaluations done on the building showed that some 84 per cent of respondents felt they were more comfortable. When asked to provide reasons for their increased comfort, the responses were:

- New building (64 per cent);
- Overall indoor environment conditions (64 per cent);
- Indoor air quality (55 per cent);
- Workspace (54 per cent);
- Lighting (43 per cent); and
- Air conditioning (40 per cent).

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An office building built in 1987 in South Melbourne and regenerated during 2004-05, is the first office refurbishment in Australia to be awarded a 6 Star Green Star – Office Design Certified Rating. With 87 per cent of the building structure recycled, the project claims to achieve:

- 70 per cent reduction in energy use compared to conventional office buildings;
- 82 per cent reduction in piped water use; and
- 72 per cent reduction in sewer discharge.

The Directive 2006/32/EC of the European Parliament and of the European Council on energy end-use efficiency and energy services includes two important aspects: (1) the public sector has to play an exemplary role in order to encourage citizens and businesses to follow the trend; (2) the public sector should develop model contracts for promoting energy efficiency services in the public and private sector. As a result, increasing number of public bodies and local authorities in Europe are resorting to energy efficiency services to reduce their energy bills and to improve the level of comfort through the retrofit of buildings that were constructed during the era of cheap energy prices.

The Province of Cremona in Italy was short of funds to renovate and refurbish 37 school buildings representing a total volume of around 750,000 m<sup>2</sup>. Based on monitoring of energy consumption of the buildings, the Province was able to try out the Third-Party Financing (TPF) scheme through an Energy Efficiency Service Company (ESCO), thus mobilizing €7.5 million to carry out various energy efficiency improvement measures that guaranteed a saving of 20 per cent of the initial consumption. The energy cost savings generated from this initiative were sufficient to cover the payment of initial investment as well as the service fee of the ESCO engaged. Moreover, the ESCO also proposed a better comfort to the final users of these buildings.

A similar project was undertaken by the Nyköping municipality to set up an energy performance contract to operate and reduce the energy consumption of a total of 250,000 m<sup>2</sup> of public premises. The purchasing and contractual process was conducted in line with the Public Procurement Act. The contacted ESCO agreed to undertake an investment of €5.5 million while guaranteeing savings of 17 per cent and 10,000 MWh/year. The results of monitoring done on the buildings showed that the guaranteed savings were actually exceeded and the level of motivation of the maintenance staff had increased after training and system upgrading.

Under the “Cities for Climate Protection” initiatives of the International Council for Local Environmental Initiatives (ICLEI), several urban authorities have initiated measures to retrofit their buildings for reducing the cost of resources consumed and abating the impact of greenhouse gas emissions. For example, the Ekurhuleni Metropolitan Municipality decided to retrofit three municipal headquarters buildings in order to lower the energy costs. Various energy efficiency measures were studied and were combined with proposals to harvest and use solar energy. The overall energy savings exceeded 50 per cent of the initial energy consumption, and the cost saving accrued could pay back the investment within a short span of 1.2 years.

Finally, under the Municipal Energy Efficiency Plan of the city of Almaty for the year 2005-2006, the Energy Efficiency and Cleaner Production Centre is reported to have undertaken several energy audits for initiating demonstration projects. A small revolving fund was created for this purpose to lend money for carrying out retrofits on existing buildings and costs savings from these buildings were used to expand the scope of activities. The demonstration projects showed that it was actually possible to reduce the energy consumption of municipal buildings in Almaty by 20 to 25 per cent. It concluded that if Almaty municipality were to implement measures in all its buildings, there was a potential to reduce the energy bills by US\$4.4 to 5 million per annum.

## 2. KEY FEATURES OF GREEN BUILDINGS

### 2.1. DEFINITION OF A GREEN BUILDING

A green building incorporates design techniques, materials and technologies that minimize its overall impacts on the environment and human health. This is achieved by better siting, design, material selection, construction, maintenance, removal, and possible reuse. Main outcomes are minimum site disruption, reduced fossil fuel use, lower water consumption, and fewer pollutants used and released during construction, occupation and disposal of the building.

**Figure 3. Design options and technologies to achieve energy-neutral building (Source: WBCSD 2007)**



**Figure 3 illustrates the example of a building that can achieve energy neutrality by adopting design options and technological measures such as:**

1. Earth duct - for fresh air intake conditioning
2. Heat recovery ventilation system
3. Geothermal heat pump
4. Ground heat exchanger
5. Hollow core concrete slab with air ducts to exploit thermal mass
6. Solar hot water system and photovoltaic cells for electricity production - space between façade and hollow core concrete slab open in summer to allow for ventilation
7. Hot water tank
8. Gravel-filtered rainwater tank and collection system
9. Non-potable rainwater distribution system for washing, gardening and toilets
10. Water basin to cool south facing facade in summer through evaporation

The Green Building Council of Australia (GBCA) defines a green building as one that incorporates design, construction and operational practices which significantly reduce or eliminate the negative impact of development on the environment and occupants with strategies for addressing the parameters that are shown in Figure 4 (GBCA 2008):

**Figure 4. The role of green building, as defined by the Green Building Council of Australia**



The terms “energy-efficient” and “high performance” buildings refer specifically to the energy efficiency whereas green buildings refer to the broader environmental consideration of a building, including the energy-efficient aspects. Many countries in Asia and the Pacific region are vulnerable to energy price fluctuations and the adverse impacts of climate change. The primordial role of energy efficiency in green buildings cannot therefore be underestimated because it makes sense from both business and environmental perspectives.

One should however recognize that there cannot be a single and definitive green benchmark or building standard. As knowledge, technology and acceptance of environmental principles increase, owners, developers and tenants are likely to aim for higher standards and raise benchmarks as appropriate and in accordance with stakeholder engagement.



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## 2.2. GREEN BUILDING RATING SYSTEMS

The overall green building movement is hardly two-decade old. Growing awareness about the adverse impacts of our use of resources on the environment and concern for national energy security in different parts of the world have led to the momentum to bring about transformation in the construction industry for achieving improved sustainability. National initiatives have been taken to create public or private voluntary green building rating systems that serve the purpose of assessing buildings against a set of performance criteria and recognizing their superior environmental performance. Such rating programmes provide guidance for design, construction, and operational practices in order to significantly reduce the environmental impact of buildings. Expertise in sustainable buildings is promoted through training, sharing of practical resources, certification and professional accreditation.

Three major certification systems for buildings were established in the 1990s, starting with the British Building Research Establishment Environmental Assessment Method, or BREEAM in 1990. This was followed by the French certification system, HQE (High Environmental Quality) in 1996. Perhaps the most widely recognized certification system around the world today is the LEED (Leadership in Energy and Environmental Design), developed by the United States Green Building Council (USGBC) in 1998. The USGBC was founded in 1993 to drive the building and construction sector towards high performance green buildings. LEED is adopted voluntarily in the U.S. and a large number of countries around the world.

**Table 3. Major certification systems for green buildings around the world (Rockwool 2010)**

| Certification                   | LEED  | BREEAM                              | DGNB                                    | HQE                        | SBTool                    |
|---------------------------------|---|-------------------------------------|---|----------------------------|---------------------------|
| Name                            | Leadership in Energy and Environmental Design | BRE Environmental Assessment Method | German Sustainable Building Certificate | High Environmental Quality | Sustainable Building Tool |
| Origin                          | USA   | UK                                  | Germany                                 | France                     | Canada                    |
| Established                     | 1998  | 1990                                | 2009                                    | 1996                       | 2002                      |
| Responsibility                  | USGBC   | BRE                                 | DGNB                                    | Association pour la HQE    | iisBE                     |
| <b>CRITERIA</b>                 |   |                                     |   |                            |                           |
| <b>Energy</b>                   |   |                                     |   |                            |                           |
| Low emissions                   |   | +                                   | +                                       |                            | +                         |
| Renewable energy                | +   |                                     | +                                       | +                          | +                         |
| Energy efficiency               | +   | +                                   | +                                       | +                          |                           |
| Electrical demand               | +   | +                                   | +                                       | +                          | +                         |
| Low carbon                      |   | +                                   | +                                       |                            | +                         |
| Refrigerant management          | +   | +                                   | +                                       | +                          |                           |
| <b>Water</b>                    |   |                                     |   |                            |                           |
| Re-use/recycling                |   | +                                   | +                                       | +                          | +                         |
| Water consumption               | +   | +                                   | +                                       | +                          |                           |
| <b>Site/Location</b>            |   |                                     |   |                            |                           |
| Public transportation           | +   | +                                   | (+)                                     | +                          | +                         |
| Site selection                  | +   | +                                   | (+)                                     | +                          | +                         |
| Grace/elegance                  |   |                                     |   | +                          |                           |
| Cyclist facilities              | +   | +                                   | +                                       |                            |                           |
| <b>Indoor Environment</b>       |   |                                     |   |                            |                           |
| Air quality                     | +   | +                                   | +                                       | +                          | +                         |
| Daylighting                     | +   | +                                   | +                                       | +                          | +                         |
| Acoustics                       |   | +                                   | +                                       | +                          | +                         |
| Thermal                         | +   | +                                   | +                                       | +                          | +                         |
| Smell                           |   |                                     |   | +                          |                           |
| Hygiene                         |   |                                     | +                                       | +                          |                           |
| <b>Materials</b>                |   |                                     |   |                            |                           |
| Materials reuse                 | +   | +                                   | +                                       | +                          | +                         |
| Waste management                | +   | +                                   | +                                       | +                          |                           |
| Robustness                      |   | +                                   | +                                       |                            |                           |
| <b>Process &amp; Management</b> |   |                                     |   |                            |                           |
| Planning                        |   |                                     | +                                       |                            | +                         |
| Construction phase              |   | +                                   | +                                       |                            |                           |
| Commissioning                   | +   | +                                   | +                                       | +                          | +                         |
| <b>Economic issues</b>          |   |                                     |   |                            |                           |
| Costs                           |   |                                     | +                                       |                            | +                         |
| Life cycle consideration        |   |                                     | +                                       | +                          |                           |
| Value stability                 |   |                                     | +                                       |                            | +                         |
| <b>Functionality/Comfort</b>    |   |                                     |   |                            |                           |
| Flexibility/adaptability        |   |                                     | +                                       | +                          | +                         |
| Access – disabled persons       |   | +                                   | +                                       |                            | +                         |
| <b>Safety and security</b>      |   |                                     |   |                            |                           |
| <b>Innovation</b>               |   |                                     |   |                            |                           |
| Innovations issues considered   | +   | +                                   |   |                            |                           |
| <b>Minimum requirements</b>     |   |                                     |   |                            |                           |
| Yes                             | +   | +                                   | +                                       |                            |                           |
| <b>GRADES</b>                   |   |                                     |   |                            |                           |
|                                 | LEED Certified                                | Pass                                |   |                            |                           |
|                                 | LEED Silver                                   | Good                                |   |                            |                           |
|                                 | LEED Gold                                     | Very Good                           | Bronze                                  | Basic Level                | Minimum                   |
|                                 | LEED Platinum                                 | Excellent                           | Silver                                  | High Level                 | Good Practice             |
|                                 |   | Outstanding                         | Gold                                    | Very High Level            | Best Practice             |

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The success of the LEED certification led, in 1999, to the creation of the World Green Building Council, a non-profit organization focusing on sustainability in the building industry. It now serves as a union of over 80 national Green Building Councils from 5 different regions around the world, making it the largest international organization influencing the green building marketplace.

### 2.3. KEY FEATURES OF A GREEN BUILDING

Modern sustainability initiatives call for integrated and synergistic design for new construction and also in the retrofitting of existing buildings. Green buildings bring in a vast array of practices and technologies that can be combined to help reduce the need for natural resources, improve human comfort and health, and mitigate negative environmental impacts. Green buildings emphasize design practices that favour the usage of renewable resources, for example, the usage of sunlight for lighting through passive or active solar design. Green buildings are associated with some key features which give the architectural design unique characteristics that are missing in traditional construction. These include:

- Integrated and innovative design process
- Siting and structure design efficiency
- Energy efficiency and environmental protection
- Building commissioning
- Water and waste management
- Materials and resources efficiency
- Indoor environmental quality enhancement

#### 2.3.1. INTEGRATED DESIGN APPROACH

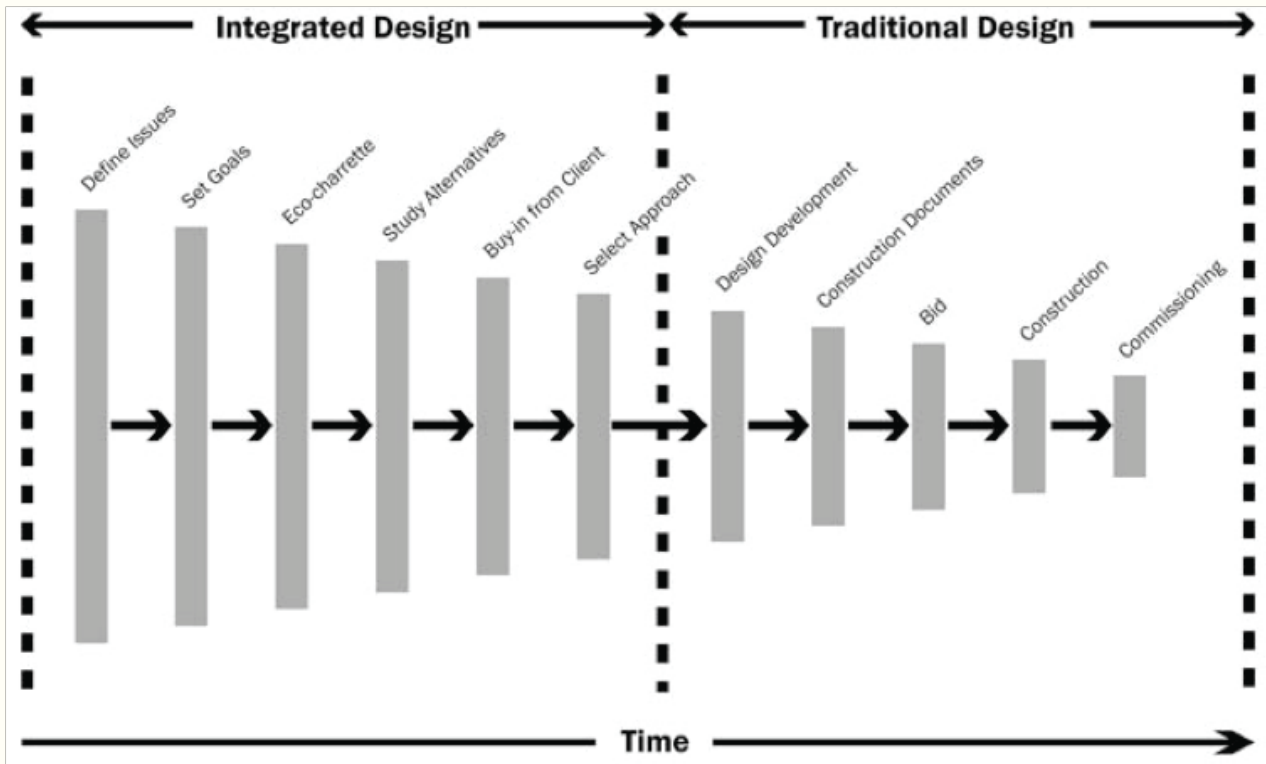
Integrated building design is an important process in which multiple disciplines and seemingly unrelated aspects of designs are integrated in a manner that permits synergistic benefits to be realized. The process of green building is distinguishable from normal conventional practices because it emphasizes the need for close collaboration from all concerned. Integrated design consists of simultaneously connecting and involving, from the initial phase to the completion of the design process, developers, contractors, architects, engineers and technicians, interior designers, landscapers and building occupants. Inputs for the project are obtained from a wide range of parties that include the project team, the owner and users, the community and other stakeholders. They work together to identify sustainable design strategies and options prior to the launch of the schematic design phase. Thus, if new considerations have to be incorporated, expensive revisions and disruptions can be avoided.

In comparison to the traditional approach or methods that require stakeholders to proceed and adapt their solutions to earlier decisions made in a vacuum by the predecessors, the integrated design approach takes into account maximum number of variables from the initiation of design through the entire process. It expands from the conventional approach by thinking out of the box with whole-systems designing, end-use efficiency and least cost planning.

A key precept of integrated design involves asking the right questions at the right time. If adequate time is not allocated to bring together all the relevant parties and study alternatives before zooming on to a final design, opportunity may be lost to make single systems carry out multiple tasks and achieve several-fold savings for the same investment. So adequate time needs to be allocated for the integrated approach to green building designing because it allows to take into account many aspects of design that are not considered until much later in the process (see Figure 5). As a result, the design gets refined by grouping high-performance strategies into appropriate combinations. Once the design is finalized to the satisfaction of all concerned parties, it helps to streamline the construction process and time, guaranteeing higher performance and lower cost.



Figure 5. The opportunities for integrated design diminish over time (Yudelson 2008)



In conventional practice of building design, it normally costs more to save more. But the case is different when one adopts the whole system thinking and optimizes the building as a whole “system” rather than optimizing individual components. The “systems” in question can be expanded to include ecological systems, social systems, timeframes beyond the usual payback horizon, and others.

End use and least cost planning involve problems from the perspective of the end-user's needs before the consideration of how to provide those needs. This could, in most cases, lead to huge savings. For instance, action to improve thermal efficiency measures in the building envelope can result in substantial downsizing of mechanical systems. By integrating passive design techniques and solar protection devices, the heat gains of the building can be lowered drastically, either avoiding altogether the need for air conditioning or resorting to a much smaller but efficient air conditioning system. Costs can be kept under control when the infrastructure and supporting systems are appropriately sized. As a result, a building conceived with integrated design and making innovative use of materials and equipment has the potential to be constructed at a cost that is comparable to that of a traditional building while it ensures lower operating and maintenance costs and high resale value for the property.

### 2.3.2. SITING AND STRUCTURAL DESIGN EFFICIENCY

The conceptual design of a building is one of the major steps in a project's life cycle because it has the largest impact on the cost and the building's performance. The aim of an environmentally optimal building is to minimize the total environmental impact that is associated with all life-cycle stages of the project, but the process varies for each building.

For a green building, it starts with proper site selection as the choice of location can affect a wide range of environmental factors such as security, accessibility and energy consumption, both direct and indirect. Carefully planning minimizes storm water runoff, reduces risks of erosion and maximizes open space, and protects existing habitats. The building can be designed to conserve energy by taking advantage of the natural site features such as breeze, sunlight, shade and topography.

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Green structures also takes into consideration proper landscaping practices, and this involves choosing appropriate plants, managing water responsibly on the site and choosing appropriate materials for landscape construction, in a manner to complement natural ecosystems. This practice contributes positively to cooling the environment and minimizing the "heat island effect" to a great extent. Thoughtful selection and siting of trees and groundcovers help to provide shading and lower ambient air temperature, creating a desirable microclimate and reducing the air conditioning energy use by 5-20 percent. Here are some aspects that may be considered to achieve better comfort and lower the energy bill:

- **Landscaping:** This aspect may be less relevant in the densely constructed urban context. Wherever possible, landscaping can create a less severe microclimate and thus reduce the amount of energy needed for a comfortable indoor environment.

- **Building orientation:** Optimal building orientation provides significant opportunities to reduce overall environmental impacts. The building orientation that relates well to the site maximizes opportunities for passive solar heating when heating is necessary, solar heat gain avoidance, natural ventilation and high-quality daylighting throughout the year. All these can result in improved comfort and lower energy bill.

- **Building form:** The building form dictates the surface area and the volume which, in turn, influence the fabric and ventilation heat losses, respectively. The building form also determines the ability of the building to harness natural energy in the form of solar light and heat, and natural ventilation.

- **Building fabric:** The heat flow across the building envelope is determined by the heat transfer characteristics of the external envelope that includes roofs, walls, windows, floor and internal walls of a building. The thermal performance of the building envelope is best when all the elements of the building have the same thermal transmittance value, though in practice some elements are better insulated than others. The use of low density materials and insulation can lower the heat flow; materials with high density and appropriate thermal mass and control of solar gains through shading devices can help to cool/heat the building better, irrespective of the variations in outdoor climatic conditions. Windows and glazing can help trapping winter heat while cutting off summer sun.

- **Air infiltration:** Where buildings are required to be heated, infiltration should be minimized to avoid cold air entering a building or warm air being lost to the surrounding. Mechanical ventilation systems adopted in a building should be operated efficiently and only as necessary in order to minimize electricity consumption.

- **Natural daylighting and ventilation:** The openings of a building should be strategically located to enhance natural daylighting and displace the use of artificial lighting, while avoiding excessive heat gains or losses, depending on the location and season. Similarly, natural ventilation should be preferred to provide adequate fresh and cool air in summer, particularly at night, while avoiding heat losses in winter.

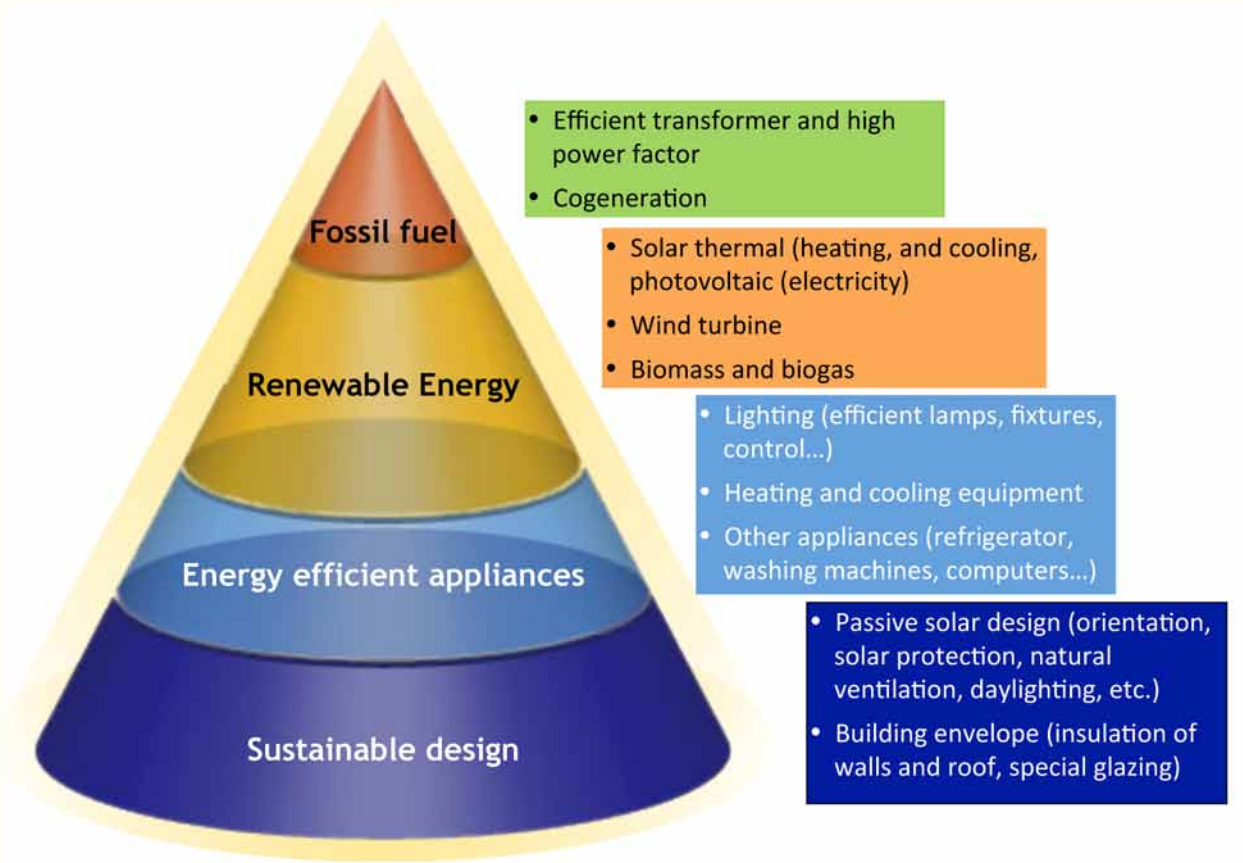
- **Passive solar heating and cooling:** Buildings can be designed with control systems to take full advantage of the natural solar energy and displace heating with fossil fuel. To avoid the need for cooling by artificial means, passive methods can be adopted such as preventing heat gain by the building and exposing building mass to night-time ventilation. In cold climates, shading devices should exclude summer sun but allow full penetration of winter sun. In climates where no heating is needed, shading of the whole building and outdoor space can improve comfort and save energy.

If transportation needs of the occupants for commuting are likely to have negative impacts on the environment and surrounding communities, then alternative transportation option may be explored such as mass transit, car-pooling or using non-polluting modes of transportation. After all, ***it does not make much sense to live in a sustainable building if one consumes more energy to drive to work than that needed for operating the building itself.***

### 2.3.3. ENERGY EFFICIENCY AND ENVIRONMENTAL PROTECTION

Energy conservation and environmental protection are essential to achieve sustainable development. One of the main aims of a green building is to have least impact on the environment through sustainable design, energy efficiency and renewable energy. Figure 6 depicts how buildings can be designed to minimize their dependence on fossil forms of energy, lower their operating costs, create healthier environment for their occupants and contribute to the fight against climate change, without necessarily incurring high total cost.

**Figure 6. Strategy to design a building to minimize its dependence on fossil energy**



**Step 1:** Green buildings are conceived to match with the specificity of the site and the local climate. In cold climates, poor building envelope affects the thermal gains and losses in the building, and contributes to excess energy use. Green buildings are carefully designed to eliminate such problems. Insulating materials and similar techniques such as high reflective building material and optimized glazed area are used to treat cooling and heating load in an efficient manner. Placing the windows effectively, with optimal window to wall ratio and by using energy-efficient glazing, the lighting load in the building can be reduced too. Air infiltration from outdoor and air leakages that contribute to losses, are minimized. Passive solar designs and appropriate building envelope may lead to higher initial investment, but they can help to divide the building energy demand by a factor of four or more. As a result, the incremental cost of the building infrastructure can be justified by the cost savings associated with the downsizing of systems needed to ensure lighting and cooling/heating in the building. Box 4 explains why it makes more sense to invest in building fabric than in renewable energy.

**Step 2:** Once the building design features have been optimized, one can then consider highly efficient mechanical and electrical systems and appliances. Green buildings possess high-efficiency of appliances, heating and cooling equipment and ventilation which are installed, calibrated and performed according to specifications. Artificial lighting is used only when required and it is provided using energy-efficient technologies. Well-positioned and high quality skylights bring in natural light in dark areas and improve the energy performance. Box 5 outlines the strategy to minimize the need for lighting energy in a building. In order to reduce the dependence on fossil fuels, energy-efficient heating and cooling systems are selected and operated only when necessary and to the level required. Where relevant, waste energy is recovered, reused and recycled.

#### Box 4. Building fabric versus renewable energy: where to put the money?

If the overall objective is to lower the energy consumption and life-cycle costs of building, it is important to start with the building fabric that helps to lower the energy demand and then look for appropriate devices to generate energy from renewable sources. Buildings tend to have a life of at least 40 to 50 years whereas most renewable energy systems have a shorter lifespan of 10 to 20 years. If a building is poorly designed from energy perspective, the overall capital cost would be much greater as more capital investment would be needed for oversized renewable energy systems. Moreover, it would be difficult and onerous to improve the building fabric cost-effectively at a later date.

In cold climates, an airtight and superinsulated building does not demand much energy, hence the investment that would normally have been required on energy supply technologies can be diverted to cover the additional cost needed for the improvement of the building fabric quality. Similarly, hygroscopic materials (such as clay plaster and untreated timber) which are readily water absorptive and evaporative can be more effective to handle the indoor air humidity than mechanical ventilation. While the wall finishing can cost more, money can actually be saved by avoiding the need for investment on fans, ducts, grilles and filters.

In China, the demand for multi-family dwellings will continue to grow rapidly owing to rural-urban migration and rising incomes. Between 2010 and 2050, the World Business Council on Sustainable Development (WBCSD) estimates electricity demand in multi-family buildings will increase by 200 per cent for lighting and 325 per cent for appliances. Current building practices are characterized by poorly designed and insulated building envelopes and inefficient heating systems, while energy for heating is priced at a fixed rate irrespective of consumption. Analysis by WBCSD (2009) looks at the impact of improving the efficiency of typical blocks of multi-family buildings in China (a six-story building containing 36 apartments) over a 45-year period spanning 2005-2050.

The table below shows the impact of a 76 per cent improvement in building energy-efficiency through a series of design and management interventions, including a better-designed and insulated building envelope, apartment-level temperature controls and electricity sub-metering.

Multi-family new building construction in China

|                                  | Base case            | Green development                    | Difference in saving (or costs) |
|----------------------------------|----------------------|--------------------------------------|---------------------------------|
| Growth in energy use 2005-2050   | ~ 530 billion kWh/yr | ~ 305 billion kWh/yr                 | ~ 225 billion kWh/yr            |
| Incremental cost per year        | NA                   | ~ US\$12 billion                     | (~ US\$12 billion)              |
| Space heat energy savings        | NA                   | 76 percent                           | 76 percent                      |
| Value of energy savings per year | NA                   | About equal to costs on annual basis | ~ US\$12 billion                |

If replicated at a national level across China, these steps could lead to a total saving of about 225 billion kWh per year, or US\$12 billion per year at current electricity prices. However, although substantial building energy-savings are achieved, the growth in national building stock in China will outpace the efficiency improvements, resulting in a net increase of 305 billion kWh per year in energy demand over the given time frame.

Source: WBCSD (2009)

A specific example is the recovery of heat from the refrigeration or air conditioning system to supply hot water to the building. Household and office equipment and appliances tend to have a growing share of electricity use in buildings. Appliances such as refrigerators, washing machines, water pumps, computers, etc. with high energy performance ratings, are purchased and used when necessary. Building energy management systems additionally contribute to the efficient control of the building's energy usage, thus bringing down the energy consumption of the building drastically.

### **Box 5. How to minimize the energy need for lighting?**

Lighting represents a non-negligible share of energy needed in a building. Suitable application of daylighting can contribute to reducing the energy need by either turning down or switching off electric lighting and improving the psychological and visual comfort of occupants. To achieve effective daylighting, several aspects need to be considered during the building design:

- fenestration plan and shape, internal finishes, partition layout designed for optimum daylight entry and distribution;
- avoidance of glare and unwanted solar heat gains;
- designing and control of electric lighting in response to available daylight.

Options to optimize daylighting through fenestration include light shelves, louvers, prismatic glazing or prismatic film, etc. Daylighting through roof can be in the form of light wells and atria, or light pipes.

Natural light cannot form a complete lighting strategy because of its variable nature, therefore artificial lighting is required to supplement natural light. Moreover, some areas in a building may not have access to daylighting and have to depend fully on artificial lighting. New energy-efficient lighting systems are capable of lowering the lighting energy consumption by as much as 80 percent while enhancing lighting quality and reducing environmental impacts.

The choice of efficient lighting system is not enough; proper lighting control is needed to ensure that lighting is available only when and to the level required. The typical lighting control methods include zoning of lighting system, timer-based switching, occupancy detectors, daylight sensing, etc. Such systems normally require sensors, additional wiring, a processor to determine action from the sensed information, and an actuator to switch on/off or modify the light output of the lamp.

In an announcement made by the U.S environmental Protection Agency in May 2011, 79 commercial buildings design projects managed to earn the ENERGY STAR certification, saving nearly 46,000 metric tons of Carbon Dioxide (CO<sub>2</sub>) annually and more than \$7 million in annual energy costs across nearly 6.5 million square feet amongst which twelve of the projects attained an estimated CO<sub>2</sub> reduction of 50 percent or more (USEPA 2011).

**Step 3:** The steps described above are capable of dividing the energy demand of the building by a factor of ten. At this stage, it becomes interesting to look for ways to replace the demand for energy deriving from fossil fuel. Depending on the location, it is possible to exploit various natural and renewable forms of energy such as solar, wind, wood and biomass, biogas, hydro and geothermal/ground source to meet the energy needs of the building in a decentralized manner, thus reducing the dependence on fossil fuels.

**Step 4:** The main sources of energy for traditional buildings are electricity, natural gas, liquefied petroleum gas (LPG) and sometimes heating oil, coke and coal. But by the time the building designing goes through the first 3 steps, its demand for fossil fuel would be zero or minimal. Box 6 gives concrete examples of the initiatives taken by the Malaysian government to create low- and zero-energy buildings.

### **Box 6. Examples of low and zero-energy buildings in Malaysia**

In a low energy office (LEO) building at Putrajaya, Malaysia, the building's energy consumption was reduced by 3 times from the energy usage in conventional buildings. Strategies adopted include, among others, proper building orientation, roof insulation, external shading of the windows to block the direct solar radiation, use of daylight along the perimeter of the building to reduce demand of artificial lighting, usage of energy efficient equipment such as energy efficient lighting system, zoning of lighting and cooling system reducing excess energy consumption, variable air volume system and variable speed drivers on air handling units, and ultimately the use of energy management/monitoring system.

Apart from LEO buildings, a net-zero energy residential or commercial buildings are enabled with specific design approaches at low incremental costs where the energy needs of the building is reduced to 70-80 percent less than conventional practices though energy efficiency and the balance of the energy needs is supplied through on-site generation of energy from renewable technology.



Further improvements can be incorporated by looking for supply-side efficiency options such as combined generation heat and power and development of district energy networks. Another possibility is the development of smart grid that optimizes the grid performance through the dynamic and real-time exchange of energy between the building and the power grid.

### 2.3.4. WATER AND WASTE MANAGEMENT

Managing of water and the waste from the beginning of the construction period until demolition is an important feature of a green building. Green buildings reduce their water demand and wastewater and solid waste generation following similar strategy as that outlined for reducing the energy demand in section 2.3.3.

**Figure 7. Strategy to manage water, wastewater and solid waste in green buildings**

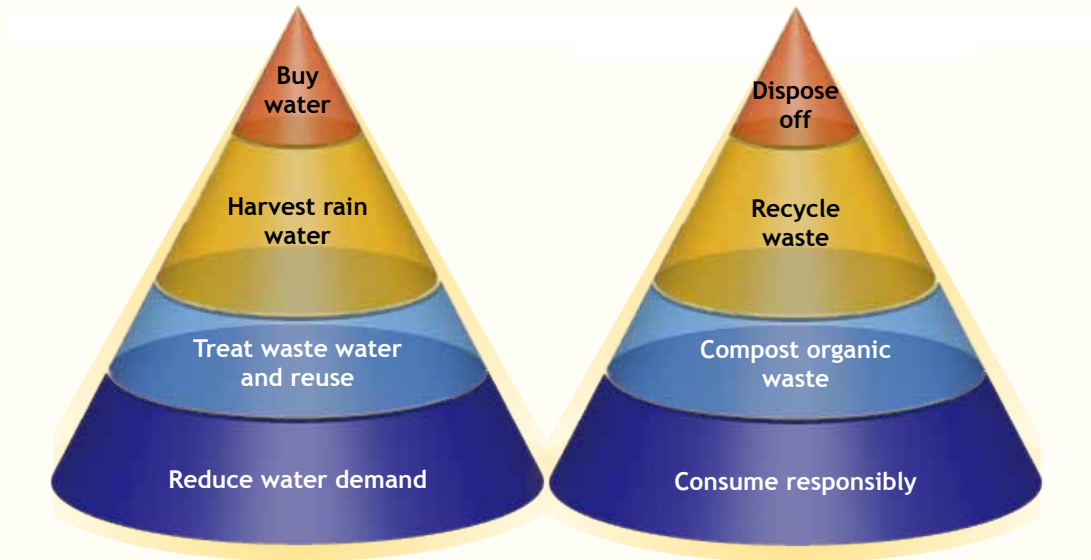


Figure 7 depicts the strategy adopted by green buildings to minimize their need for municipal water supply, and the amount of wastewater and solid waste to be disposed off responsibly. As far as water is concerned, the following steps are recommended:

**Step 1:** Green building designing process includes the use of technological options to minimize the need for water, such as low-flow water fixtures, faucets and shower-heads fitted with aerators, water-efficient washing machines and dish washers, waterless urinals, sensor-based faucets, urinals and flush-toilets. They also opt for landscape and native plants that are well suited to the local climate and are draught-resistant, allowing to reduce or eliminate the need for irrigation. Drip irrigation and sprinklers are employed to increase infiltration rate and uniform distribution. Most of these options are capital-intensive but divide the water demand by two or more, thus helping to lower the water bill and the investment on water piping. Box 7 presents the techno-economics of reducing water consumption in a typical house.

#### Box 7. Water savings in a 4-person single house

Water use in a standard 4-person single-family detached house can be reduced by 57 per cent (from 500 liters to 218 liters per day) by installing more efficient devices in place of conventional toilets, showerheads, taps, dishwashers, washing machines, etc. (van Wyk 2009). Water-efficient appliances such as rainwater harvesting systems and devices for re-using grey water require additional investments, but most cost-saving effects relate to saved potable water. These are determined by the average cost of potable water. In the case of a 4-person single-family household, setting a high price for water (US\$1.91 per m<sup>3</sup>, as in Germany) will result in a saving of about US\$202 per year, whereas with a lower price of US\$0.40 per m<sup>3</sup> (as in Canada) the saving estimated is about US\$42 per year.

Source: UNESCO (2001)

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**Step 2:** Once the water demand is minimized, the next option is to look for treating lightly-contaminated grey water from wash basins, showers, etc. for its treatment on-site using natural systems such as constructed wetlands or biological nutrient removal systems, or high-efficiency mechanical filtration systems. The treated water can be used for flushing urinals and toilets, washing floors and cars, gardening or in cooling towers of air conditioning systems that are high water consumers.

**Step 3:** Rain water harvesting system and storage system are included in the building construction to reduce dependency on water from municipal connection, and surplus water after its use is sent to recharge groundwater and the aquifer.

**Step 4:** Lower water consumption also means lower demand for municipal water supply and reduced burden on municipal wastewater handling system. The municipal potable water use can thus be limited to cooking, drinking and hygiene, reducing the water bill and the minimizing the volume of water that needs to be treated.

These measures serve the dual purpose of reducing the water demand by a factor of 5 to 8 and lower the cost of infrastructure needed to evacuate wastewater from the building. Even during the construction phase water use is minimized by using material such as pre-mixed concrete or by using recycled treated water.

The entire practice of solid waste management is founded upon the well-known 3R principles: waste reduction, reuse and recycling. Green building occupants are sensitized to purchase responsibly by opting for materials and products that are long-lasting and are more environment-friendly. Instead of purchasing a product on the basis of its initial cost alone, emphasis is given to life-cycle costing that considers all costs associated with its purchase, operation and disposal.

Waste segregation at source is encouraged in order to extract maximum value from the waste and minimize the volume of waste that is ultimately sent to land-fills or for incineration. All organic waste is used as animal-feed or used on-site for producing either organic fertilizer by composting or producing biogas through anaerobic techniques of fermentation. All recyclable wastes such as metal, glass, paper and plastic are sent for recycling.

### 2.3.5. MATERIAL EFFICIENCY

Building construction is resource intensive. The building sector is responsible for more than a third of global resource consumption annually. The manufacturing of building materials consumes about 10 percent of the global energy supply.

In green buildings, there is a preference for building materials that are less resource exhaustive, recycled to a great extent, and are non-toxic. Thanks to the greater awareness about the relevance of green production materials, the market is undergoing innovation and rapid transformation. Green construction materials (certified wood-based or rapidly renewable) and materials with high recycled-contents are now available in greater numbers and at costs that are very much competitive with their traditional counterparts. Green buildings opt for concrete that contains fly ash from coal-fired power plants or slag from the iron and steel industry. Similarly kiln-fired bricks are giving way to sun-dried compressed and stabilized earth blocks that require much less energy to manufacture, create greater employment opportunities in developing countries, and create no debris or pollution when buildings are demolished.

Building green involves establishing construction waste management plan which starts with the adoption of design that minimizes construction debris. Standard-sized or modular construction techniques are adopted to generate less waste and lower disposal costs. Policies adopted to purchase building materials from local and regional markets within a radius of 300 – 500 km and to recycle materials on-site as much as possible help to lower the environmental impacts and transportation costs.

The waste prevention and recycling options have the biggest positive impacts on the environment: reduced depletion of natural resources such as trees, oil and minerals, lower emissions from manufacturing and transportation, less demand for energy and water compared to virgin material manufacturing processes, and reduced greenhouse gas emissions due to lower demand for energy in manufacturing and transportation.

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A study carried out in Sweden concludes that buildings constructed with recycled materials reduce the environmental impacts by 45 percent in comparison with those using all new materials (Thormark 2006). Other studies also show that if recycled materials are used for construction, between 12 and 40 percent of the energy used for material production can be saved (UNEP 2011).

### 2.3.6. INDOOR ENVIRONMENT QUALITY

Green buildings are designed to create a healthy, pleasant and productive work environment. The design and construction of the building especially focuses on the indoor air quality (IAQ), thermal and lighting comfort to ensure healthier indoor environment, improved comfort and well-being of the occupants, increased productivity and better marketability of the building. Provision is made for the occupants to control the level of lighting and ambient temperature in the space occupied by them. Architectural features allow occupants to operate windows in order have access to natural air, get rid of pollutants trapped within the building, and alter the temperature of the living or work space.

Material selection is extremely important for maintaining a healthy non-toxic indoor environment. Building materials, furnishings and finishes are selected with close attention being paid to the toxic component in the product, such as formaldehyde. Materials with low chemical emissions are utilized like wool carpets and jute padding and paints that do not contain off-gas volatile organic compounds (VOCs) and that have chemical composition acceptable by the design team. Usage of adhesives is avoided.

Highly efficient ventilation system with quality air filters assures good indoor air quality and also minimizes moisture intake. When necessary, more fresh and outdoor air is brought in the conditioned room but at the same time keeping an optimal level of air intake or adopting mechanism that allow heat transfer between the exhaust and fresh inlet air so that cooling or heating load is minimized. The moisture accumulation control in the building is treated with equal importance to the indoor air quality as it leads to mould growth and presence of bacteria and viruses as well as dust mites and other organisms which are of health concern.

Well insulated and tightly sealed envelopes are constructed to reduce water condensation on cold surfaces on the interior part of the building that can enhance sustain microbial growth, but adequate ventilation is provided to eliminate moisture from indoor sources as well. This is done to create an environment that guarantees adequate thermal comfort to the occupant. Careful control of humidity and temperature not only provides comfort but also helps to achieve significant operation and maintenance savings over the life of the building. Furthermore, green architectures help to retain employees and occupants, thus raising property value and income.

Design of lighting system is a major part in the improvement of the indoor environment quality. The human eye works better with the natural light but excess outdoor light creates glare. Green buildings enable the ability to control the amount and intensity of natural light entering the space so that it is suitable to the need of the occupant. Even when artificial lighting is utilized, appropriate colour rendering of the light is done to increase productivity of the occupant.

The acoustics of the building is another factor that has profound effect on the environmental quality of the building. Poor acoustical qualities in work places or school environments result in stress and fatigue and also hinder verbal communication. Background noise levels are carefully monitored and regulated with sound-dampening options such as sound absorption material and acoustics barriers, wherever necessary.



### 3. BARRIERS TO THE PROPAGATION OF GREEN BUILDINGS

Despite the fact that there is a strong business case for building green, the shift towards more sustainable construction practices is slow because of a number of roadblocks. Preference is still given to “build fast and cheap” and there is a lack of value attached to the life cycle benefits of green buildings. Moreover, there is an overall resistance to change at all levels: government, industry and individuals.

The challenges confronting the greening of buildings are different for industrialized and developing countries. Industrialized countries have a head-start in addressing challenges and overcoming barriers but they are overburdened by the predominance of existing building stock that are to be retrofitted and converted into green assets. On the other hand, developing countries have a huge need to construct new buildings but are lagging behind in adopting suitable policies to tackle various barriers to green building. In addition to the typical economic and financial challenges, there is also a huge vacuum in terms of awareness and capacity to deliver. There is urgency for developing countries in Asia to hasten policy efforts in order to achieve the paradigm change needed to make new buildings sustainable and avoid the huge financial burden of retrofitting them later.

Understanding the different barriers that hinder the growth of green buildings and community is extremely important before any action or measure can be taken to bring in appropriate changes. While many believe that a major barrier to green buildings is the cost, this is not true in most cases. In the urban context, it is the land price that makes the difference. In central urban areas such as Singapore, Hong Kong, China and Shanghai, land prices can represent up to 75 percent of the total cost for a building, so adding a few percent on building cost would be quite marginal to the total (Kornevall 2007). Barriers are more linked to lack of policies, understanding of the crucial issues, business models, markets, know-how and technologies, commitment, etc. The barriers can be classified into four categories, as shown in Table 4.

**Table 4. Barriers hindering the penetration of energy-efficiency in the building sector (Carbon Trust 2005)**

| Barrier categories                              | Definition  | Example   |
|---|---|---|
| Financial costs/benefits                        | Ratio of investment cost to value of energy savings   | Higher up-front costs for more efficient equipment<br>Lack of access to financing<br>Energy subsidies<br>Lack of internalization of environmental, health and other external costs  |
| Hidden costs/benefits                           | Cost or risks (real or perceived) that are not captured directly in financial flows   | Costs and risks due to potential non-compatibilities, performance risks, transaction costs, etc.<br>Poor power quality, particularly in some developing countries   |
| Market failures                                 | Market structures and constraints that prevent the consistent trade-off between specific energy-efficient investment and the energy-saving benefits | Limitations of the typical building design process<br>Fragmented market structure<br>Landlord/tenant split and misplaced incentives<br>Administrative and regulatory barriers (e.g. in the incorporation of distributed generation technologies)<br>Imperfect information |
| Behavioural and organizational non-optimalities | Behavioural characteristics of individuals and organizational characteristics of companies that hinder energy efficiency technologies and practices | Tendency to ignore small opportunities to energy conservation<br>Organizational failures (e.g. internal split incentives)<br>Non-payment and electricity theft<br>Tradition, behaviour, lack of awareness and lifestyle<br>Corruption                                     |

Some of the commonly perceived barriers are discussed below before discussing in Chapter 4 policy measures to address these barriers.

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### 3.1. MARKET FAILURES

Market failure is an important barrier that seems to hold back the development of green and sustainable buildings. Market is said to have failed if specific energy-efficient investments fail to guarantee energy saving benefits. Market failures usually occur when there is a flaw in the manner the markets operate, violating the neoclassical behaviour that defines an ideal market for product and services, such as rational behaviour, costless transactions and perfect information.

Market failure occurs when resources in the market are inefficiently allocated due to imperfections in the market mechanisms. Jaffe and Stavins (1994) have identified the causes of market failures as:

1. misplaced incentives;
2. distortionary fiscal and regulatory policies;
3. unpriced costs such as air pollution;
4. unpriced goods such as education, training, and technological advances; and
5. insufficient and incorrect information.

Low-cost feasible solutions are needed to address these barriers leading to market failures.

*Misplaced incentives* are the main cause why energy efficiency investments are difficult to make in each of the economic sectors. This happens when the agent has the authority to act on the needs of the consumer, without thinking of the best interest and benefit for the consumer. For example, in selecting technologies which the consumer will use, architects or engineers seek to minimize the first cost but do not select the technology based on its life cycle cost. Even the fee structure of the architects and the engineers, which is a percentage of the capital cost of the project, causes incentives to be distorted and thus penalize the efficiency as higher efficiency installation adds to the capital. As builders and contractors are often hired for new building construction projects on the basis of the lowest-priced bid, they tend to “cut corners” to save money, such as improperly installing insulation or heating and air conditioning duct work. On the other hand, public officials may lack the resources or motivation to enforce building energy codes.

Another very common example is the landlord-tenant relation. The landlord has no incentives to make higher investment in an efficient building as long as the tenant pays the utility bills and does not express any self-interest for efficient equipment. About 90 percent of the households in multifamily buildings are renters, and this poses a significant barrier in the market to take up energy efficiency in the residential sectors. For commercial tenants, energy charges are often passed on as management fees and are assessed on the basis of the amount of space occupied rather than energy usage.

Split incentives also occur in the hotel industry, where the occupants seek maximum comfort and do not pay directly for the energy use. The hotel owner, on the other hand has to bear the energy costs, which is why many hotels typically install compact fluorescent lamps and key-cards that deactivate the room's energy supply or use when removed from their slots (Brown 2001). For the public sector, budget constraints are a major barrier which discourages energy efficiency investments. Many residential and commercial buildings lack heat or gas meters, and residents paying a fixed monthly bill for heating energy are least motivated to conserve energy.

*Distortionary fiscal and regulatory policies* also restrain the use of efficient and clean technologies. A lot of distortionary policies are observed in the case of distributed generation, which involves generation of electricity from either fossil fuels or renewable energy near the point of use. The distortions could be in the form of prohibition to install distributed systems, tariff barriers that include buyback rates that do not provide credit for on-peak production. The pricing of electricity in the market is not based on the time of use and it is set months or years ahead of the actual use, thus the consumers are not responsive to the price volatility of the wholesale electricity. Time-of-use pricing would encourage consumers to use energy more efficiently, for which metering and communications and computing technologies are needed to support such dynamic pricing (Brown 2001).

*Unpriced costs* relate to negative impacts from the extraction of fuel to its consumption in various forms, including electricity. Most forms of fossil fuels are under-priced as the market does not take full account of the variety of social costs that are related to the fuel usage, such as greenhouse gas emissions, air, water and land pollution. As no cost is given to the damages the pollutants make on the society, energy prices are undervalued. The idea

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of carbon trading is a way to address this effect as it takes into account the full cost of the resource, and helps in reducing the usage of fossil fuel. In a similar manner unpriced (public) goods dampen the energy productivity of the economy. As public goods are under-priced, market tends to under produce them. These imperfections can be addressed by public policies which have the capacity to bring the market choices in line with full costs and benefits. But investments made by employers in creating such a platform of change are dampened because of the firm's inability to ensure that the employee will work long enough to repay the investment cost.

The difficulties of selecting and installing new energy-efficient equipment compared to simply purchasing energy prohibit many cost-effective investments from being realized. This is a particularly strong barrier for small and medium-sized enterprises (Reddy 1991). With the current trend towards lean firms, there are very few trained technical personnel who can conduct audits to overcome such barriers. Even if private entities invest in R&D, individual firms are not able to realize the full economic benefits from the investment. The problem is especially pronounced when an industry is as fragmented as the construction and homebuilding industries (Brown 1997; Oster and Quigley 1977). Fragmented market structure is a problem in the building sector with the design and engineering of buildings split between small firms.

*Insufficient and incorrect information* on the other hand causes suboptimal investments in energy efficiency to take place (Brown 2001). It was pointed out by DeCanio (1998) that firms lack the time and ability to process information they have. A common example of which could be to make everyone believe that energy-efficient products are expensive, which has been disproved by several recent analyses.

Lack of knowledge about the energy features of product and their economics also leads to market failures. Residential consumers get a monthly electricity bill which gives the total usage of electricity but not broken down into individual end-uses, thus not allowing the consumer to know the energy consumption or cost for individual uses. At an individual consumer level, the cost is ignored because it is typically small, but when it is summed up across all consumers, the potential savings are relevant.

Even the complexities of decision making are another source of imperfect information that can completely confuse customers and inhibit rational thinking and decision making. Most fail to recognize the importance of life-cycle cost and fall back on the first-cost rules of thumb. While some of energy-efficient products can compete on the first-cost basis, most cannot. Builders generally minimize the first cost, as they believe that higher cost of more efficient equipment will not be easily translated into higher resale value for the building. However, if consumers were concerned about savings over the life-cycle, manufacturers would have a strong incentive to provide better information about energy efficiency to serve as the basis for making purchases (IEA 2007). Another factor to take into consideration is that energy efficiency investments are not visible as renewable energy investments, mainly because of the relative lack of credible building energy performance rating and certification system. In the absence of market appreciation, any investment in energy efficiency becomes difficult to value and recover.

### 3.2. ECONOMIC / FINANCIAL BARRIERS

Financial barriers put another hurdle in the realization of energy efficiency and do not favour green buildings. Many companies face huge financial barriers when improving energy efficiency of buildings, despite the increasing recognition that such projects can deliver significantly long-term benefits. Purchasing energy efficiency equipment that are specified according to standards increases the investment cost and that is why consumers are reluctant to spend on such equipment. Furthermore, low income consumers cannot afford higher investments due to limited availability of capital and limited access to capital markets, especially in developing countries.

In developing countries which face acute housing shortages, actual or perceived upfront costs are often a key barrier. Companies tend to avoid investments on green buildings unless the net benefit stream starts flowing in within a couple of years. Longer-term commercial lending is rare or nonexistent in many developing nations and poses one of the biggest hurdles to overcome. For large scale green building programmes, governments usually need to raise significant funds.

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In green buildings, energy efficient architecture is a complex design problem and thus it requires extensive assessment and expertise of related disciplines allowing for alternatives and extended fees which can rarely be justified in conventional projects. Investors are discouraged as they do not have access to financing, because financing companies misjudge them as high-risk investments. Moreover, there are no incentives from the government to boost such investments, increasing the challenges for investors and the market to develop.

In fact, distorted energy pricing and tax regimes hamper the penetration of energy efficient products, which increases the risk of these products achieving success in the market when implemented.

Energy subsidies from the government are perceived to have done the biggest damage as they reduce incentives to use energy rationally. While it is true that the population “at the bottom of the pyramid” already finds it difficult to pay a substantial share of the earning on energy, the policy of keeping energy price low for all does not provide any incentive for the affluent in the society to move towards higher efficiency. Even when energy prices are not subsidized, they rarely reflect the full costs borne by the society associated with energy production and its use, including social and environmental costs. The failure of clients to pay in full for energy services tends to induce waste and discourage energy efficiency. The low energy price is deterrent to the adoption of energy-efficient equipment and processes, eroding the competitiveness of manufactured products and services. Moreover, when the limited financial resources of the government are channelled to import fossil fuels and erect energy supply infrastructures at high costs and distribute energy at subsidized rates, fewer resources are left to meet more critical needs of the society.

### 3.3. LACK OF APPROPRIATE TECHNOLOGIES AND EQUIPMENT

Thanks to the policies adopted by governments in industrialized countries, there has been a great boom of innovative green and clean technologies in the market. The picture is very different in many developing countries, including those in Asia. Because of the lack of government policies and the poor recognition of the multiple benefits of green buildings, the market for suitable technologies is yet to take off. Neither new developers nor existing building owners are ready to pay for the perceived high-cost of building components and technologies. Interestingly, many manufacturers of building-related technologies and products have regional or international outlook and may already be manufacturing products that are suitable for green buildings. However, when the energy efficiency market is not mature, equipment manufacturers and suppliers tend to market less efficient products that are “affordable” to their clients. As a result, green technologies and products are not readily available in the market or due to lack of economy of scale; their costs remain out of bound for most buyers. Government intervention may therefore be required to trigger the market transformation towards energy efficiency and make energy efficiency more affordable.

It is essential for the appropriate institution to favour public and private cooperation so that the private sector participates actively in programme implementation and the limited public funding is leveraged by private sector investment to accelerate the process of market transformation. It is a relatively inexpensive mechanism for stimulating innovation and competition among potential manufacturers of energy-efficient products by guaranteeing higher market share for their products.

Market transformation happens through interventions that pull and push the market simultaneously: manufacturers or suppliers influence consumers' behaviour by providing energy efficient products. For example, setting minimum energy performance standards (MEPS) helps to “push” highly inefficient products/appliances out of the market (on condition of not falling into commercial protectionism and in conflict with the World Trade Organization), and promote mandatory or voluntary labelling of quality on products that consume energy (e.g. energy star rating). Such instruments favour market “pull” by kindling innovation among manufacturers and assisting users in making the right choice to acquire products with higher quality, particularly for an equivalent price. Setting norms also forms part of the market transformation instruments as it helps in clearly identifying the Best Available Technologies (BATs) and assuring main players.

It is equally important to note that some of the indigenous technologies and construction practices that are inherently resource-efficient and environment-friendly are slowly disappearing because of their artisanal ways of production cannot cope with the present demand patterns and many of the labour-intensive production prac-

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tices have given way to mechanization. As a result, the ancient know-how, knowledge and skills are fading into the past. Moreover, with modern market mechanism favouring the procurement of raw materials and resources at least cost irrespective of their origin, the old dictum of procuring them in the neighbourhood is not longer respected.

### 3.4. BEHAVIORAL AND ORGANIZATIONAL CONSTRAINTS

Players involved in construction projects do not have the intention to build in an environmentally harmful manner, but there is an unrecognized cognitive and social barrier that stands in between the technical and economic solutions and the successful construction of a green building. These barriers exist on individual, organizational and institute levels.

At an individual level, people make a lot of suboptimal decisions that are biased in systematic and predictable ways which occur without the awareness of the individual. Behavioural decision research sees individuals as attempting to act rationally but bounded in their ability to achieve pure rationality. People rely on simplifying strategies, also known as cognitive heuristics. Although these heuristics are frequently useful shortcuts, they also lead to a wide variety of decision-making biases (Kahneman & Tversky 1973, 1979). Such biases include the use of extreme high discount rates in their consumption behaviour. Due to lack of information they purchase inefficient appliances or under-insulate their houses. Even well-educated consumers do not take advantage of some of these simple energy efficiency opportunities — energy-efficient lighting generally provide return on investments of 30-50 percent per year (US EPA, 1997). The causes of resistance to make long-term and wise decisions are failure to calculate and make decisions based on payback periods. But payback periods could be a problem as the tenure may be shorter than the time frame of recovery; so individual and companies may eschew energy efficiency upgrades with short payback periods (Hoffman et al 2008).

Apart from over discounting issues, substantial empirical work shows that people make self-serving, or egocentric judgments of what is fair (Babcock et al 1995; Messick & Sentis 1983; Thompson & Loewenstein 1992). This leads to decision making that may seem fair at individual level but when summed up, it may be in contradiction with the sustainable built environment. Positive illusion is another behavioural constraint where companies see their products creating social benefits and are less harmful to the environment than they actually are in the reality. For example, companies use carbon-neutral footprints to sell their products but the metrics used are selective and self-serving towards a positive illusion. Even if consumers try to be responsive and project an aspiration towards environment protection, their behaviours face weaknesses in responses due to positive illusions. People are much more likely to deny harming the environment than to claim that they were helping the environment (Hoffman et al 2008).

The behaviour of building's occupant can have as much impact as the efficiency of equipment. Analysis of a study conducted by the World Business Council for Sustainable Development (WBCSD 2009) concludes that technology alone is unlikely to guarantee good building energy performance. Wasteful behaviour can add one-third to a building's designed energy performance, while conservation behaviour can save a third. In developing countries, using energy can be a symbol of progress and affluence, particularly for wealthy people who can well afford it.

Along with individual level biases, there are organizational resistances to green construction. Organizational culture shapes individual consciousness, imposing routines that reflect socially approved, purposive action. In an organization the typical structure is such that the decision flows are not efficient and tend to distort and thus it create a communication breakdown. And it is amplified by competing interests in the organization that shield the potential economic benefits. In design and construction of a building which is formed by a temporary team that includes the owners, architects, engineers, contactors and consultants, such behaviour is exemplified during the jockeying of power and influence within the team, which leads to suboptimal decision. The structural relationships within the construction team have traditionally followed a linear pattern where the owner hires the architect for the design, which is then handed to the engineer, sent out for bid, and ultimately built by the contractors according to the drawings; it ultimately fails to promote the tight integration of systems needed in high performance buildings.



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Similar to organizational breakdown, misaligned rewarding systems are a major obstacle for organizations to participate in green reforms. Typical reward structure sees only the process yield of the company and skips the environmental categories. Also, organizations are perpetually stuck to a set of routine and ideas and people do not like to change or resist to changes brought about, maintaining a state of inertia that hampers green development. A fear is developed in the organization when changes are proposed; this could be due to the habitual routine where things are taken for granted such as design practices, fear of the unknown, resource limitations that restrict the ability of an organization to overcome sunk cost in plants, equipment and personnel leading to psychological roadblocks, creating biased decisions and actions (Hoffman et al 2007).

Looking at barriers at an institutional level, regulative institutions create standards that are suboptimal with direct attention towards the law itself and away from the purpose of the law. Apart from the fact that energy codes are not enforced in many countries, one should take note of the fact that these codes have also not been upgraded in years and efforts to do so become protracted political battles leading to compromise that are suboptimal for green designs. So once these standards are established, decision makers become constrained by rigid rules that forbid creative solutions to complex problems from coming up.

Market incentive structures also shield opportunities to correct environmental destruction. For example TV makers produce the equipment that remains in stand-by mode when it is not in use so that consumer can use a remote control and not encounter any warm up delay. The manufacturers have no incentive to cut the power this mode uses as they are not paying the electricity bill. Likewise consumers have little incentives to be concerned as the incremental costs are low. Thus without proper aligned incentives this kind of waste will continue. Banks are often unwilling to finance certain environmentally sound technologies fearing that they would be unsuccessful and believing that they are unnecessary.

Electricity theft along with non-payment of bills for energy used is another behavioural constraint, especially in developing countries. The poor economic conditions combined with underdeveloped policies and regulations often pay no heed to overcome such issues. And thus people carry on with the traditional ways of living and adapt to lifestyles that are environmentally unfriendly. Moreover the traditional knowledge is not retained or revived, and more designing approaches, especially of buildings and lifestyle, mimic the western standards that are unsuitable for the Asian environment. There are very few voluntary agreements that are supposed to promote energy efficiency practices within the organization. This barrier is common to most countries and in particular to developing countries due to corruption, political instability, lower income and poor standard of living (IPCC 2007).

### 3.5. INFORMATION BARRIER

The building sector is subjected to various information barriers within the industry and also among the end-users. Information regarding energy efficiency options is often incomplete, unavailable, expensive and difficult to obtain and verify (Levine, et al. 2007). For example, there are misperceptions regarding the cost of building and the cost of operating sustainable buildings, which impede progress towards sustainability. A research by WBCSD shows that professionals underestimate the GHG contribution of buildings by half. The same research also suggests that perception of the cost to achieve green buildings is significantly higher than actual costs, estimated around 11-28 percent. Actual studies of properties conclude that it is likely to be in between 5-10 percent for developed countries and little higher for rapidly developing countries. Another survey by WBCSD shows that 64 percent of buildings professionals in India are aware of sustainable building practices but the actual involvement of the people interviewed dropped drastically to 5 percent, showing a lack of practical information for decision making, which vary from issues, including equipment quality, energy efficiency features of buildings, energy saving technologies and appliances, etc. (WBCSD, 2007). The business as usual scenario has been the common approach that contractors and others involved in the business choose over new approaches.

Lack of information also influences end users in decision making. Neither do they have the knowledge about how their daily behaviour influences their energy consumption, nor is the link between energy and the environment well understood so that they can take actions. And even if they are aware of it, they possess limited rights

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or abilities to change their energy consumption features. There is no feedback received from the utilities, appliance manufacturers or building owners about their behaviour affecting energy consumption and costs.

Another problem of lack of information of the client or consumer pertains to codes and regulations. With increasing complexity of codes and standards, developers and consumers have difficulty assessing the cost and requirements to comply with the regulations; so when regulations require site plan or design changes, they believe green specifications cause these costly delays. Thus improved communication of local building codes and their implications for green process and product choices would allow developers and end-users to make better choices among efficiency, aesthetics, product choice, and cost that would satisfy regulators without any compromises made (UNEP 2008).

Financial institutions lending capital for potential construction projects generally focus on construction costs without attention to implied future costs for energy. As a result, even though green buildings are assessed to be feasible and profitable, banks are reluctant to fund features that can render the building greener, especially improving energy efficiency and thermal comfort. Builders and building owners may thus find it hard to obtain loans for resource-efficient buildings.

### 3.6. POLITICAL AND STRUCTURAL BARRIERS

Market alone may not be adequate to push for green decision-making and it needs to be accompanied by strong government policies. There is however a strong institutional bias towards supply-side investments in many countries around the world. Political decision makers are less interested in energy efficiency because they are not convinced in the ability of demand-side efficiency measures that can offset the need for new capacity in a more cost-effective manner. In the case of buildings, energy costs constitute only a small share of the operating cost. As a result, there is a greater political focus on creating the supply infrastructure necessary for ensuring rapid economic growth. Moreover, as far as the building sector is concerned, the market is highly fragmented. Coordination between all the stakeholders is a major challenge and there is inefficient enforcement of policies due to inadequate enforcement structures and institutions and lack of qualified personnel.

In India, projections of electricity demand show the need for adding 40,000 MW of power generation capacity per year up to 2030 whereas the current rate of addition is only of the order of 12,000 MW per year. There is a huge challenge to mobilize resources, both financial and fuel, needed for the purpose. About 70 percent of the infrastructure in 2030, including buildings, will be added in the next two decades. If these new buildings are constructed inefficiently, their inefficiencies will be locked in for several decades and a large low-cost opportunity to reduce the energy needs for operating these buildings will be lost.

Fossil-fuel based power plants require huge investments, ranging from S\$500 to US\$2,000 per kW according to the fuel used and technology employed, have a long gestation time and a long payback period. Moreover, the operation and maintenance costs of such power plants represent two-thirds to three-fourth of the cost of the electricity generated from these plants. On the other hand, if a part of the investment on such power plants is made available for the purpose of building green, it would help to not only reduce the pressure on constructing new power plants considerably but also recover the incremental investment within a much reasonable time frame.

Figure 8. Building emissions abatement opportunities at cost savings (source: Vattenfall 2007)

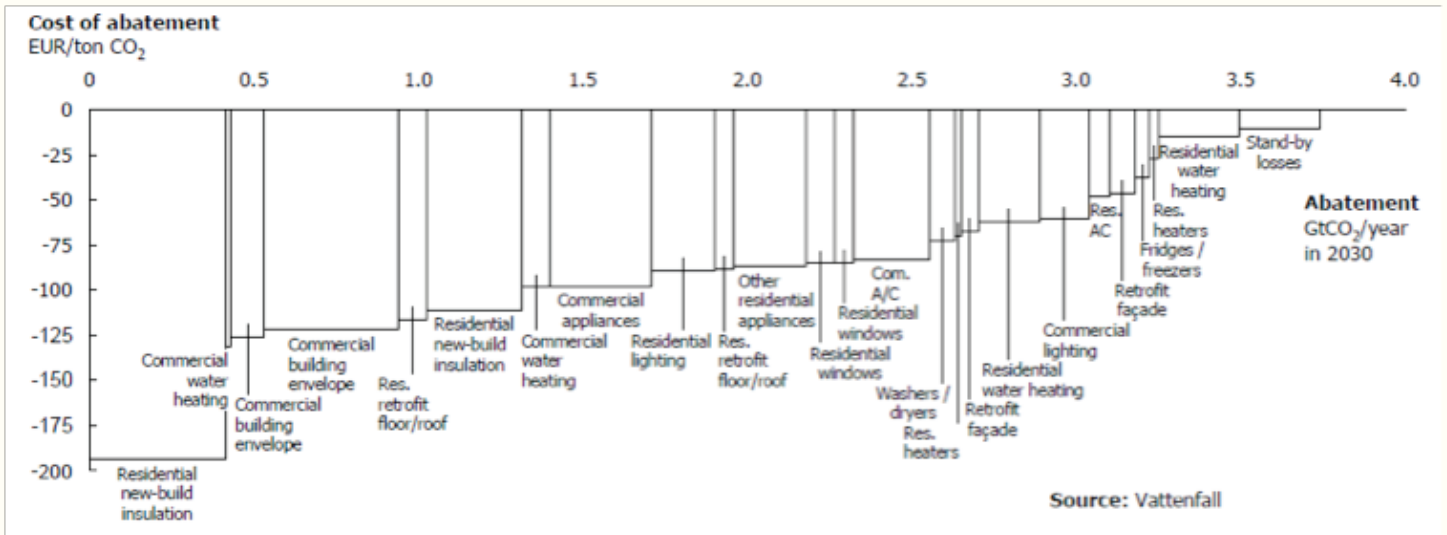


Figure 8 shows a large number of building energy efficiency improvement measures with negative CO<sub>2</sub> abatement costs and paying for themselves in a matter of a few years. The carbon footprint of a new apartment or office building may persist for more than half a century, while inefficient designs only increase the demand for energy. Hence the priority for this sector should be to meet ambitious energy efficiency standards so that huge resources needed for erecting and operating coal fired power plants can be avoided altogether.



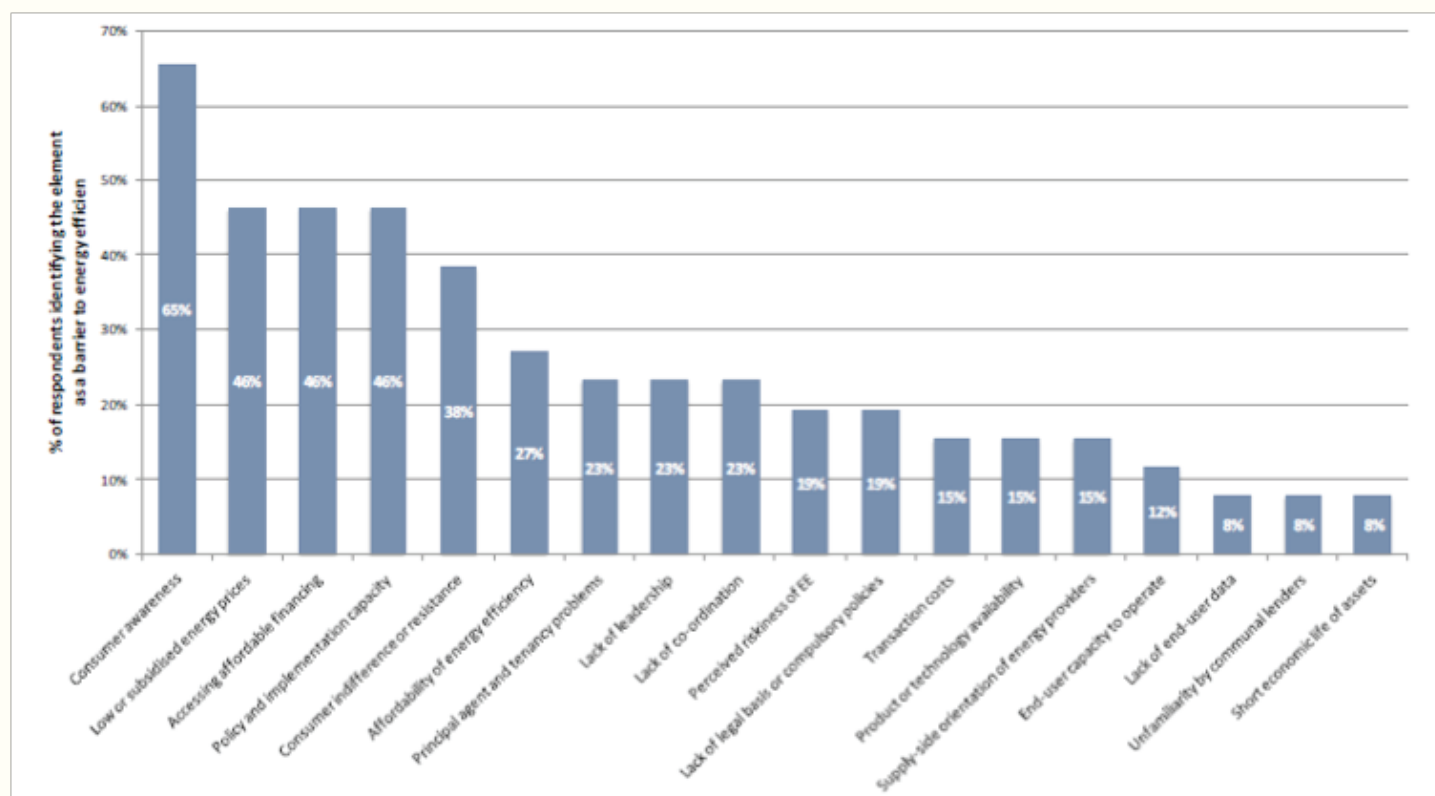
## 4. POLICY OPTIONS TO TACKLE BARRIERS TO GREEN BUILDING DEVELOPMENT

Governments around the world have initiated and implemented policies to address country-specific barriers to the propagation of green buildings. Corresponding to each type of barrier encountered, appropriate policy instrument is needed to overcome it. The ultimate objective is to tackle various barriers in an organized manner and accelerate the market transformation for new constructions and existing buildings. As the green buildings are in the nascent stage in Asia, there is significant opportunity for evolving public policies in this direction.

There are various ways to classify policy measures into different groups. In this document, policy measures are classified into five distinct categories and are presented in a sequential manner, as follows:

**1. Awareness and sensitization:** In a recent survey conducted by the International Energy Agency around the world to identify barriers to energy efficiency, the most frequently cited barrier was lack of information and low awareness. Other frequently cited barriers included low energy prices, difficulty in accessing affordable financing and lack of policy implementation capacity (IEA 2010).

**Figure 9. Result of an international survey to identify energy efficiency barriers (source: IEA 2010)**



Hence the first barrier to address is the lack of awareness and understanding about the potential benefits that can be accrued from green buildings. Creating awareness and/or sensitization requires identification of the target groups and “speaking the language” they understand. The target groups in this case are not only the private players such as building developers and users but also politicians as well as planners, policy makers, and economic players. The awareness effort is not likely to be effective if it does not highlight the gains that the different beneficiaries can reap.

**2. Advice and capacity building:** The second barrier to handle is the poor knowledge and inadequate capacity of the target groups to adopt green building technologies and practices. There is constant evolution of technologies with regards to the way resources can be used more efficiently. There is however a strong tendency to copy exactly the past designs in order to gain time. This discourages the adoption of any new and more efficient designs. Moreover, most building users are highly sensitive to the initial investment cost and not so much the cost of energy needed to run their facilities. In the traditional thinking process, it is generally assumed that green

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features invariably add to the costs and entail delays in project execution. It is therefore necessary to assist important stakeholders to upgrade their knowledge on green building design process and help them to understand the multiple benefits of making investment not on first-cost criterion but on the basis of life-cycle analysis. Another type of support may be in the form of training and capacity building of targeted players so that they are empowered to make their own decision and take appropriate steps towards the implementation of suitable solutions. There can be different categories of training on the basis of requirement.

**3. Market transformation:** Once target energy users are convinced of the ways in which they can reduce the need for resources and the operating and maintenance costs of their facilities, they will be keen to know from where and at what cost they can get access to such technologies and processes. At this stage, it becomes important to address the third barrier related to the unavailability of green building technologies and products in the market. In general, the private sector is most active in the marketplace and the government does not have much of a role to play there. However, when the green building market is not mature, equipment manufacturers and suppliers tend to market less efficient products that are "affordable" to their clients. As a result, green products are not commercialized or due to lack of economy of scale, their costs remain out of bound for most buyers. Government intervention may therefore be necessary to trigger market transformation and make green buildings more affordable. In this step, it is essential to favour public and private cooperation so that the private sector takes active part in programme implementation and the limited public funding is leveraged by private sector investment to accelerate the process of market transformation. It can be a relatively inexpensive mechanism for stimulating innovation and competition among potential manufacturers by guaranteeing higher market share for their products.

**4. Innovative financing:** In spite of the green building market transformation and technical solutions becoming cost-effective, target beneficiaries face the challenge of financing the incremental cost associated with green building projects because of the fourth barrier one comes across in reality: access to capital for green building financing. Moreover, the fact that investment in green building does not necessarily generate revenue but leads to operational cost reduction is not well recognized by financial institutions whose lending is normally conditioned by the capacity of the borrower to generate revenue from the capital investment. On one hand, there is a need to create awareness among financial institutions that green buildings can actually render the loan repayment more attractive, especially in the unstable environment of sudden energy price hikes. On the other hand, the main challenge is to avoid providing "free money" to promote green building investment but adopt innovative financing mechanisms that address the genuine problem of the target beneficiaries not having access to funds for investing in green buildings. This is an important aspect to take into consideration in order to avoid market distortions because green technological solutions that are intended to be financed should make business sense.

**5. Legislation and regulation:** Once the above four barriers have been effectively tackled, addressing the fifth barrier, that of legislation and regulation, becomes relatively easier. Instead of applying rules and regulations on the whole target group, the focus will be only on those errant beneficiaries that refuse to pursue the green building codes and standards in spite of all assistance extended to address the other important barriers. Regulations taking the form of energy codes, labels, and standards may serve various purposes: providing the required information to the intended beneficiary, ensuring a minimum guarantee on the green performance of equipment or product, or even completely eliminating very low-quality products from the market. Setting of appropriate standards for new products or construction projects can play a crucial role in the context of developing countries in Asia that have high demand for new buildings and facilities associated with the rapid economic growth.

Policy instruments that are assessed in this document are based on information available in the public domain from countries around the world. Wherever available, information is provided on the status of policies in Asian countries context though many Asian countries are lagging behind industrialized countries in formulating and enacting policy instruments effectively.

Table 5 summarizes various policy options that are grouped into five categories. These policy options are elaborated in the following sections.

**Table 5. Green building policy measures classified into five distinct categories**

| Awareness/ Sensitization  | Advice/Training/ Capacity Building  | Market Transformation   | Innovative Financing   | Legislation/ Regulation   |
|---|---|---|--|---|
| Raise awareness (by energy agencies, energy suppliers etc)                | Support training programmes for building professionals and practitioners          | Sign voluntary and negotiated agreements with actors of the building sector | Provide financial incentives for designing and soft loan for constructing low-energy buildings | Mandate building Performance Codes and impose penalty on non-compliance                         |
| Regional and local information-cum-demonstration cells on green buildings | Include comprehensive educational curriculum in syllabus                          | Sign voluntary agreements with public or private services                   | Provide soft loan for constructing resource-efficient buildings                                | Impose minimum thermal insulation in buildings that experience high or low ambient temperatures |
| Institute green building awards and disseminate good practices            | Register & maintain a list of accredited architects, designers and auditors       | Initiate technology procurement for green buildings / components            | Exempt tax for buildings with high "presumption ratio"   | Mandate energy performance labelling for major electrical and thermal appliances                |
| Promote research & development  | Train & familiarize building professionals with building energy code              | Initiate technology procurement for resource-efficient appliances           | Reduce tax on investments for retrofitting existing buildings                                  | Apply energy codes on large buildings planned to be renovated                                   |
| Introduce voluntary certification and labelling                           | Disseminate green building design manual for professionals                        | Promote cooperative procurement   | Extend financial incentives for architects who integrate green features                        | Mandate periodic inspection of building and facilities (boiler, HVAC, etc.)                     |
| Launch public leadership programmes                                       | Develop protocols and methodologies to determine energy use of the whole building | Encourage service and Performance contracting (EPC, shared savings, ESCO)   | Create revolving funds to provide loan for buildings with green attributes                     | Mandate minimum/maximum indoor temperatures depending on the climate                            |
|   | Support green building audit for retrofit projects                                | Introduce white certificate schemes   | Offer preferential loan guarantee conditions   | Mandate energy efficiency certificates for new and existing buildings                           |
|   | Fund studies to reinforce the direct and indirect benefits of green buildings     | Institute utility demand-side management programme                          | Extend capital subsidy to develop/retrofit buildings for low-income households                 | Mandate audits for large tertiary sector buildings  |
|   | Train financial institutions to develop green credit                              | Make use of Kyoto flexible mechanisms                                       | Provide accelerated depreciation for capital intensive investments                             | Mandate adoption of energy management system in large tertiary sector buildings                 |
|   |   | Set resource efficiency targets for public buildings                        | Public benefit charges   | Mandate use of solar water heating mandatory for buildings having access to the sun             |
|   |   | Adopt life cycle accounting for public procurement                          | Support audits/ training/ benchmarking activities  | Mandate rainwater harvesting in buildings at locations which experience adequate rains          |
|   |   | Support R&D for innovative technology development                           | Develop national emission trading scheme for buildings   | Prohibit the use of direct electric resistance for water heating in buildings                   |
|   |   |   |  | Mandatory annual energy report for municipalities   |

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## 4.1. AWARENESS RAISING AND SENSITIZATION

Public awareness is a key element to enhance the basic understanding of the building owners and tenants regarding the multiple benefits of green buildings and their impacts at the national and global level. Awareness and sensitization aimed at changing behaviour, attitude and values, can be considered as low-cost and low-risk options to reduce the demand for natural resources and adverse effects on the global climate. Information campaigns can be more effective if those sensitized can be put in link with professionals who can provide advisory services and assisting in actual implementation. Finally, persistent sensitization efforts can enhance the effectiveness and long-term impacts of other policy instruments, mainly by reducing the rebounding effects of regulatory and control policy measures.

Green building awareness raising to sensitize a large audience addressing both new and existing building stock can be taken up in various ways such as awareness campaigns, information-cum-demonstration centres, exhibition of good-practice concepts, technologies and products, instituting green building awards, promoting research and development, favouring voluntary certification and building energy performance disclosure, launching public leadership programmes, etc.

**Awareness raising and dissemination of good practices:** Among the various green features, energy saving is perhaps the most widely recognized benefit. In most countries, organizations assigned by their respective governments serve as comprehensive information sources for all aspects related to energy conservation and efficiency. The Bureau of Energy Efficiency in India works closely with State-level designated agencies to set up energy information centres and create awareness regarding both architectural and technical aspects of reducing the energy demand of new constructions but also sensitize school children to adopt good energy conservation habits/practices. The Department of Mineral Resources in Indonesia has set up energy information centre to enhance dissemination of energy information. In the Philippines, the Department of Energy started a major Power Patrol programme to encourage energy conservation and demand management through information and education efforts. Energy-smart guides in Singapore offer tips and measures that consumers can adopt to reduce their home or office energy bills and help preserve the global environment.

The National Energy Policy Office of Thailand under the Ministry of Energy has launched innovative “Divide by Two” campaigns to encourage consumers to adopt simple and pragmatic measures that can divide their demand for energy and water consumption by two. Under the same Ministry, the Department of Alternative Energy and Energy Efficiency has created an impressive Technology Demonstration Centre that displays physical models of systems and technologies that explain the principles in a very pedagogical manner. The Energy Commission under the Ministry of Economic Affairs in Taiwan Province of China has created web sites to promote the concept of energy savings by displaying data on demonstration projects and disseminating pamphlets and notes. The National Science and Technology Museum of Taiwan Province of China displays demonstration systems all round the year for citizens’ education.

**Green building awards:** The Jakarta-based ASEAN Centre for Energy convenes annually to give away ASEAN Energy Awards to recognize efforts of organizations and establishments in adopting renewable energy and energy efficient solutions in their projects, including best practices in new and existing buildings. With the passage of years, greater number of building developers and owners have been participating in this regional competition to get recognition and this has created a high level of awareness in the whole region. Similarly, the Hong Kong, China Energy Efficiency Award was instituted in 2004 to draw public and private professional attention to the importance of building energy codes. The Ministry of New and Renewable Energy of India has a solar buildings programme that disseminates information on the design and construction of energy-efficient and passive solar buildings.

**Research and development:** Research and development to better grasp the barriers to and benefits from green buildings through quantitative analysis can help to reinforce the business case for green buildings. Funds should be allocated to gather relevant data from green buildings to quantify their economic, social and environmental benefits in the form of case studies in order to sensitize crucial stakeholders in the building sector. Enough evidence has to be gathered to emphasize the fact that buildings that are conceived by adopting integrated thinking and solution driven design process actually reduce capital costs, construction time and several other

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risks. Though such studies have been commissioned in industrialized countries, similar initiatives are needed to ensure wider acceptance among market players and transform the nascent green building market in Asia.

In order to jump on the bandwagon of green building movement, some unscrupulous developers and builders “greenwash” their buildings by adopting some random but visible green features in their buildings without really having an in-depth integrated approach. Therefore funding should be provided for research efforts to support post-occupancy analysis in order to make clear distinctions between buildings that are genuinely green and those claiming to be green.

To encourage research and development activities in the building sector, the Government of Australia provides a number of tax concessions to companies that incur expenditure on such activities.

**Voluntary certification:** Voluntary certification and labelling programmes need to be well designed and updated periodically in order to be effective. Such initiatives are widely used for appliances than for buildings though voluntary certification of green building has been gathering momentum in many Asian countries in recent years.

Perhaps one of the first voluntary certification initiatives in Asia was the Building Environmental Assessment Method (BEAM) introduced in Hong Kong, China in 1996 by the HK-BEAM Society, a non-profit organization that represents developers, building professionals, contractors and property managers. BEAM aims at improving the environmental performance of building design and management. Buildings complying with BEAM's energy performance criteria are said to achieve above 32 percent savings (Lee and Yik 2002). BEAM seems to have found considerable success; by May 2005, about 100 buildings representing around 5.6 million m<sup>2</sup> of floor space were assessed by BEAM.

The Chinese Ministry of Construction unveiled the “Evaluation Standard for Green Buildings” in June 2006 in order to encourage the designing of buildings that perform better than the minimum energy-efficiency requirements. Building energy consumption data is collected to assess its performance based on the standard, and qualified buildings are issued the three-star Green Building certification. Under the programme, the local government is given the responsibility of issuing lower level one-star and two-star certifications. Another green building rating system was sponsored by the Beijing Science and Technology Commission to recognize the green performance of the new buildings that were to be constructed as a part of the Green Olympics of 2008.

The Indian Green Building Council (IGBC) founded by the Confederation of Indian Industry can be considered as the pioneer of green building concept in India. IGBC adopted the LEED rating of the USGBC and later developed its own green building rating programme for new construction (Government, Commercial, Institutional buildings, etc.), core & shell (IT Parks, Malls, etc), homes and factory Buildings. Thanks to the various initiatives of IGBC such as the IGBC Green Building Certification Services, feasibility studies, training programmes, annual congress and green building missions in India and in other countries of the region, several hundreds buildings have been registered in this programme. Interestingly, it has caught the imagination of corporate houses, several of them having been “platinum” or “gold” certified. India has a second voluntary building environmental performance rating system developed by The Energy and Resources Institute (TERI) jointly with the Indian Ministry of New and Renewable Energy (MNRE), which targets buildings that are not necessarily fully air-conditioned. TERI's GRIHA (Green Rating for Integrated Habitat Assessment) system is developed with the philosophy that best buildings are designed around nature and not against it. GRIHA promotes the use of solar passive design to optimize indoor thermal and visual comfort, resorting to air-conditioning only during periods of extreme discomfort. Considering the fact that India faces a serious shortage of resources such as fossil fuel and water, the MNRE provides financial assistance to developers, design teams and institutions involved in developing and promoting energy-efficient and green buildings. There are so far over a hundred buildings already registered for GRIHA certification.



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The Green Building Council of Australia (GBCA) was launched at the end of 2002 for the purpose of developing a comprehensive national Green Star environmental rating system. Within a short span of 3 years, GBCA had nearly 200 member organizations and had trained more than 1,300 industry representatives and more than 50 projects registered for Green Star certification. Green Star has transformed Australia's property and construction market; there are presently more than 4 million m<sup>2</sup> of Green Star-certified space around Australia, and a further 8 million m<sup>2</sup> of Green Star-registered space.

The Japan Sustainable Building Consortium developed a green building rating system to assess the environmental efficiency of buildings, known as CASBEE (Comprehensive Assessment System for Building Environmental Efficiency). CASBEE is adopted as a voluntary programme by local governments, with training for assessors and third-party assessments. CASBEE has also inspired other such green building rating systems in Asia, including Beijing's Green Olympic Building Assessment System.

The Building and Construction Authority of Singapore launched the Green Mark scheme in January 2005 in order to promote environmental consciousness in the construction and real estate sector. Developed as a tool to rate the environmental friendliness of new and existing buildings, Green Mark encourages the adoption of various green technologies to achieve a sustainable built environment by improving energy and water efficiency and indoor environment quality.

**Public leadership programmes:** Governments in many countries own and operate a large number of buildings, either for their own activities or extending public facilities such as schools, hospitals, etc. They are in a privileged position to adopt green building standards for such buildings owned and managed by them in order to significantly reduce their operating costs and provide valuable leadership to relevant private stakeholders. Governments can also show leadership by making key contract decision through the adoption of the life-cycle cost accounting approach for all public tender contracts.

The benefits of public leadership programmes have been reported for both industrialized and developing countries. For example, following the executive orders from the President of USA obliging federal agencies to reduce their energy use by 35 percent in 2010 compared to 1990 levels, the US Department of Energy reported energy savings of 4.8 GWh and cost savings of US\$ 5.2 billion annually (US DOE 2006). In Brazil, 140 GWh are saved annually thanks to the funding provided by the government agency PROCEL to retrofit government buildings (Van Wie Mc Grory et al 2002).

In Hong Kong, China, the Government uses some of its buildings as showcases of energy efficiency technologies and practice. Malaysian Government has commissioned a number of buildings to demonstrate energy-efficient features, including the Security Commission building, the Low-Energy Office Building (LEO) and the Zero-Energy Office Building (ZEO). Republic of Korea has an aggressive public sector energy conservation programme, encompassing the national as well as provincial and local governments. An efficient public building code requires the installation of energy-efficient systems and equipment in all public buildings. The Architecture Research Institute of the Ministry of the Interior in Taiwan Province of China developed a green building evaluation system, known as EEWH (Energy, Water, Waste and Health), which is a special chapter in the national building code. EEWH is a voluntary programme targeting new buildings but it is mandatory for any new public building construction project funded by the government that exceeds US\$1.5 million. In 2002-2003, 28 green retrofitting projects were completed for official buildings and public schools.

In Australia, the South Australian and Victorian Governments have been recognized for their leadership in achieving best practice green building standards across a comprehensive range of environmental criteria for all new government buildings. The South Australian State Strategic Plan embraces the notion that the social, economic and environmental elements must be addressed together to build a sustainable future. Government gives preference to office accommodation that meets 5 Star Certified Rating for all new leases or leases renewed from June 2006. In Victoria, under Office Accommodation Guidelines which became effective from July 2005, all buildings either leased or built for the Victorian Government are required to have a 4-Star Green Star Certified Rating. The Minister for Planning announced in November 2005 that proposals for office developments larger than 2,500 m<sup>2</sup> within the city of Melbourne would be assessed against a range of environmental considerations.



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## 4.2. ADVICE, TRAINING AND CAPACITY BUILDING

Green building designing and development requires an integrated approach and a thorough understanding of the different parameters influencing the overall performance of a building. While the transition to building green is gaining momentum, it is hampered by a lack of understanding of sustainability principles and those specific to green buildings, particularly among key players and decision makers. Professional education is a must to address the limited industry knowledge and lack of skills in green building practices and technology. OECD report highlights the fact that the demand for green buildings increased where there was evidence of an educational programme which identified the benefits associated with green buildings (OECD 2003). Training and capacity enhancement of the building sector professional and practitioners are key activities to hasten the growth of green buildings. Government intervention is necessary to extend existing programmes that educate and build capacity of industry professionals on green building concepts, designing aspects and technologies.

Training and capacity building activities can be taken up in various ways to address the specific needs for new buildings and retrofitting existing ones. In Asia, there is urgency to address the expertise needed to transform the huge volume of new buildings to be constructed in the next couple of decades. Examples of such activities include training and accreditation of professionals on integrated building design and systems, practical training of building practitioners to develop a skilled workforce, assessment of the direct and indirect benefits of green buildings, protocols and methodologies to determine energy use of the whole building, standard setting, code enforcement, data collection and evaluation, performance benchmarking, building energy management, life-cycle costing, financing options, etc. For existing buildings, focus will be more on auditing and retrofit options to make buildings green. In order to bring about a paradigm shift and ensure continuity, emphasis should be given in developing a new generation of specialists who are professionally trained to think and act “green”. Changes should be made in the academic curriculum by introducing innovative and comprehensive syllabus to promote life-long learning on all aspects related to green buildings.

**Training programmes for building professionals:** The construction sector involves an important number of players who are specialized in specific areas of their profession. There seems to be a level of discord about what needs to be done and how. There is therefore a need to reach the wide range of stakeholders in the industry and bring them together so that they form a network of experts who are able to appreciate the contribution of whole system designing which integrates and intertwines economic, environmental and social objectives to enhance the attributes of each other. Moreover, the training should include holistic and closed loop thinking. On one hand, the holistic approach enhances synergies between building systems, building scales and facades, landscapes, surrounding communities, activities and amenities, community health and well-being, transportation, economy and relationship building. On the other hand, the closed loop thinking creates opportunities for specific functions and systems to feed off each other, thus embracing the principle of the waste of one use providing the nutrients for other uses. It has the effect of compounding the economic, environmental and social attributes of all uses by the building occupants.

Increasing awareness and building capacity through skills enhancement, education and sponsored research and development are among the primary roles of the government. Accordingly, in several Asian countries, governments have initiated programmes to enhance the technical capacity of building professionals so that they are able to follow the contents of energy-related building codes and learn the technical nuances involved in achieving the standards set. There are also cases of government agencies developing assessment tools with model and data that appraise life-cycle costs and life-cycle performance of building materials and components. Professionals using such tools are provided with guidelines on the use of alternative materials and systems which could improve the energy, economic and environmental performance of buildings. Apart from the government initiatives, private and non-profit organizations promoting green building certification schemes have developed design and training manuals for professionals and conduct regular training programmes round the year. Upon successful completion of the training programme, trainees are required to undergo an examination in order to get an official green building accreditation certificate. The list of accredited architects and designers are registered and maintained in the public domain so that anyone wishing to avail the services of green building experts can go through the registers and select the one who matches their expectations.

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In Hong Kong, China, there is provision for training building industry professionals on how to conduct technical and financial analysis of materials and components used in buildings. The Government of Hong Kong, China has also developed a freely available Life Cycle Assessment (LCA) tool which provides a processing template, with design-oriented data-entry sheets and informative reporting documents for users.

In India, the Bureau of Energy Efficiency under the Ministry of Power as well as the Ministry of New and Renewable Energy organize regular training programmes for different groups of stakeholders to train them on the different features of the National Energy Conservation Building Code as well as the voluntary GRIHA rating scheme for green buildings. The CII's Indian Green Building Council conducts regular training programmes in different parts of the country, covering green building concepts, approaches and case studies. It trains aspiring green building professionals and conducts professional examination to accredit them to participate, advise and assess green building projects. It also holds an annual Green Building Congress for hosting international conference on green buildings, exhibition, missions and training programmes.

The Japanese government provides training of construction techniques for building contractors so that they are able to construct buildings that follow the latest energy-saving standards for non-residential buildings.

The National University of Singapore has developed a comprehensive training program to train building managers on how to monitor the performance of their buildings and how to operate them more efficiently.

The Green Building Council of New Zealand runs several courses for professionals as well as those who intend to be accredited for green commercial building and homes. It also offers a general course covering fundamentals of green building practice and how rating tools contribute, and respond to, green building principles. The latter is of interest to those who are new to green building and wish to learn about this rapidly growing area of the building market.

**Education programs for life-long learning:** Sustainable architecture and building designing with passive systems have always formed an integral part of the general curriculum of academic programmes for architectural students. However, the manner in which the subject was taught remained quite theoretical and students completing their studies rarely had the opportunity to practice what they learnt. However, the renewed interest in green architecture has brought about changes in the educational programmes related to sustainability issues. A few Asian countries have initiated education programmes in schools and colleges so that students are fully aware of the policy initiatives and technological progresses that are taking place in the building industry. In addition, there are specialized training programmes developed with educational establishments to cater to the continuing education needs of the rapidly evolving green building industry.

The Government in Hong Kong, China has initiated a series of school outreach programmes, starting from kindergarten till universities. Agreements have been signed with power companies which have the obligation to promote energy efficiency and conservation. The power companies have supported the development of energy-efficiency educational kits for schools.

As a part of demand-side management initiative, the Electricity Generating Authority of Thailand was instrumental in setting up several hundreds of "Green Learning Rooms" in public schools around the country in collaboration with the Thai Ministry of Education. These spaces educate children on how energy is generated and used, and what measures they can take to reduce their daily energy consumption in schools and at home.

**Building audit programmes:** Building owners and managers do not necessarily have the technical knowledge and expertise to know how and where they should intervene for making their buildings more resource-efficient and environment-friendly. They need advice from experts to adopt no-regret options, particularly at the time of making capital investments for building retrofits. Governments can play an important role in supporting training programmes that upgrade the skills of building professionals as well as skilled technicians. Recognizing the growing impacts of buildings on the national energy outlook, many Asian countries have initiated action to achieve greater building energy performance, taking the lead to initiate energy audit programmes for public buildings, and then sharing the experience with the private sector.

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The Energy Efficiency Office (EEO) of Hong Kong, China has been conducting energy audits in all major government buildings since 1994. Results of the measures implemented in these buildings and the actual energy savings achieved are documented and disseminated to the private sector, including property owners and property management companies. A set of energy audit guidelines has also been developed and published by the EEO.

In India and Thailand, and very recently in Viet Nam, energy auditing is mandatory for all existing commercial buildings above a certain threshold of connected load and the law requires that recommendations of the audit are implemented within a stipulated timeframe. Though there is no specific law mandating energy auditing in Malaysia, government has taken the lead to audit several public buildings under various technical assistance programmes.

The Korea Energy Management Corporation or KEMCO has been conducting regular energy audits in large residential and commercial buildings at the request of their owners. Based on the findings of energy audits, KEMCO recommends energy-saving measures along with offer for technical assistance for the adoption of measures such as thermal insulation or installation of double-glazed windows. Government may require the building owners to implement corrective measures to reduce the energy consumption of the audited buildings by extending low-interest loans.

### 4.3. MARKET TRANSFORMATION

While industry-initiated efforts are playing a significant role in accelerating the market for green buildings in industrialized countries, barring a few exceptions the situation is quite different in Asia. Market inefficiencies limit both supply and demand. As far as the supply is concerned, there is a limited understanding of life-cycle costs; hence the focus is on first-cost. There are presently not enough green products in the market to satisfy potential demand for building green. Moreover, many technologies associated with green buildings are still embryonic and evolving. As a result, sustainable buildings are regarded as an opportunistic play in many Asian countries. With so little green building product developed specifically for the investment market, investors seeking to "green their portfolio" must either build new green product or retrofit existing product. And in many markets, the product is still viewed as exotic, if not radical (Nelson 2008). There is a need for government intervention and support to stimulate the market and send the right signal for the private sector to act.

According to Neij (2001), there are three distinct stages involved in achieving overall market transformation: market introduction, commercialization, and market enlargement. Government's role in market introduction is essential. This can be achieved by supporting research and development for innovative technology development, initiating cooperative procurement for green building components and resource-efficient appliances, launching public leadership/demonstration programmes followed by replication and dissemination activities, setting resource efficiency targets for public buildings, and adopting life cycle accounting for public procurement. Green building and product commercialization could be accelerated by signing voluntary and negotiated agreements with actors of the building sector and with public or private services, using the competitive market forces whenever possible. Experiences around the world show that market strategies are more common for products but not for buildings which require standardized measurement procedures to assess the building quality.

Support for industrial research and development helps in innovation and emerging of new tools, methods, products and practices. This alone is not adequate if there is no follow-up technical assistance for ensuring transfer of know-how and technology in order to accelerate the designing and development of products as an effective response to changing market dynamics. It is in this context that demonstration projects can be effectively used to showcase technologies and practices and trigger market transformation. Such initiatives are quite common in Asia.

The public sector occupies a large share in many countries and many buildings are owned and operated by governments. Therefore market practices can be influenced significantly if governments can set good example by requiring greener features for all new constructions, and for retrofitting of existing buildings. Procurement regulations in the public sector can make provision for higher-efficiency products and technologies. For example, the Federal Energy Management Program (FEMP) of the USA has one of the more stringent legislative frameworks for procurement of products that energy-star compliant (FEMP 2007).

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#### 4.4. INNOVATIVE FINANCING

Despite the life-cycle cost advantages, green buildings in general cost more to build than the standard ones. Traditional financial solutions are inadequate to overcome the financial barriers to green building development, hence there is a need to look for innovative financing options that can help overcome such barriers and provide incentives to the potential building developers and owners. Financial incentives are also instrumental in stimulating investment in performances beyond the required minimum standards and in stimulating demand for energy-efficient devices and products used in buildings. Innovative financing encompass economic and market-based instruments as well as fiscal instruments and incentives.

Though there are many examples of innovative financing around the world, care should be taken to adopt policies that are well adapted to the individual country's context. For low-income countries, the incremental cost of green building is a major issue. Priority is given to increase the floor area for the available financial capital, hence there are hard tradeoffs between the urgent need for adequate housing and the long-term benefits of having energy-efficient housing. Such countries could explore the scope for getting access to international development financing mechanisms including funds available for climate change mitigation and adaptation. For mid-income countries, building owners can be largely expected to finance the incremental costs associated with green buildings. Some tools to promote the greening of buildings are summarized in Box 7.

##### **Box 7. Innovative tools to promote the greening of buildings**

*Following are some innovative tools to promote greening of buildings:*

**Rebates:** *These can be built into the tax system to give credits to homeowners for adopting specific energy saving measures rather than whole building performance.*

**Feebates:** *This new form of credit incentive is currently being tested and is based on a carbon tax or a tax on the carbon footprint of a building or sale certification fees. The feebate rewards homeowners who maintain energy efficient homes or carry out upgrades prior to sale. They pay less or their fees get waived, rebated or tax credited. In this system, tax revenue is not lost because the feebates pay for themselves as higher fees offset lower fees. The level of feebates can also adjust to higher standards of efficiency and can gear up as more building owners go above minimum requirements...*

**Green mortgages:** *Credits based on a home's energy efficiency are factored into the mortgage, allowing individuals to finance energy-efficient improvements in their property.*

**Equity finance or external capital:** *This is used for funding high-risk projects whereby project developers sell a majority of their ownership in the project to entities that have sufficient resources to finance the project. The disadvantage is giving up part of the control over the project.*

**Third-party financing:** *Energy Service Companies (ESCOs), by engaging in Energy Performance Contracting – sometimes referred to as Energy Savings Performance Contracting – with building owners, develop, install and monitor projects designed to improve energy efficiency. Compensation for an ESCO service and often the initial investment needed are directly linked to the energy savings associated with the project. Hence, the major barrier of upfront cost is addressed by allowing future energy savings to pay for the investment.*

**Revolving Funds:** *Loans can be repaid with the cash-flow arising from energy savings. The repaid loans then finance new energy efficiency projects.*

**White certificate:** *These certificates, also known as energy efficiency certificates, can enable building owners and even residential landlords to trade their emissions allowances. In principle, the various trading schemes will promote the desired effect, such as the reduction of GHG emissions, at a minimal cost.*

**Carbon credits:** While the building sector offers theoretically great potentials, only around 1 per cent of the certificates have been generated through demand-side energy efficiency measures. Therefore, the potential for green buildings to be eligible for carbon credits needs to be explored further.

Source: UNEP (2011)

Incentives are needed to overcome the inertia and resistance to change in nascent markets by extending financial benefits to market players. Some examples of incentives and their direct and indirect benefits to the intended beneficiaries are summarized in Table 6.

**Table 6. Incentives to adopt or exceed the requirements of building energy codes (Liu et al 2010)**

| Type/name of incentive  | Intended beneficiary | Direct/indirect benefits  | Example of practice  |
|---|----------------------|---|--|
| (Partial) grants<br><ul style="list-style-type: none"> <li>• For design costs</li> <li>• For homes/commercial buildings beyond building energy code</li> <li>• For demonstration of buildings complying with voluntary code</li> <li>• For audit</li> </ul> | Developer/owner      | Reduce incremental costs (of design, of energy-efficient building materials, equipment and construction)<br><br>Direct: reduce incremental costs<br><br>Indirect: provide information on costs/benefits of energy efficient buildings<br><br>Information on cost-effective energy-efficient renovation measures | United States (often through utility programs. E.g. in California)<br><br>Singapore (Greenmark)<br><br>Thailand (2002-2005 for energy efficiency projects in designated buildings)<br><br>Denmark, Tunisia |
| Subsidized loans/interest rates   | Developer/owner      | Reduction of first cost   | Austria, Germany, Japan, Netherlands, Republic of Republic of Korea, Switzerland, United States  |
| Energy-efficient and green mortgages  | Owner<br><br>Lender  | Secure otherwise impossible mortgages<br><br>Recognition; advantage in marketing; customer default risk reduction   | United States, Mexico  |
| Tax benefits (reduced import tax duties or VAT rates or income tax deduction/credits for EE appliances/ equipment)  | Developer/owner      | Reduction of first cost   | United States  |
| Nonmonetary incentives<br><br>Expedited permits<br><br>Relaxed zoning restrictions (size, density)  | Developer            | Reduced costs of doing business, increased earnings   | United States (e.g. Hawaii, Seattle, Santa Monica)<br><br>Republic of Korea<br><br>Lebanon (for complying with voluntary code)   |
| Awards  | Developer/builder    | Public recognition and marketing advantage  | China, United States (e.g. for Energy-Star buildings)  |
| Rating systems  | Developer/owner      | Recognition; advantage in marketing; higher market value of rated buildings   | LEED and other green building rating systems in China, India, European Union countries, United States, etc.  |



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**Grants and subsidies:** These are effective in dealing with the financial barriers to the adoption of energy efficiency measures and technologies. Grants and subsidies are more suited to low-income households that shy away from making energy-efficiency investment even though they may have access to capital. On the other hand, it may be more appropriate to extend preferential loans to middle- or high-income households for encouraging them to undertake energy efficiency improvements. Government can establish public-private partnership with banks and financial institutions to provide loan at lower-than market interest rate for customers wishing to adopt energy efficiency measures in their buildings. For example, the Government Housing Loan Corporation (GHLC) of Japan offers a long-term and fixed interest rate loan called “Flat 35” for those willing to voluntarily construct energy efficient housing with a floor area not exceeding 2,000 m<sup>2</sup>. The Asian Development Bank has a scheme that provides partial credit guarantee in support of green buildings. The total investments made on energy-efficient buildings and building retrofits supported by this guarantee loan is expected to exceed S\$150 million by 2012 (ADB 2009).

Grants and subsidies can also be mobilized to address a specific gap in the market and encourage innovators and businesses which would like to develop energy-efficiency products but have difficulty in accessing capital from the market. For example, the Danish government realized the potential benefits from improved glazing and decided in 2004 to support the industry in developing more energy-efficient windows that could phase out the traditional double-glazing from the market. Industrial partners such as the glass industry, window producers and the installers responded positively by assuring that the share of high-efficiency double-glazing would increase from 70 to 90 per cent within the span of 3 years. Government subsidy was used for the development of efficient windows and a voluntary labelling scheme. One of the drawbacks of such schemes is that as soon as the subsidy is withdrawn, the market demand for such products tends to come down. Grants and subsidies will therefore not have lasting effect if not accompanied by adequate training and awareness programmes. The Danish programme took this into consideration and overcame such shortcomings by providing adequate training to suppliers as well as consumers (de T'Serclaes 2007).

**Tax and public benefit charges:** Taxes imposed by the government allows it to mobilize the tax revenues into energy efficiency improvements of buildings, through the development and implementation of standards and provision of subsidies to motivate energy efficiency investments.

Public benefit charges are a special form of energy tax, very often managed by the public energy utility which charges in the customer bill an additional amount that is intended to cover costs related to services that a utility provides in the public interest. The public energy utility may be mandated by regulatory agencies or public-interest organizations to provide some or all of the services covered by this charge, and these services range from educational initiatives to funding low-income customers for building energy efficiency programs. Public benefits charges typically range from 2.5 per cent to 5 per cent of a customer's total energy bill. In the case of deregulation of the energy sector, the energy utilities may be mandated to levy the charges and deposit the funds collected into a public trust. The funds can then be used by an independent third party or advisory board for promoting various types of energy efficiency activities, including support for green buildings. Public benefit charges can be cost-effective and appropriate mechanism to raise funds for energy efficiency measures and possibly to accelerate market transformation.

**Fiscal incentives:** Fiscal schemes, in the form of fiscal cuts or reimbursements and fiscal credits, are financial incentives aimed at overcoming the liquidity barrier and encouraging potential actors to make their buildings greener. Unlike grants, fiscal incentive is an indirect means that offers considerable scope for market transformation on condition that it is available for long enough for the market to adapt and create suitable tools. On the negative side, fiscal incentives may lack the clarity so that they are comprehensible by all concerned actors. Moreover, the potential actors may lack the information on the means to implement the schemes promoted through fiscal incentives. Finally, financial incentives of this nature may also benefit some free-riders, those who would have anyway implemented the proposed solution, with or without financial incentives. The example of the fiscal measures adopted in France to stimulate the market for building energy efficiency is illustrated in Box 8.



### **Box 8. The French fiscal measures to improve performance of buildings**

France introduced the “Plan Climat 2000” or the 2000 Climate Plan with an ambitious goal of dividing the national carbon emissions by a factor of 4 by the year 2050. One of the lucrative measures to move towards this target was to promote energy efficiency aggressively. To encourage more people to adopt energy efficiency measures in homes, the government announced tax credits for all such measures. Interestingly, the tax credit entitles individuals/families to receive money from the tax authority even if they did not pay any income tax. If the sum involved in carrying out the energy efficiency measures represents an amount greater than the tax that an individual pays, he or she receives a cheque corresponding to the balance.

The eligible works includes most types of home energy conservation, provided the installation meets agreed performance standards and the works comply with the regulations. All types of residential property are eligible for the tax credit, although in relation to thermal insulation and condensing boilers the property must be at least two years old. The main works for which the tax credit is granted in 2011 are: roof and wall thermal insulation, double glazing, thermostatic controls and equipment, solar water heating, heat pump, condensing boiler, wood based heating systems/equipment, rainwater harvesting systems, and geothermal space heating pumps. Tax credits are not available for thermal insulation and double glazing of new properties in the course of construction.

There are maximum limits on the level of the tax credit that can be granted, although these are quite generous. Thus, the maximum for one person is €8000, and €16,000 for a couple, which is increased by €400 for each additional person in the household. The allowance can be received over a five-year period. No means testing is carried out. The tax credit is presently available until 2012, but it is anticipated that the concession will be extended, although the standards to be achieved are being increased each year and the level of the tax credit being reduced.

Source: <http://www.french-property.com/guides/france/building/renovation/energy-conservation/>

**Revolving fund for building energy efficiency:** A revolving fund addresses the problem of the lack of liquidity. It can be used to lend money for building energy efficiency such that the savings accrued from energy efficiency can replenish the fund, which in turn can finance new energy efficiency projects. Thailand has created a revolving fund and has forged partnership with banks for providing capital at subsidized rate in order to attract potential beneficiaries. Banks that forge partnership to provide loan using the revolving fund gain confidence about the positive benefits of energy efficiency and realize the risk-free nature of the scheme. The revolving fund can be considered successful when the partner banks decide to leverage their own financial resources to widen the scope of the building energy efficiency activities.

A revolving fund can be promoted further through public financial incentives such as mandatory audit, tax credits and quick depreciation, etc. It can also complement the role played by Energy Service Companies, or ESCOs which are often regarded as providing comprehensive solutions to energy efficiency issues. ESCOs can have high impact and relevance but they often lack adequate capacity to handle risks and uncertainty associated with projects. They can however play an intermediary role of energy adviser to overcome the initial first cost barrier and to facilitate the deal between banks that are handling the revolving fund and the intended beneficiaries.

**National emission trading scheme for green buildings:** The Clean Development Mechanism (CDM) under the Kyoto Protocol could be adopted by the developing Asian countries to claim carbon credits from the green building sector. Reliable measurement and baselines are essential for the carbon credit trading schemes. In practice however, there have been very few projects in the building sector because of the fragmentation of the building market, small scales of energy efficiency projects for buildings, few baselines and reference cases to determine additionality, high transaction costs, etc. (UNEP 2011).

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## 4.5. LEGISLATION AND REGULATION

Building energy standards and codes (BESC)<sup>11</sup> together with energy efficiency standards for appliances and equipment are used worldwide to promote energy efficiency in buildings and have the potential to yield high energy savings. BESCs are legal requirements that regulate the energy performance of building design and construction. Almost all BESCs address aspects related to building envelope and the equipment (heating, cooling, lighting, etc.) within or associated with the building. An attempt to assess the legal status of BESC in 81 countries through survey, reports and websites in 2009 concluded that 61 countries had some form of mandatory and/or voluntary existing standards, 11 countries had proposed standards, and 9 countries did not have standards (Janda 2009).

### Box 9. Buildings energy standards and codes

*There are various ways to set the building energy efficiency requirements. The basic types of regulations are:*

**Prescriptive:** *Separate energy efficiency requirements are set for each component of the building (e.g. thermal transfer values for walls, roof and windows) and for each part of the equipment (e.g. heating/cooling system, lights, fans, pumps, etc.). Individual components must achieve compliance with their specific targets.*

**Trade-off:** *Values are set for each individual part of the building and/or for parts of the installation, similar to the prescriptive method. However, trade-offs can be made between the efficiency of some parts and installations such that some values are better and some are worse than the requirements.*

**Model building:** *Values are set as in the trade-off, and a model building with the same shape is calculated with those values. A calculation done with the actual building should demonstrate that it will be as good as the model building.*

**Energy frame:** *An overall framework establishes the maximum of energy loss from the building. A calculation of the performance of the building has to demonstrate that this maximum is respected.*

**Performance:** *Energy performance requirements are based on a building's overall consumption of energy or fossil fuel or the building's implied emissions of greenhouse gases. This method gives optimal freedom for designers or constructors to reduce energy consumption within the frame. There is a need to develop and maintain sophisticated calculation methods and computer tools that take all the important factors into consideration.*

*Some countries use a mix of the above methods. For example, two or more models have to be fulfilled at the same time. In this case, energy efficiency requirements will gradually evolve from the prescriptive models over the energy frame to energy performance.*

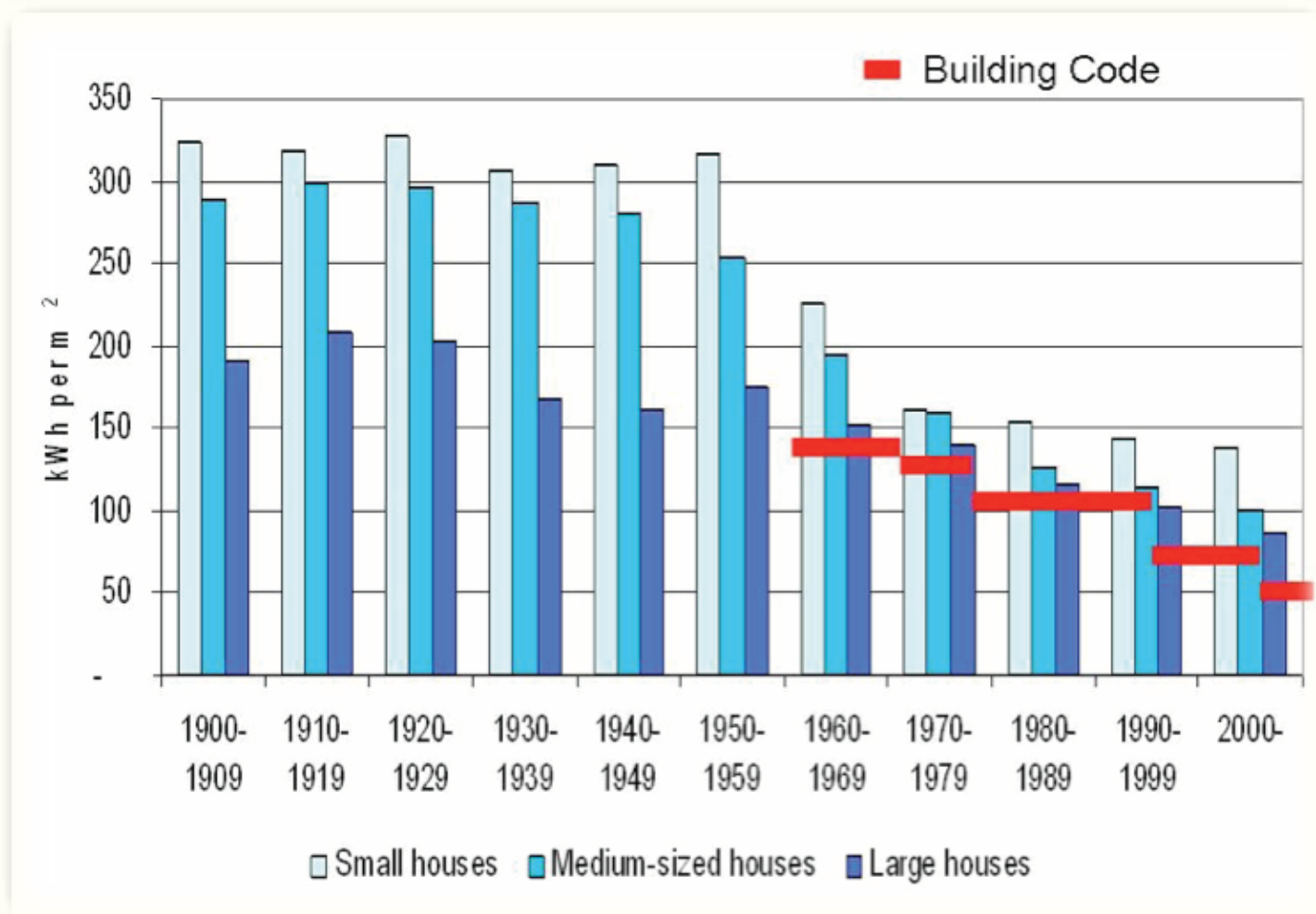
Source: Laustsen (2008)

Building codes are particularly important for Asian developing countries undergoing a construction boom. Experience of industrialized countries shows that once a building is constructed, it is very costly and sometimes impractical to attain the efficiency that can be achieved cost-effectively at the time of construction. Standardization should therefore provide the spark to truly ignite investor participation in the green building movement. As these trends mature, the industry should see the creation of more funds and investment vehicles that focus on the ownership and operation of green buildings. In turn, demand for these products should be significant, from major financial institutions and small investors alike (Nelson 2008).

<sup>11</sup> Building energy standards and codes refer to standards, codes, criteria, guidelines, norms, laws, protocols, provisions, recommendations, requirements, regulations, rules, etc. Depending on the country, BESCs can be in the form of one document, or comprise several documents, or be a part of another larger document (e.g. general building code).

Governments clearly have the potential to impose on property owners significant penalties beyond those dictated by the market – altering the product that can be brought to market and the cost of occupying green vs. conventional buildings. Europe and North America were the first to introduce energy-efficient design requirements in building as effective policy instrument after the first oil crisis of 1973. In fact, Denmark established one of the first building codes in 1961 and has updated them several times, as illustrated in Figure 10. One can observe the declining trend of the actual energy consumption of single family houses thanks to the introduction of rising energy efficiency requirements.

**Figure 10. Impact of building energy code on the evolution of energy consumption in single family houses in Denmark (Laustsen 2008)**



More and more governments around the world will be mandating sustainable construction either through greener minimum standards or through energy disclosure requirements, which drives the market to be more sustainable through the weight of public pressure.

Regulatory pressures undoubtedly are driving the sector to embrace greener building standards faster than unfettered market dynamics would otherwise dictate. Though the United States does not have a national BESC, many states and local authorities have adopted two national model codes: the International Energy Conservation Code (IECC) of the International Code Council (ICC) and the ASHRAE/IESNA Standard developed jointly by the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) and the Illuminating Engineering Society of North America (IESNA). A recent study comparing states with building energy codes to those without in the US found a decrease of roughly 10 per cent in energy consumption per housing units relative to those not built under the energy codes (Deason and Hobbs 2011).

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In China's cold and severe cold regions, the heating load of apartment buildings compliant with the current national BESC save 50 percent energy. According to a recent review of the low carbon development in China, the building codes policy cluster proved particularly effective in terms of energy efficiency gains, achieving an energy savings of 31.0 Mtce from 2006 to 2008, which accounted for 40 per cent of total energy savings in the buildings sector (CPI Beijing 2011). The cities of Beijing and Tianjin, two of the largest construction markets in China, have enforced more stringent requirements than the national building energy efficiency code for all new residential constructions since 2005, providing further reduction potential of 30 percent by increasing envelope insulation and using windows with low thermal losses (Liu et al 2010).

**Mandate building Performance Codes and impose penalty on non-compliance:** Many countries impose penalties for noncompliance of building energy codes. In Canada, where the responsibility of adoption and enforcement is given to provinces and territories, penalties for not complying with the energy code can include stopping construction, and withholding permits, and levying fines (Pacific Northwest National Laboratory 2009). In Germany, BESC enforcement is based on the self certification of the builder-architect to the owner. In some states, municipalities carry out spot checks and if the requirements are not met, the Energy Saving Law specifies penalties between €5,000 and €50,000 (Liu et al 2010).

In Singapore, the Building Construction Authority (BCA) operating under the Ministry of National Development is accountable for building regulation enforcement in the country. Non-compliance with the Building Control Act and subsequent regulations may result in significant penalties. An individual can be fined up to S\$20,000 or imprisoned for up to six months if he/she is found to be guilty of non-compliance (BCA 1989).

One of the difficulties with building performance codes in countries like China is that although there are policies and regulations being implemented, many are lacking effective enforcement and penalties. For example, China's centralized Ministry of Construction (MOC) has developed mandatory standards for the building industry, but in a survey conducted in 2005 the MOC found that over 87.5 percent of buildings met the energy standard on paper and only less than 49 percent of those buildings actually met the standard when inspected on site. This is due to difficulties in training and information dissemination, and the lack of political will in enforcing codes (Hong et al 2007).

In Tianjin, China, authorities are deploying third-party inspection to overcome some of the limitations. For example, if improper installation of wall insulation is identified through a random site inspection, reports will be filed with the General Station for Building Construction Quality Supervision, which will suspend the construction and require completion of remediation measures by the developer before such sanction is lifted (Liu et al 2010).

Under Japan's Energy Conservation Law, a penalty is imposed if an energy conservation report is not submitted to local authorities for all new constructions, additions, alterations, major repairs and remodelling of buildings over 2,000 m<sup>2</sup>. However, there is no provision for site inspections. The submission rate is reported to be 100 per cent by the Ministry of Land, Infrastructure, and Transport of Japan. Similarly, building owners in Republic of Korea are required to submit an energy-saving worksheet signed by a licensed professional such as architect, mechanical and electrical engineer. The concerned authority has the right to conduct an audit of the buildings after construction and revoke the permit or order the building to be rebuilt if elements of the energy-saving worksheet have been not been implemented (Alliance to Save Energy 2009).

In Thailand, the Ministry for Energy was created in 2002 to crack down on inefficient energy consumption in the country. There are different government agencies working under this Ministry on different aspects. Under the Energy Conservation Act (ENCON Act), buildings that do not meet the code requirements must go through retrofit changes. There have been around 2,000 audits that have genuinely been brought up to the level of the energy code based on a formal written agreement between registered consultants and project owners. This transformation has not been drastic, but has shown positive change for Thailand's efforts in mandating building performance codes (Hong et al 2007).

Prescriptive BESC are easier to apply by designers and builders and easier to verify by reviewers and inspectors, particularly if the individual components and equipment have been tested and certified. Performance-based BESC are more difficult to understand, apply and verify. Designers and builders as well as building control staff should develop the expertise and need to allocate time to check data and calculations.

The main reasons for the lack of enforcement are identified as high enforcement costs and under-resourcing of public agencies, including for staffing and staff training, inspectors' lack of qualifications and specialist knowledge, and finally the perception that energy-saving building regulations are not as important as safety-related regulations. Liu et al (2010) propose the following for better enforcement of BESCs:

- Impose political energy savings or CO<sub>2</sub> reduction targets on all levels of government to emphasize the importance of energy saving solutions;
- Provide adequate resources for enforcement by government agencies, with budgets enhanced by utilities, carbon finance and other interested parties;
- Organize specialist training for code officials and all building stakeholders;
- Set up a mechanism of accredited third party enforcement, possibly combined with government spot checking and significant sanctions against fraudulent approval;
- Inform and provide incentives to builders and home owners, and consider penalties for noncompliance in the longer time frame.

**Imposing minimum thermal insulation in buildings that experience high or low ambient temperatures:** Thermal insulation can significantly reduce the energy required to cool or heat a building, particularly in locations with very high or low ambient temperatures. A way to determine whether a location is very hot or cold is to check if the Heating or Cooling Degree Days are really high. The need for thermal insulation may be less relevant in mildly hot but humid climates where it is possible to minimize the daytime solar gains into the building by adopting bioclimatic architectural principles. Similarly, buildings located in moderate climates can do without insulation because of the need for the building envelope to respond to the varying needs of heating, cooling, ventilation and lighting during different periods of the year.

#### **Box 10. Heating and cooling Degree Days**

*Degree days are basically a simplified representation of outdoor air temperature data. They serve as quantitative indices reflecting the impact of outdoor air temperature on building energy consumption.*

***Heating Degree Days or "HDD"** are a measure of a combination of how much (in degree Celsius) and how long (in days) the ambient air temperature was lower than a specific "reference temperature", that is considered to provide indoor thermal comfort. A building located at a site with high number of HDD is a good candidate for thermal insulation because in the absence of insulation, considerable amount of energy would be needed to keep the indoor air warm.*

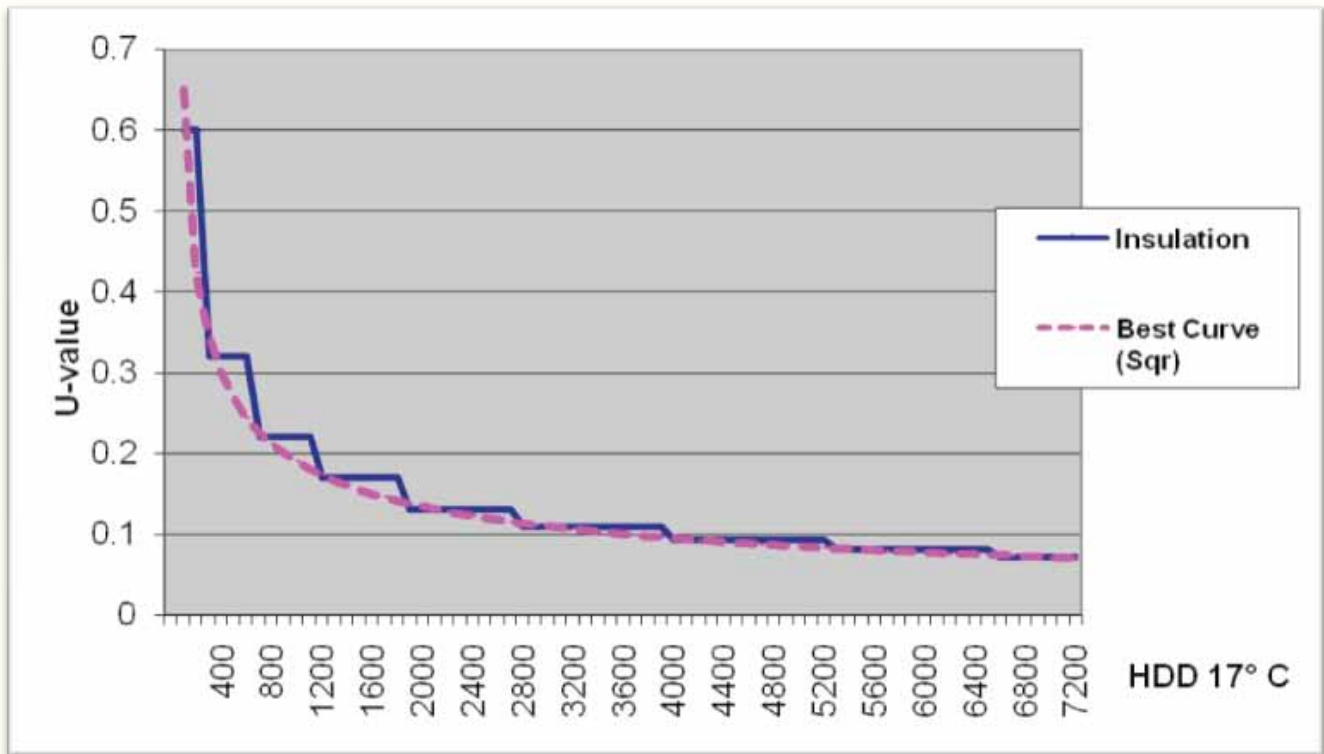
*Similarly, **Cooling Degree Days or "CDD"** are a measure of a combination of how much (in degree Celsius) and how long (in days) the ambient temperature was above the specific "reference temperature" considered to provide indoor thermal comfort. At a site with high CDD, the building would need more energy to keep the indoor air cool unless it is well insulated.*

Source: <http://www.degreedays.net/>

The insulation is required for the entire building envelope including the roof and surrounding walls exposed to solar radiation. But energy savings with additional insulation tend to decrease with increased insulation and will depend heavily on climatic conditions. Therefore care should be taken to impose the minimum thermal insulation for buildings for a given climate such that it makes economic sense. The optimum thermal insulation should be determined by computing the least life-cycle cost that includes the initial investment on insulation and the cost of energy saved over a long time frame, typically 30 years. An example of the least life-cycle cost optimum for simple roof insulation is shown in Figure 11.



Figure 11. Example of optimum life-cycle costs for simple insulation as a function of the heating degree-days of a site (Laustsen 2008)



In Japan, the national Energy Conservation Law contains performance criteria for residential buildings that are both prescriptive and performance oriented. This focuses on heat transfer coefficients, resistance of insulation materials, and summer solar heat gain coefficients (SHGC).

China has already enforced requirements for cost-effective reduction of heating and cooling loads and buildings are created to save 50 percent of energy. Cities with largest construction markets such as Beijing and Tianjin have adopted more stringent regulations to further reduce the energy consumption by 30 percent through the use of more envelope insulation and windows that have lower thermal losses.

Another country that has had success putting BESC's into effect is the Republic of Korea. In 1977, the first building code requiring thermal insulation was put into effect. What was impressive with this code was that it required compliance with region-specific materials including thickness for insulating materials and the rate of heat losses (commonly known as U factors) for the site's envelope. Even Mexico's National Housing Agency (CONAVI) has specifications for thermal insulation as a part of the voluntary national housing regulation (CEV-Codigo de Edificacion de Vivenda) (Liu et al 2010).

**Mandate energy performance labelling for major electrical and thermal appliances:** The most widely deployed and studied programs on energy conservation, in domestic settings, are the minimum energy performance standards (MEPS) and energy performance labelling for appliances and equipment. The MEPS establish a minimum energy performance standard, eliminating inefficient models and forcing consumers to purchase a minimal level of energy-efficient products. On the other hand, energy performance labels offer product differentiation and allow consumers to make informed choices.

These mechanisms shift the distribution of energy-efficient models upward in numbers. They form the foundation for most energy-efficiency policies worldwide and drive the change for energy efficiency on a wide range of appliances and equipment that consumers plug in.

In Asia, MEPS and labelling of appliances have been widely endorsed. China, Indonesia, Japan, Malaysia, the Philippines, Singapore, Republic of Korea, Taiwan Province of China and Thailand have mandatory MEPS. Hong



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Kong, China is the only economy that does not have a standard program for appliances, while Singapore has standards for only one type of appliance and China, the Philippines, Republic of Korea and Thailand have mandatory performance labelling for certain types of appliances/equipment. In Asia, China has a program that covers the most types of products with MEPS and labelling followed by Japan, Republic of Korea, and Taiwan Province of China. However, China's standards for room air conditioners are nearly 50 percent lower than their Japanese counterparts (Farrell et al 2007).

Japan has adopted a unique approach in setting energy conservation standards for appliances called the Top Runner Program. This program has adopted an opposite approach than most MEPS and was implemented in 1998. The Top Runner Program searches the market for the most efficient model. The model that is selected becomes standard within a time frame of some years. Once that time frame is over, energy performance of every single manufacturer must be at least equal to that of the model selected. The Top Runner was estimated to have avoided 29 million tons of CO<sub>2</sub> emissions by 2010, accounting for about 3 percent of Japan's greenhouse gas emissions using 18 top runner products from August 2005 (Energy Conservation Center, Japan (ECCJ)).

There is no doubt about the effectiveness of MEPS and labelling programs for energy savings. The energy consumption of Republic of Korea's refrigerators has been reduced by 74 percent in 10 years (Waide 2003). Thailand managed to increase the market share of its high-efficiency refrigerators from 12 percent to 96 percent in only three years (du Pont 2001). In the United States, refrigerators sold today use only a quarter of the electricity of those refrigerators sold 30 years ago when standards and labels were first incorporated, taking into account the increased size and added attributes of present-generation refrigerators (CLASP).

**Mandate energy efficiency certificates for new and existing buildings:** In places like Hong Kong, China, Japan, Taiwan Province of China, Republic of Korea, India, and Singapore green building programs have reaped considerable amounts of benefits in the past five years. In 2006, China's government implemented a green building rating system that the public is beginning to recognize, thus changing the market and consumer demands which designers are adjusting to meet.

A voluntary labelling system for housing performance was adopted in Japan in 2000 called the Housing Quality Assurance Law. The building's energy efficiency is based on a portion of an assessment of the thermal environment in the building. Singapore awards an "Energy Smart" badge to the top 25 percent of commercial buildings that excel in energy performance as a part of the Energy Smart Building Scheme that began in 2005.

Starting in 1998, designers, developers and property management companies in Hong Kong, China, submit building reports for assessment through a voluntary program called Energy Efficiency Registration Scheme. If the building meets the standards they are issued with a registration certificate. Almost ten years later 1,722 certificates were issued for 713 buildings in 2006 (Hong et al, 2007).

While most programs are voluntary and have effects based on consumer demand and standards, Singapore's Building and Construction Authority created a scheme based on financial incentives called the Green Mark Scheme. Launched in 2005, this scheme is meant for new as well as already existing buildings. It uses incentives based on three grades of energy performance: gold, gold plus, and platinum. Gold corresponds to energy efficiency based on the level needed by building standards. Gold Plus and platinum grades require an energy performance, 25 and 30 percent higher, respectively, than the standard. Incentives are based on gross floor areas, ranging from S\$3-S\$6 per m<sup>2</sup> for new buildings, and for retrofit of existing buildings, about 40 per cent of the incentive given to new buildings. The government is planning to make Green Mark certification mandatory for all new public sector buildings and those undergoing major retrofits (Hong et al 2007).

**Mandate audits for large tertiary sector buildings:** A mandate that stipulates regular energy audits for large buildings and encourages them to retrofit in order to become energy efficient can have a huge impact on a city's and the nation's energy footprint. However, it does not seem to be high on the priority list of most nations.

Some cities in the US are taking the lead in mandating audits for large tertiary sector buildings. The local law 87 of New York City requires large buildings to undergo an energy audit every ten years, along with retro-commissioning, to "tune up" the building's existing systems and ensure efficient operation. It includes residential as well as commercial buildings (New York City Government).

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Although energy-efficiency retrofits generally result in major cost and energy savings, it was noted that before the law came into force, many buildings were not participating in the audits that would identify such cost-effective measures. The energy audits must include all of the base building systems, including building envelope, HVAC systems, conveying systems, electrical and lighting systems. The audit must identify all reasonable measures and capital improvements that would result in energy use or cost reductions, associated savings, cost of implementation, and simple payback period ([www.SmartPlanet.com](http://www.SmartPlanet.com)).

From February 2011, non-residential buildings in San Francisco are held accountable to the public for how much energy they use. Existing commercial buildings will be required to make their energy-usage reports available to the public annually. The new city code also requires that buildings over 10,000 ft<sup>2</sup> complete an energy efficiency audit every five years. The mayor of the city hopes that the new green building code will educate building owners about what they need to do to save energy and money, and boost the local green economy. This initiative will help the city's climate action plan — adopted in 2002 — that aims to reduce greenhouse gas emissions by 20 per cent below 1990 levels by 2012.

One key component of the new law will mandate “benchmarking” with Energy Star, which provides an energy performance rating system that compares similarly sized buildings and uses. The results will be made public, creating transparency in a building's energy costs, which had never existed before. It will enable buyers, tenants, and insurance companies to consider energy in valuing buildings. In addition, the City Administration is offering various tax incentives to achieve the energy reductions that are presently voluntary. Buildings larger than 50,000 ft<sup>2</sup> will be required to start energy audits in October 2011 and subsequently the mandate will expand to properties 10,000 ft<sup>2</sup> or larger by 2013.

**Mandate use of solar water heating for buildings having access to the sun:** Israel is the leader in adopting solar water heating and has been experimenting with it since the 50s. By 1967, solar water heaters were being used by 20 per cent of the population. In 1980, the Israeli government passed a law requiring installation of solar water heaters in all new homes except high towers with insufficient roof area. As a result, Israel is now a world leader with 85 per cent of the households today using solar thermal systems accounting for 3 per cent of the primary national energy consumption (Wikipedia Solar Water Heating).

Australia has a variety of incentives at the national and state level, and regulations (state) for solar thermal have been introduced, starting with the Mandatory Renewable Energy Target (MRET) in 1997.

In April 1994 the Indian Ministry of Urban Development (MOUD) requested State Governments to consider issuing suitable directives to the local bodies to modify the building bye-laws with a view to making the installation of solar water heating systems mandatory in hotels and hospitals in the commercial sector. The model regulation, when adopted by the local bodies, will make it mandatory for several categories of buildings, including residential buildings of a certain prescribed minimum plinth area, to have solar water heating systems.

So far, several Indian states have issued government orders for amendment of building bye-laws to mandate the use of solar water heaters in commercial buildings. Some states are offering rebate in electricity tariff to those who have adopted solar water heaters (MNRE).

In November 2007, the Parliament of the state of Baden Württemberg of Germany approved the Renewable Heat Law for Baden Württemberg. The law was initially targeted at all residential buildings constructed after April 2008, for which house builders were obliged to cover 20 per cent of the yearly heat demand with renewable heat sources. From January 2010, the law also affects existing residential buildings, which, in the case of a modernization of the central heating system, have to reach a share of renewable heat of 10 per cent of the yearly heat demand.

In July 1999, the Barcelona Solar Thermal Ordinance (municipal legislation) was approved and came into effect in August 2000. It has been subsequently updated in 2006. The purpose of this ordinance is to regulate the use of solar thermal energy for producing sanitary hot water in the city's buildings. The Solar Ordinance is applicable to new, restored and fully refurbished buildings. It applies to buildings intended for residential, health-care, sports, commercial and industrial use and, generally, any activity involving the existence of canteens, kitchens, laundries or other circumstances that lead to a large consumption of hot water, regardless of whether they are public

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or privately owned. Already, 60 per cent residential blocks, 20 per cent hotels and 10 per cent sports facilities have been covered.

In 2003, the small Municipality of Carugate (less than 15,000 inhabitants) in Italy adopted a new building regulation which promotes energy efficiency in general. The law stipulates the use of solar thermal systems to produce at least 50 per cent of the Domestic Hot Water demand as a mandatory measure.

In Hawaii, all new single family homes in the state must be equipped with solar water heaters as of January 2010 ([www.getsolar.com](http://www.getsolar.com)).

**Mandate rainwater harvesting in buildings at locations which experience adequate rains:** In India rainwater harvesting is being encouraged by state governments and city municipalities. In many cities and states, rainwater harvesting system has been made an integral part of the building permission process and is mandatory ([www.rainwaterharvesting.org](http://www.rainwaterharvesting.org)).

In Himachal Pradesh, all commercial and institutional buildings, tourist and industrial complexes, and hotels, existing or planned and having a plinth area of more than 1000 m<sup>2</sup> will have rain water storage facilities commensurate with the size of roof area. "No objection certificates" required under different statutes, will not be issued to the owners of the buildings unless they produce satisfactory proof of compliance of the new law. Toilet flushing systems will have to be connected with the rainwater storage tank.

In 2004, the Kerala Municipality Building Rules, 1999 was amended by a notification issued by the Government of Kerala to include rainwater harvesting structures in new construction.

In New Delhi, since 2001, the Ministry of Urban affairs and Poverty Alleviation has made rainwater harvesting mandatory in all new buildings with roof areas exceeding 100 m<sup>2</sup> and in all plots with an area of more than 1000 m<sup>2</sup> that are being developed. In addition, the Central Ground Water Authority (CGWA) has made rainwater harvesting mandatory for all institutions and residential colonies in notified areas (South and southwest Delhi and adjoining areas like Faridabad, Gurgaon and Ghaziabad) in 2002. This is also applicable to all buildings in notified areas that have tube wells.

Since 2003, the government of Tamil Nadu has made rainwater harvesting mandatory for all buildings, both public and private, in the state. The ordinance cautions that if the system is not put in place, the Commissioner will build one and recover the costs from the owner. The owner may also lose the municipal water connection for non-compliance.

In addition to this, a number of city municipalities have made rain water harvesting mandatory sometime more stringent than their respective states. In 2007, Port Blair Municipal Council (PBMC) directed rain water to be utilized for various domestic purposes other than drinking. Ahmadabad, Bangalore, Chennai, Indore, Kanpur and Hyderabad city municipalities are leading in rain water harvesting related regulations.

Some countries are in the process of enacting laws that ban rain water harvesting on the ground that the water does not belong to the building owners but to the state and the water companies operating in the region. Many Western states in the USA, including Utah, Washington and Colorado, have long outlawed individuals from collecting rainwater on their own properties because, according to officials, 'that rain belongs to someone else' ([www.naturalnews.com](http://www.naturalnews.com)). A state like Utah is the second driest state in the nation and from a sustainability point of view, it would make sense to collect and use water locally for non-drinking purposes.

In Colorado, two new laws were recently passed that exempt certain small-scale rainwater collection systems, like the kind people might install on their homes, from collection restrictions. Prior to the passage of these laws, Douglas County, Colorado, conducted a study on how rainwater collection affects aquifer and groundwater supplies. The study revealed that letting people collect rainwater on their properties actually reduces demand from water facilities and improves conservation ([www.naturalnews.com](http://www.naturalnews.com)).

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**Prohibit the use of electricity for water heating in buildings:** Using electrical power for water heating is highly inefficient regardless of the power source due to conversion losses. For example, a fossil-fuelled power plant may only deliver 3 units of electrical energy for every 10 units of fuel energy released. Even with a 100 per cent efficient electric heater, the amount of fuel needed for a given amount of heat is more than if the fuel was burned in a furnace or boiler at the building being heated. Moreover, most of the countries in the Asia-Pacific region are well endowed with the sun, hence there is considerable potential for meeting the hot water requirement in buildings from solar thermal devices.

Sweden is leading in regulation to restrict the use of direct electric heating. The regulation was introduced in the 1980s and there are plans to phase direct electric heating out entirely. Denmark has banned the installation of electric space heating in new buildings for similar reasons (Wikipedia Electric Heating). It seems the rest of the world is lagging behind on this.

**Mandatory annual energy report for municipalities:** In most countries across the world the issue of Energy is considered too important to leave the regulation in the hands of local authorities. Though local authorities play a role in certifying the required energy efficiency of new buildings for building approval process, most of the technical work is outsourced. As a result the capacity and skills base to collect energy related data is limited among local authorities. Moreover, in many of the developing countries, tools and resources are limited.

There are some exceptions to this rule where the local authorities have been delegated the power to enforce Building Energy Codes. Local authorities are responsible for Building Energy Codes in Denmark, Germany, Netherlands, Australia, China, Canada, Russia and the USA.

Nonetheless the local authorities are best positioned to track and report energy performance of buildings to evaluate enforcement and efficacy of Building Energy Codes (Liu et al 2010).

#### 4.6. COMBINING POLICIES TO ACHIEVE THE BEST RESULTS

The building sector is quite complex and involves many stakeholders. One cannot therefore expect one set of policy that would fit all. As it was pointed out in Chapter 3, there are many market barriers to the proliferation of green buildings and improvement in the performances of existing buildings. There is in fact a need for multiple policies to even address a single barrier.

While regulatory tools seem the most effective to achieve resource efficiency and environmental targets, economic and fiscal as well as the other tools are equally relevant. Regulatory instruments that are particularly mandatory in nature provide the market push for high efficiency buildings. The requirement of public sector to take the lead in adopting or exceeding energy codes and standards provides a greater impetus to the private sector to follow the trend. Voluntary certification and labelling of green buildings prepare the marketplace for more stringent energy codes and standards through energy saving tools, technologies and advanced building techniques and materials. Information campaign and awareness raising about the costs and benefits of energy-efficient buildings are aimed at educating the general public and prospective buyers or tenants of energy efficient buildings; in addition to highlighting the potential for savings, they provide social incentives by emphasizing the positive health and environmental benefits of green buildings. Incentives, not necessarily monetary in nature, are effective to overcome resistance to change due to unfamiliarity and lack of experience with new techniques and materials, as well as financial risks associated with higher construction costs to comply with building energy codes. Incentives also contribute to encouraging market deployment and recognition of energy efficiency innovations that exceed the requirements of energy codes (Liu et al 2010).

An integrated policy framework that combines regulatory instruments, capacity building and training and information campaign coupled with fiscal and other incentives is most likely to be successful in the developing countries of Asia and the Pacific. In low-income countries of the region where the per-capita energy consumption is rather low, the focus should not be that much on reducing energy consumption but rather on ensuring greater access to more and affordable energy services with the available resources (UNEP 2011).

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There is a need to carefully design policy approaches that reinforce each other and are well adapted to the specific context of a country. In this context, energy pricing plays a critical role. Countries where energy price is kept artificially low and does not internalize external costs, need to first get their pricing right so that life-cycle investments become profitable.

For countries that have not yet adopted any building energy codes and standards, the first step could be to introduce some voluntary standard in order to create awareness and then to move quickly to make it mandatory in order to eliminate the possibility of creating a building stock with very low energy performance. In India, for example, the Bureau of Energy Efficiency undertook the development of Energy Conservation Building Code (ECBC) and introduction of the national energy labelling programme in 2006. Initially the adoption of energy labelling was voluntary to create awareness among all stakeholders and sufficient time was given to the manufacturers to adapt and improve the energy performance of their products. In January 2010, energy labelling became mandatory for energy intensive appliances such as refrigerators and air conditioners, thus wiping out very inefficient products from the market. However, similar steps has not been taken so far for mandating ECBC in the whole country due to lack of consensus among all stakeholders, thus losing a great opportunity to avoid the development of new buildings that do not meet the minimum energy efficiency standards.

There is growing awareness and experience of sustainable buildings among policy makers in Asian developing countries but it remains relatively weak, hence the need for strengthening the policies to ensure that the opportunity to go in the right direction is not missed.

As many countries in the region are striving but falling short of meeting the Millennium Development Goals, it is more appropriate to link the mainstreaming of green building movement to other national development priorities such as energy security, economic development, employment opportunities, productivity, better health, safety, environmental protection, etc.

Savings that last long are crucial in bringing about structural changes to lower energy consumption. For example, low-energy buildings provide savings throughout their long life. On the other hand, rebounding effects that erode initial savings should be dealt with appropriately. There have been cases of the money saved from energy efficiency being spent on extra energy consuming systems or behaviour. For example, free distribution of compact fluorescent lamps or extending subsidies to clearly profitable saving measures create room for new energy using activities. It is reported that people who have opted to insulate their house in cold climates resort to higher thermostat setting (Throne-Holst 2005). Standards, taxes and incentives should therefore be formulated such that they discourage the rebound effect by only allowing to recover the investment costs over the life time of the building. Keeping the above in mind, policy initiatives should meet all conditions for implementing performance improvement measures, and provide long-term savings, avoid rebounding effects that erode initial savings, tackle energy poverty issues, and attain better indoor climate.



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## 5. RECOMMENDATIONS FOR POLICY MAKERS

Sustainable buildings are undoubtedly one of the most cost-effective solutions to reduce the pressure on rapidly diminishing natural resources and the adverse environmental impacts associated with their use. The capital investments to be mobilized for the purpose are substantial, however the price to be paid for not adopting sustainable building practices is predicted to be even much greater. Policy makers should therefore give sustainable buildings the top priority by working with all relevant stakeholders in order to overcome the financial, organizational and behavioural barriers. They need to act decisively and introduce a comprehensive and mutually reinforcing package of policy options including regulation, fiscal and financial measures in order to ensure improved energy security, stimulate their economies, reduce the burden of rising energy prices while improving the quality of life of the population, and mitigating the impacts of global warming and climate change.

Experiences around the world lead us to believe that building regulations are a sure way of creating resource-efficient infrastructure that will reap benefits over the whole life cycle of buildings. Hence public authorities have the onus of enforcing building energy codes and standards with high energy-efficiency requirements, and adopting suitable compliance mechanisms. Building standards should be appropriate to the local climatic conditions and take into consideration the type of building and activity. Countries in which the standards and codes are being formulated or are planned to be introduced need to be less stringent in the beginning but as the market evolves, codes need to be strengthened to achieve the best result. Because many well-designed buildings do not achieve the intended energy-efficiency levels, emphasis should be given to actual performance of the building than the designed level. This requires training and capacity building of the compliance team and development of common measurement and data reporting schemes.

Regulation can become more effective by making building energy labelling mandatory as it provides transparency and stimulates market transformation. Standardized labelling of buildings provides a strong foundation for performance-based building standards. Building energy audits should be made mandatory in order to assess the energy performance and identify cost-effective improvement opportunities.

Policy makers will face an uphill task in setting high building energy performance targets in countries where energy price is rather low. While working on corrective measures to achieve rational energy pricing mechanism, different types of revenue-neutral schemes can be introduced to reward those willing to invest in building performance improvement measures. One such scheme could be to raise the energy tariff and use the revenue thus generated to cover the incremental investment for integrated energy-efficient designs. As a result, those who avail the capital for such integrated building performance improvement measures will be able to lower their energy consumption substantially, thus paying lower energy bills in spite of the higher energy tariff. Another revenue-neutral policy could be to impose higher tax on buildings with low energy-ratings and provide financial incentives to high energy-rated buildings. Yet another example of revenue-neutral scheme could be raising the electricity tariff to support higher feed-in-tariff for renewable energy supplied by the building to the grid. To date, there are over 40 countries around the world that have adopted policies of open access and feed-in-tariff for renewable energies, including roof-top solar and small wind systems.

Policy makers can collaborate closely with other stakeholders such as public agencies and market players such as local authorities, financial institutions, energy utilities and energy service companies to promote innovative financing mechanisms and achieve the required market transformation. For example, a revolving fund can support any initiative undertaken by partners as a part of win-win strategy. Energy utilities that are faced with the challenge of bridging the demand-supply gap can use the revolving fund to finance those clients who are willing to invest in energy-efficiency measures such as insulating their homes, purchasing more efficient boiler or air conditioner, etc. The capital can be recovered through additional surcharges on the monthly energy bill over a reasonable time frame that is acceptable to the borrower as well as the energy utility. Similarly, energy service companies that are cash-starved can tap into the revolving fund to invest in energy-efficiency measures for interested building owners and pay back the capital through savings shared with the owners. Local authorities who are targeting to develop low-carbon cities can provide loans to finance building energy efficiency investment and recover the capital in several instalments along with the property tax.

Transformation of the building sector would require not only availability of appropriate building materials, equipment and system but also a large workforce with the skill necessary to construct sustainable buildings using



holistic and integrated design approaches that lead to optimal solutions. Policy initiatives should include creating professional training programs for all building stakeholders and vocational programs for building workers.

Finally, many of the economic or financial incentives may have short-term impacts if adequate efforts are not made to create an energy-frugal culture and avoid the so-called “rebound effect” or the reduction of potential savings because of higher energy use in response to those savings. Moreover, people tend to forget good habits and go back to the old way of doing things. To avoid such occurrences, wide-ranging and sustained campaigns should be undertaken to communicate and sensitize in order to change behaviour/attitude and create new mindsets.

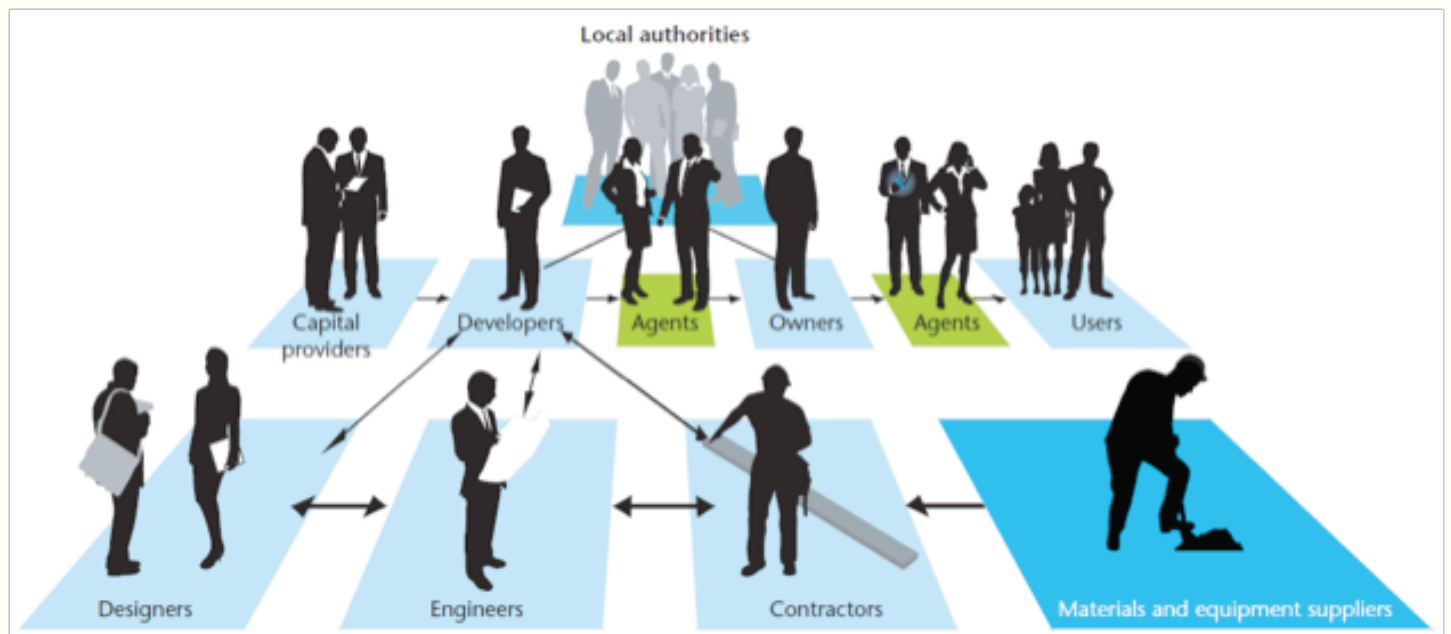
### 5.1. MAIN STAKEHOLDERS TO IMPLEMENT POLICY OPTIONS

The building supply chain involves many stakeholders such as the national and local authorities, developers, capital providers, owners, contractors, designers, architects, engineers, etc. The complexity of interaction between these stakeholders can be one of the important barriers to sustainable buildings (WBCSD 2009).

The overall responsibility for the development of sustainable buildings lies with three main entities:

- The concerned national authority entrusted with the responsibility to translate the national vision for the sustainability of the building sector into concrete objectives and targets. In order to put the concept of sustainable buildings into the right perspective, it is important to highlight their positive contribution to the economy, energy, environment, development and climate change issues.
- The national agency mandated to design policy by reviewing the barriers and evaluating policy instruments that lead to the creation of appropriate enabling legal and financial frameworks for the successful implementation of the strategy and action plan.
- The local authorities who play a key role of enforcing the national building codes and standards in their localities and creating synergies among all the stakeholders in the building sector, as shown in Figure 12.

**Figure 12. Stakeholders in the building sector (Source: WBCSD 2009)**



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## 5.2. INSTITUTIONAL STRUCTURE TO PROMOTE GREEN BUILDINGS

Depending on the context of the country, the most suitable institutional structure should be proposed that can be given the mandate to engage with stakeholders and to mobilize resources internally as well as through international development assistance.

It is essential to create an agency or organization which serves as an effective institution with the key role of executing national policies and strategies through the coordination of sustainable building policies and programmes, including programme design, administration, management, monitoring, evaluation, etc. Such agency should demonstrate strong leadership and have the capacity to coordinate within and across levels of government, and engage key stakeholders in consultative processes to help build consensus. The onus of implementing building performance improvement activities at the decentralized level lies with government services, regional and local authorities, builders and developers, financial institutions, manufacturers, distributors and service providers, architects and engineers, professional associations, owners, users, etc. The role of the designated institution is to take the lead in promoting, supporting, and facilitating the creation of an enabling environment for the above stakeholders to execute activities in order to have the best impacts on the economy, society, and the environment.

Studies conducted around the world have shown that there is no such universal model of organization with the specific task of promoting sustainable buildings. ESMAP's analytical compendium of institutional framework to promote energy efficiency has classified the following categories of energy efficiency organizations observed around the globe (ESMAP 2008):

- Government agencies that deal with all aspects of energy: energy security, supply, pricing, legislation, efficiency and conservation, renewable energy, etc.
- Government agencies specialized in energy efficiency, renewable energy, or clean energy
- Independent statutory authorities with the mandate of executing government energy efficiency policies and strategies
- "Parastatal" corporations in-charge of energy efficiency programme implementation
- Public-private partnerships to promote energy efficiency
- Nongovernmental organizations specialized in implementing energy efficiency programmes

It is not possible to categorically say which organization structure is the best because each type of organization has its own advantages and drawbacks. The concerned national authorities may decide to adopt whatever model of organization that suits best the country's political, cultural, and economic priorities. Irrespective of whatever structure of organization a country may opt for, a statutory basis is desirable in order to establish an effective institutional structure because it provides legal basis and legitimacy to the organization in terms of its authority, role, and means to carry out the sustainable building mandate. The designing of the sustainable building organization should be according to the specific policy implementation requirements and targets set.

Experience of building energy efficiency promotion both in industrialized and developing countries has shown that strong mandate from the government, consistent policy, and long-term commitment for supporting the sustainable building goals are essential elements on which basis the designated agency can develop and flourish.

The most critical aspect for the success of such an agency is the people who form the organization. They should have appropriate background and training suited for the job and should project leadership and professionalism in their day-to-day activities involving interaction with major stakeholders and beneficiaries. Administrative and management autonomy should be granted and adequate financial resources should be made available to them not only to cover the organizational expenditures but also initiate programmes and activities in order to achieve building sector transformation targets set for the country.

Taking into consideration the specificities of the country, the agency should design programmes that are well suited to the targeted beneficiaries and empower partners and stakeholders in making decisions at the decentralized level. For this to happen, the organization may need to be structured such that in addition to the head office conveniently located close to the central government, there may be satellite and branch offices located

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at the regional or local level (e.g. bigger cities) so that the decentralized units are closer to the local stakeholders and have a better grasp or feel of the local requirements. They will then be able to develop programmes that are in line with the national objectives while meeting specific local requirements. Through active interaction with the local decision-makers and through the consultation process, the local counterparts of the organization can leverage budget and funds, including those from private players, with national budget allocated specifically for green building promotion.

The organization responsible for promoting sustainable buildings can be structured such that it has units to set target, plan, implement, and monitor the outcome. On the other hand, it is also useful to have thematic groups that are specialized and are focused on specific policy instruments targeted to overcome typical barriers to sustainable buildings: awareness and sensitization, advice and capacity building, market transformation, innovative financing, and legislation and regulation.

### 5.3. STEPS FOR THE SMOOTH EXECUTION OF SUSTAINABLE BUILDING STRATEGY

Building energy efficiency policy design involves reviewing of barriers, identifying policy options to address barriers, documenting best practices and selecting those that are well suited to the national context, evaluating policies options by assessing the economic, social and environmental effectiveness of policy instruments, and securing high-level endorsement.

The following steps are recommended for the smooth execution of the sustainable building strategy and action plan:

- Selecting the most suitable target(s)
- Defining tools and instruments for effective implementation of a specific activity.
- Establishing institutional partnership and stakeholder engagement for better success
- Allocating adequate human and financial resources and exploring ways and means to leverage funds from partners and stakeholders.
- Monitoring and evaluation in order to assess the success and drawbacks so that these factors can be taken into consideration in designing the next cycle of green building promotion.

One of the most critical factors for the success of the programme is the manner in which the mandated organization engages partners and involves stakeholders in various activities aimed at removing barriers to the development of green buildings. While some activities are to be performed in a completely unbiased and business-free environment in order to raise the confidence of target beneficiaries, other activities will need to be performed in a full-business environment.

For example, awareness and sensitization as well as advice and capacity-building activities have to be conducted such that information or advice remains unbiased and factual without any exaggeration. Accordingly, due care should be taken to avoid engaging partners who may have vested interests. On the other hand, activities related to market transformation and innovative financing are aimed at making energy efficiency a business case. In this case, it is crucial to forge partnerships and involve stakeholders who understand the market well and are willing to take financial risks to some extent, with the knowledge that state support is extended to minimize perceived risks.

Analysis of building energy efficiency policies of many industrialized and developing countries shows the inconsistency of institutional commitment to energy efficiency over a sufficiently long time frame. Some of the reasons for this are large fluctuations in international energy prices over time or lack of patience and foresight of public decision makers who expect quick results from building energy efficiency actions. In such cases, the results fall far below their expectations because market players are not willing to participate in green building initiatives if they do not see long term signals from the government.

National decision-makers should therefore be patient and willing to provide sustainable institutional support and commit themselves to take up the challenge over much more than just one cycle of building energy efficiency implementation.

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Lastly, building energy efficiency movement can get a big boost and momentum through better sharing of knowledge and best practices among countries. Regional and international cooperation is therefore essential to accelerate the implementation of building energy efficiency actions in individual countries and save resources by learning from the experience of countries that have taken a lead in this domain.

Regional cooperation can accelerate the energy efficiency movement through dialogues to identify policies and measures that have been tested and successfully adopted in individual countries and have the potential to be replicated within the same economic region. Such initiatives can help in more effective dissemination of information, experiences and good practices related to regulations, market transformation, education, capacity building, etc. This can lead to the introduction of common policies and measures in countries within the same economic zone and avoid the need to “reinvent the wheel”.

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## 6. GOOD PRACTICES AND CASE STUDIES

### 6.1. ENERGY CONSERVATION BUILDING CODES AND STANDARDS

#### 6.1.1. BACKGROUND

The energy efficiency of new buildings determines the building sector's energy consumption for far longer than any other end-use sector components determining their sector's efficiency. Buildings will typically be constructed to be used for several decades. The capital lifetime for efficiency improvement of other energy end uses will be, at most, a few decades. Improvement of buildings' efficiency at planning stage is relatively simple while improvements after their initial construction are much more cumbersome and sometimes impossible.

#### Main Attributes of Building Energy Consumption

- Building Envelope (Walls, Roofs, Windows)
- Lighting (Indoor and Outdoor)
- Heating Ventilation and Air Conditioning (HVAC) System
- Service Water Heating and Pumping
- Electrical Systems (Power Factor, Transformers)

By reducing buildings' energy consumption, a nation can reduce dependency on imported energy and strengthen its strategic position. Moderation of energy-end use in buildings will also reduce greenhouse gas emissions and pollution derived from the combustion of fossil fuels. This environmental benefit appears on two scales, local and global.

#### 6.1.2. ENERGY EFFICIENCY STANDARDS FOR BUILDINGS

Buildings account for about one-third of worldwide energy consumption, and much of this consumption footprint is locked in through the building design and construction. Building energy standards are therefore important tools to improve energy efficiency in new buildings. For example, In the United States, building energy codes save over \$1 billion in energy costs per year, and this figure is growing.

Denmark was among the first countries to adopt comprehensive building energy codes in 1961, and since then it has seen average household energy consumption per unit of space drop substantially. Building energy standards set requirements for energy efficiency. Standards vary between countries in several respects including the extent of their coverage, the specific requirements, means of attaining compliance and the enforcement system (some countries refer to their building energy regulations as codes and others call them standards).

Though most energy efficiency requirements in building codes have been developed to suit the local region, the past decade has shown a trend in supranational collaboration to develop international energy efficiency requirements or standards. Examples are the US based Energy Efficiency standards (IECC 200415 and ASHRAE 200416) which are used in US and Canada, and the European Energy Performance in Buildings Directive (EPBD) that requires member states of the European Union to establish requirements for energy efficiency in new buildings, effective from January 2006. To supplement the EPBD, the European Union aims to establish a model building code for energy efficiency for the European region (2006 EU Action Plan for End-use Efficiency) and to develop European standards set by European Committee for Standardization (CEN) for energy performance calculation. These CEN standards are on the way to be amended and adopted as ISO standards too. Building Codes for Energy Conservation and rationale use of energy have been developed by many countries such as US, EU, Japan, etc.; however there are only a few countries such as Sweden and Germany that have adopted mandatory regimes.

If the rate of heat loss or the so-called U values set by the member states of the European Union are compared with the least cost optimum over 30 years for the different types of energy efficiency requirements in the building regulation, then these requirements are shown to be quite far from this optimum.

There is a big difference in how close the values in the building codes are to the least cost optimum. Only a few countries have values, which are close to these values. Additional savings from reduction of heating and cooling installations not are included in the calculation.

### 6.1.3. BEST PRACTICE EXAMPLE OF BUILDING CODE IN SWEDEN

Sweden has very long tradition of energy efficiency requirements for new buildings. Already in the late 1970s stringent requirements was introduced in Sweden. Although they have only been slightly changed over time they are still today among the highest energy efficiency requirements in the world.

| Building Code in Sweden | South (U-value W/K per m2) | North (U-value W/K per m2) |
|-------------------------|----------------------------|----------------------------|
| External Walls          | 0.13-0.14                  | 0.12-0.13                  |
| Ceilings / roofs        | 0.15                       | 0.13                       |
| Grown deck              | 0.16                       | 0.13                       |
| Floors with heating     | 0.12                       | 0.10                       |
| Floor over open air     | 0.10                       | 0.08                       |

Source : IEA Report on Building Codes for G8 Plan of Action

The Swedish building regulation requires that individual values depend on the type of construction, and where the building is located. All of the values for efficiency are high and comparable with the values for passive houses in central Europe.

Rules are set for ventilation and other thermal comfort and for efficiency in installed products, such as boilers and air conditioners. At the same time, values are set for the overall energy performance and consumption of the building. Values depend on whether the building is in the north or south of Sweden with different values for commercial and residential buildings.

### 6.1.4. GUIDE TO BUILDING ENERGY STANDARDS AND CODES AROUND THE WORLD

This section gives a quick preview of the building energy standards and codes adopted by a selected number of countries around the world.

| Guide to Building Energy Standards and Codes Around the World |  |
|---|--|
| Country   | Standards (Most are Voluntary)   |
| Australia   | Building Code of Australia 2007 (BCA)  |
| Canada  | 1. Model National Energy Code of Canada for Buildings 1997 (MNECB)<br>2. Model National Energy Code for Houses 1997 (MNECH)  |
| China   | 1. Energy Conservation Design Standard for New Heating Residential Buildings 1995<br>2. Design Standard for Energy Efficiency of Residential Buildings in Hot Summer and Cold Winter Zone 2001<br>3. Design Standard for Energy Efficiency of Residential Buildings in Hot Summer and Warm Winter Zone 2003<br>4. Design Standard for Energy Efficiency of Public Buildings 2005 |
| India   | Energy Conservation Building Code 2007 (ECBC)  |
| Japan   | 1. Criteria for Clients on the Rationalization of Energy Use for Buildings 1999 (CCREUB)<br>2. Design and Construction Guidelines on the Rationalization of Energy Use for Houses 1999 (DCGREUH)<br>3. Criteria for Clients on the Rationalization of Energy Use for Houses 1999 (CCREUH)  |
| Republic of Korea   | 1. Building Design Criteria for Energy Saving 2008 (BDCES)<br>2. Rules for Building Facility Criteria & Otherwise 2008 (RBFCO)   |
| USA   | 1. International Energy Conservation Code 2006 (IECC)<br>2. ASHRAE Standard 90.1 - Energy Standard for Buildings except Low-rise Residential Buildings 2007 (ASHRAE 90.1)  |



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### 6.1.5. PROMOTION OF ENERGY EFFICIENCY IN NEW CONSTRUCTION

Many means to save energy in new buildings also offer the potential to save money. Individual homeowners and building users investing in energy efficiency will often recover costs in a short period through lower energy expenses. This “payback time” on energy efficiency investment can be as short as a few years. These energy savings are similarly profitable from the macro-economic perspective of national policy. Increased efficiency in new buildings is hence profitable for individual building owners and society as a whole.

In many developing countries, new constructions account for a larger share of buildings. In these countries, such as China and India, energy savings through energy efficiency in new buildings will have a larger and faster impact on the economy and result in larger savings than in OECD countries. Many countries have developed a building energy or integrated sustainable resources usage rating and labelling systems. These ratings are given in order to recognize best practices and incentives for leadership in sustainable practices in new buildings.

#### Energy Star Positive Labelling

For many countries in the European Union a level beyond the building code is defined as a part of the certification of new buildings, which has to be implemented as part of the Energy Performance in Buildings Directive. Typical specific classes such as A or B on a scale from A-G or A+ and A++ are used to indicate that these buildings are constructed better than the standard. Some countries have used a large part of the scale or even the whole scale to show the difference in new buildings using all the letters from A-G to classify new buildings.

In Germany, Austria, Denmark and Switzerland, special standards exist for low energy buildings. Niedrigenergiehäuser (G, Au) 30 W/m<sup>2</sup> per year, Minergie (Sw) 42 W/m<sup>2</sup> per year of heat demand for space heating and sanitary hot water and Low Energy Class 1 on 50 per cent and 2 on 25 per cent reduction of the energy needs in the building code (Denmark).

In Australia and India different stars are used to show the efficiency of buildings. As many as 5 stars are awarded for maximum energy efficiency. With the increase in energy efficiency requirements over time, the minimum requirements in the state of Victoria are equivalent to 5 stars. In the US a label called ENERGY STAR is used for buildings which use 15 per cent less energy than the requirements in efficiency standards for new buildings as defined by ASHRAE and IECC 2004.

#### Concept of Zero Energy Buildings

Zero Energy Buildings do not use fossil fuels but only get all their required energy from solar energy and other renewable energy sources. Zero Net Energy Buildings are buildings are energy-neutral, meaning that they deliver as much energy to the supply grids as they use from the grids. Seen in these terms they do not need any fossil fuel for heating, cooling, lighting or other energy uses although they sometimes draw energy from the grid.

### 6.1.6. BUILDING ENERGY AND ENVIRONMENTAL PERFORMANCE CERTIFICATION

In US and Canada a specific standard LEED (Leadership in Energy and Environmental Buildings) is adopted, setting the requirements for the buildings to fulfil. The LEED standard can be obtained on different levels: Certified, Silver, Gold and Platinum with increasing adherence to the different requirements for the building. The LEED standard is set and controlled by the US Green Building Council, USGBC.

The LEED standard includes Sustainable Sites, Water Efficiency, Energy and Atmosphere, Material Resources, Indoor Climate, Innovation and design. Energy and Atmosphere are the most important criteria for the buildings, but there are many other criteria which give the possibility of earning points too. In connection to the LEED buildings ASHRAE is developing a special standard for the Design of High-Performance buildings. This will lead to further stringency of the LEED requirements in US.

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Canada has established its own LEED standards which is set and controlled by the Canadian Green Building Council (CaGBC). There are other Green Building Rating Systems, including the Japanese CASBEE system. In India GRIHA is one of the rating systems used for total resources used in a building. The World Green Building Council assures the coordination and sharing of information between the different Green Buildings organizations around the globe.

## 6.2. ENERGY PERFORMANCE CERTIFICATION OF BUILDINGS

### 6.2.1. INTRODUCTION

Energy performance certification is a key policy instrument for lowering the energy consumption and improving the energy performance of buildings. It is aimed at addressing two critical market failures: inadequate or inaccurate information of the energy consumption of a building, and the split-incentive or the landlord-tenant problem. It provides an indication of the level of energy consumption and energy efficiency rating of individual buildings, expressed in terms of the amount of energy required to provide the user with expected degrees of comfort and functionality.

Certification can be useful for new as well as existing buildings and can help in transforming real estate market. It is an effective public awareness tool, informing prospective buyers and tenants the expected running cost of a building and comparing it with the energy rating of a range of similar buildings. It indicates if a new construction complies with the national building energy codes. It also provides an incentive for achieving a better performance in comparison with same type of buildings.

For existing buildings, it indicates the energy performance and provides information that is useful for creating demand for more efficient buildings, thus acting as a prerequisite for improving the energy efficiency of the existing stock of buildings. Those who are planning to buy or rent a property can make an informed decision and select a building that allows them to save on energy bill. Owners intending to give the building on rent can identify cost-effective measures and invest for improving the building's energy performance.

Finally, certification can also serve as a technical basis for providing incentives, imposing penalties or initiating legal proceedings.

### 6.2.2. STEPS TO PREPARE AN ENERGY CERTIFICATE

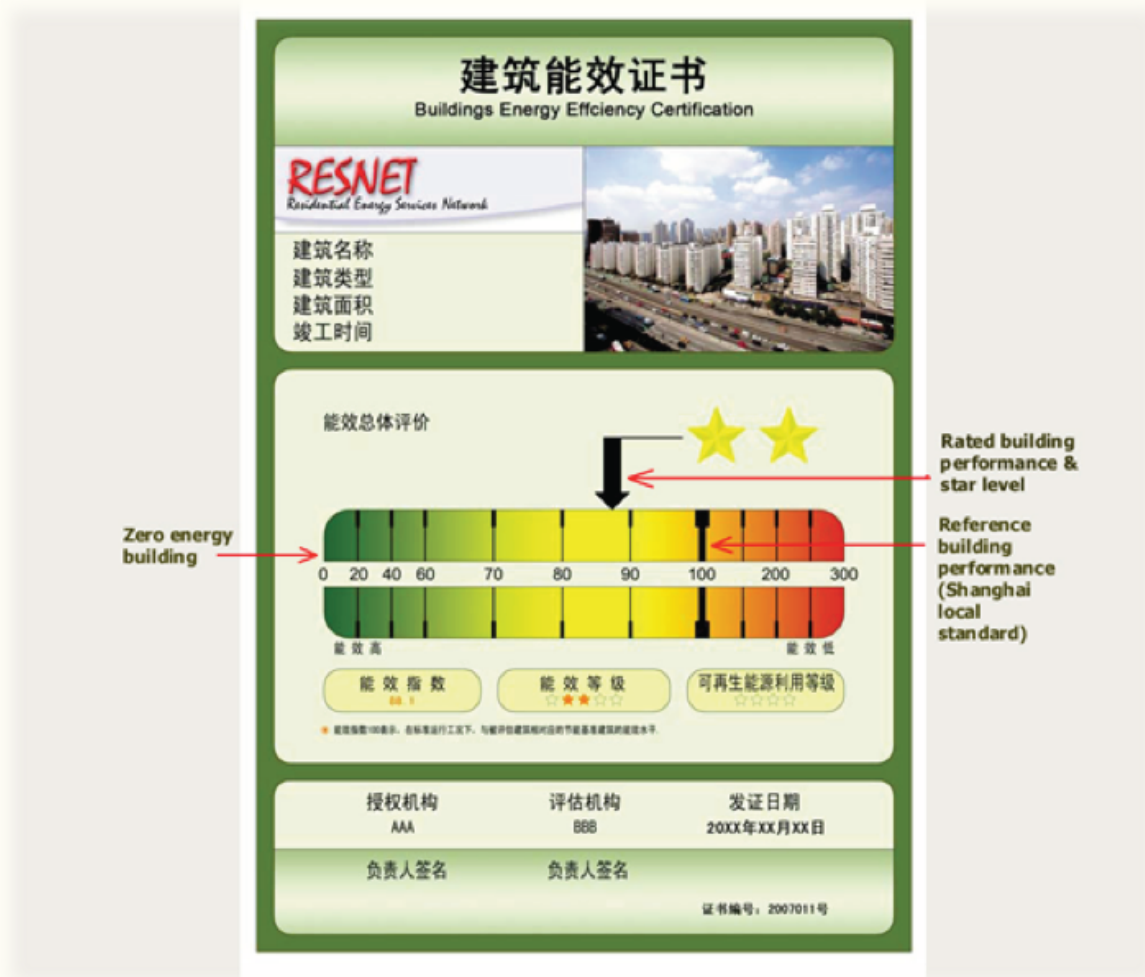
Certification is a complex procedure that requires very good knowledge of the building components and the integrated systems because the degree of efficiency depends on a number of parameters such as the local climate, design of the building, materials used and the method of construction, systems employed to provide heating, ventilation, air conditioning or sanitary hot water, equipment and appliances needed to support building's functions.

Three important steps in the preparation of an energy certificate include the assessment of the energy performance of a building using an agreed methodology, issuance of a certificate rating the building's energy performance, and communicating the information to stakeholders through publication of the certificate.

The energy performance assessment of a building is normally conducted by a qualified assessor who considers the building's characteristics and components, energy systems, and energy consumption. The information gathered is used in a standard calculation model or software tool that derives the building's energy consumption under local climatic conditions, typically expressed in (kWh/m<sup>2</sup>.year), or/and related CO<sub>2</sub> emissions, measured in (kgCO<sub>2</sub>/m<sup>2</sup>.year). An energy benchmark calculated for the specific building is used as a yardstick to determine the energy efficiency grade of the building. Further, the energy supplied is broken down by end use. The potential energy efficiency measures are identified and cost-benefit analyses are done to prioritize the measures and calculate the scope for the building to improve its energy efficiency grade. The above findings are reported in the energy certificate.

Figure 13 shows an example of building energy certification developed by RESNET (Residential Energy Services Network) for China. The star-based rating system gives a single star to the building that complies with the existing building code. The most energy-efficient building can earn up to 5 stars.

**Figure 13. Example of building energy certificate developed by China (the label shows the performance and star level of a particular building located in Shanghai)**



### 6.2.3. EXAMPLES OF BUILDING ENERGY CERTIFICATION INITIATIVES

Building energy certification can be either mandatory or voluntary. The mandatory certification scheme is more complex and costly to implement but it ensures greater energy savings. As it covers all buildings, it helps to identify the share of energy-inefficient building stocks and provides guidance on how to improve the energy rating of energy-inefficient buildings.

The European Union adopted the Energy Performance of Buildings Directive (EPBD) in December 2002, setting 4 key energy efficiency requirements for buildings, including the system for the energy certification of new and existing buildings, and large existing buildings intending to undertake renovation. European building energy certificates are designed to push for performance that surpasses building codes and standards. According to the Directive, it is mandatory to have energy performance certificates when buildings are constructed, sold or rented. Moreover, large public buildings must be certified regularly every 10 years and are required to display the energy performance certificate. Denmark has taken a further step by mandating all buildings greater than 1000 m<sup>2</sup> to have the certification updated every 5 years. A recast adopted in May 2010 broadens the scope of the Directive by demanding that all existing buildings undergoing major renovation should meet certain energy efficiency criteria. Additional savings expected from this latest initiative are expected to result in 5 to 6 per cent reduction of EU energy consumption.

The Energy Star is a voluntary scheme developed by the US Department of Energy (DOE) and is awarded to new buildings with energy performances that exceed the 2006 IECC Code by at least 15 per cent. Subsidies and tax exemptions have helped Energy Star to play an important role in energy markets towards higher energy efficiency.

Energy Stars are also used in labelling scheme to highlight the energy efficiency of buildings in some parts of Asia, such as Australia, China, and India. The Bureau of Energy Efficiency under the Indian Ministry of Power has introduced a national star-rating program to ensure that energy-efficient commercial buildings are well recognized. The star ratings are based on the actual energy performance of buildings, measured in kWh/m<sup>2</sup>.year, and adjusted to three different climatic zones.

The Building Construction Authority (BCA) of Singapore has developed BCA Green Mark which includes the following criteria: energy and water use, indoor air quality, and other types of environmental impacts. BCA Green Mark is supported by the National Environment Agency and is applicable to new residential and commercial buildings. There is also a special version for labelling existing buildings too. Singapore also has another energy certification scheme for commercial buildings, known as Energy Smart. The certification is undertaken with an Energy Smart Tool developed by the Energy Sustainability Unit at the National University of Singapore and the National Environment Agency of Singapore. This certification allows building owners to assess the efficiency of their buildings and only 25 per cent of the best buildings in each category are awarded a smart label which can be used in the branding of companies.

There are other types of building certification that go beyond energy by incorporating life-cycle cost analysis, environmental quality and other environmental issues. Some of the well-known whole-building qualitative but voluntary assessment schemes include Leadership in Energy and Environment Design (LEED) in the USA, Building Research Establishment Environmental Assessment Method (BREEAM) in the UK, GBTool in Canada, Comprehensive Assessment System for Built Environment Efficiency (CASBEE) in Japan, etc. There is presently a wide network of National Green Building Councils around the world to initiate green building certification.

Finally, there is an International Green Construction Code (IgCC) developed in 2009 by the International Code Council (ICC) focused on new and existing commercial buildings.

#### 6.2.4. POLICY PATHWAY TO DELIVER EFFECTIVE ENERGY CERTIFICATION

Based on experiences of selected countries, the International Energy Agency (IEA) has outlined 4 stages, 10 critical elements and 38 steps for the successful and cost-effective implementation of building energy certification. These are summarized below (IEA 2010):

| PHASES | CRITICAL STEPS                                | STEPS  |
|--------|---|--|
| PLAN   | 1. Define terms of reference                  | <ol style="list-style-type: none"> <li>1. Define objectives in relation to targets, local requirements, and existing codes and standards.</li> <li>2. Determine the scope in terms of type of buildings, and number of new and existing buildings.</li> <li>3. Determine the appropriate method of assessment depending upon scope, targets and approach.</li> <li>4. Decide whether to include other environmental issues.</li> </ol> |
|        | 2. Establish policy framework and action plan | <ol style="list-style-type: none"> <li>1. Determine if scheme will be voluntary or mandatory.</li> <li>2. Develop a comprehensive action plan and establish an implementation group.</li> <li>3. Involve all stakeholders at an early stage.</li> <li>4. Set a realistic time frame for implementation.</li> <li>5. Adopt the action plan and stick to it.</li> </ol>  |
|        | 3. Secure the necessary resources             | <ul style="list-style-type: none"> <li>• Develop a comprehensive administrative system with integrated data collection capabilities.</li> <li>• Assess institutional capacity.</li> <li>• Allocate financial and human resources.</li> <li>• Test systems and processes in advance of launch.</li> </ul>   |

| PHASES    | CRITICAL STEPS                          | STEPS   |
|-----------|---|---|
| IMPLEMENT | 4. Provide for training                 | <ul style="list-style-type: none"> <li>• Develop a training strategy at the earliest possible stage.</li> <li>• Assess capabilities of existing professionals, and of existing training accreditation systems and programmes.</li> <li>• Demand high pre-qualification standards for assessors and establish an appeal system.</li> <li>• Retain control of training modules and materials, and of examination and registration processes.</li> <li>• Ensure sufficient assessors are trained before launching the certification scheme.</li> </ul> |
|           | 5. Raise awareness                      | <ul style="list-style-type: none"> <li>• Ensure all stakeholders have access to relevant information.</li> <li>• Develop ongoing information campaigns that target the general public.</li> </ul>   |
|           | 6. Collect, review and disseminate data | <ul style="list-style-type: none"> <li>• Collect data centrally in a comprehensive administrative system.</li> <li>• Use the data to monitor and review the certification process.</li> <li>• Review data and use to foster greater overall energy efficiency.</li> </ul>   |
| MONITOR   | 7. Assess quality and compliance        | <ul style="list-style-type: none"> <li>• Develop an overall quality assurance approach to include training and national examinations, validation of certificates and auditing processes.</li> <li>• Establish a comprehensive quality assurance system including complaint and appeal procedures.</li> <li>• Develop an initial auditing system within the centralized administration system.</li> <li>• Train specialists to undertake desk reviews and practice audits.</li> <li>• Provide support for assessors.</li> </ul>                      |
|           | 8. Communicate the results openly       | <ul style="list-style-type: none"> <li>• Communicate both positive and negative results to retain confidence in the certification scheme.</li> <li>• Translate energy savings into cost savings so that stakeholders can readily understand the benefits.</li> <li>• Communicate openly any weaknesses or errors uncovered through auditing.</li> </ul>   |
| EVALUATE  | 9. Evaluate the scheme continuously     | <ul style="list-style-type: none"> <li>• Undertake continuous evaluation to ensure high quality and compliance with national buildings regulations.</li> <li>• Maximize the benefits through revisions of the scheme.</li> <li>• Adapt calculation methodologies to integrate stricter building standards.</li> </ul>   |
|           | 10. Adapt the scheme as                 | <ul style="list-style-type: none"> <li>• Link the certification scheme to other energy efficiency policies for buildings.</li> <li>• Consider implementing life-cycle assessments to determine the full impact on energy use or emissions (carbon footprint).</li> <li>• Assess the possibility to include other environmental effects on energy, water and land use, global warming and ozone depletion, toxic emissions (to air, land and water), and the impact on human health (environmental footprint).</li> </ul>                            |

### 6.2.5. PROMOTION OF ENERGY EFFICIENCY IN NEW CONSTRUCTION

The energy certification process will lead to more accurate energy data of buildings, assisting in the development of future policy to improve energy efficiency in the building stock. It can help governments achieve national energy targets and enhance economic, social and environmental sustainability in the buildings sector. Often, certification is most successful when complemented with other initiatives that support energy efficiency such as financial incentives and building codes.

## 6.3. APPLIANCES STANDARDS AND LABELLING \*\*

### 6.3.1. BACKGROUND

Energy Efficiency Standards and labelling program (SLP) is one of the most effective policy tools to improve energy efficiency at end use, reduce GHG emissions and can be integrated as a part of the national standards. The program has the potential of overcoming information asymmetry as well as high first-cost barrier usually associated with high-efficiency equipment. It is aimed at rapidly accelerating the adoption and implementation of energy standards and labels, and in doing so, bringing about energy savings from the use of energy efficient appliances/equipment.

The informative labels provide a simple tool to spread awareness about the higher efficiency and therefore lower operational costs of consumers. A robust SLP backed by a strong awareness programme could overcome the high first-cost barrier and help accelerate market transformation. The Standards and Labelling Program (SLP) provides for comparative pictorial labels, based on energy consumption standards and, after testing and certification on each equipment/appliance. Further these standards are dynamic which are improved in a pre-defined period.

#### Definition of standards and labels

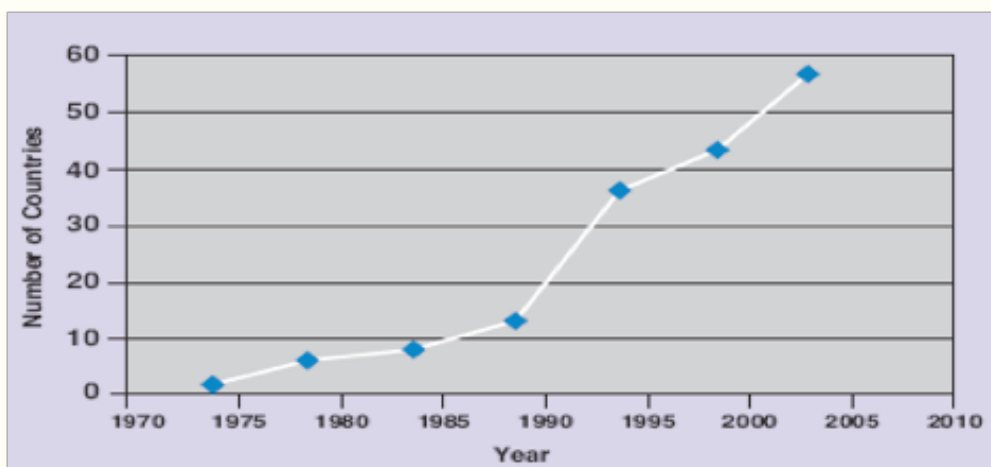
**Standards:** Energy-efficiency standards are procedures and regulations that prescribe the energy performance of manufactured products, sometimes prohibiting the sale of products that are less energy efficient than the minimum standard, often called Minimum Energy Performance Standards (MEPS).

**Labels:** Energy-efficiency labels are informative labels affixed to manufactured products to describe the product's energy performance (usually in the form of energy use, efficiency, or energy cost); these labels give consumers the data necessary to make informed purchases.

### 6.3.2. STANDARD AND LABELLING PROGRAMME WORLDWIDE

This is usually a government-run program to create demand for higher efficiency appliances and also enforce efficiency standards. Most Governments propose voluntary labelling by the manufacturers before going into mandatory phase.

**Figure 14. Energy-efficiency labels and standards (Source: CLASP)**



\*\* This section is based on information and data available from the following sources:

1. CLASP ([www.clasponline.org](http://www.clasponline.org)) – The Collaborative Labelling and Standards Program.
2. Bureau of Energy Efficiency – [www.beeindia.in](http://www.beeindia.in)
3. IPEEC (International Partnership for Energy Efficient Countries) – [www.ipeec.org](http://www.ipeec.org)
4. Energy Conservation Center of Japan - [http://www.eccj.or.jp/top\\_runner/](http://www.eccj.or.jp/top_runner/)



Figure 14 shows how the standards and labelling program has been used by a large number of countries and is also being upscaled by a great number of countries today as it is being recognized as a very strong policy tool for achieving energy efficiency. The program, initiated in a few developed countries as a response to the first oil crisis in 1973, has gained momentum since 1990s.

### 6.3.3. GLOBAL SAVINGS FROM STANDARD AND LABELLING PROGRAMMES

The total potential for emissions reductions in the building sector globally is assessed as follows:

EES&L programs would save 1,339 TWh of electricity and 388 TWh of fuels per year by 2020, and 3,860 TWh of electricity and 1,041 TWh of fuels by 2030. EES&L programs would reduce cumulative CO<sub>2</sub> emissions from 2010 through 2030 by a total of 21.3 Gt, which is 85 percent of the total estimated global energy related emissions for 2005. In the residential building sector, potential emissions reductions from EES&L are large enough to level that sector's emissions by 2015, and reduce them after about 2020, bringing the emissions of the world's homes almost back to 2005 levels by 2030. In the commercial building sector, EES&L programs would likely level growth, but not reverse it (CLASP).

### 6.3.4. VARIOUS STANDARD AND LABELLING PROGRAMMES

There are mainly 2 types of labels that are used around the world for distinguishing energy efficient appliances in the end use sector. They are as follows:

**Endorsement Label:** These labels are awarded in the case where the appliances have to comply with a standard benchmark. If the tested equipment meets the required standards it is awarded an endorsement label. Usually such labels just indicate that the product is efficient. However, there are no further details of the program. It is a useful tool to provide simple choice to consumers. One the most famous programs in the world for endorsement labelling is the ENERGY STAR program of USA, which can be seen on most of the consumer electronics items.

Figure 15. Energy Star Endorsement Label



**Comparative Labels:** These labels are basically used to compare the energy efficiency of one appliance of a particular make with that of another. This is one of the most famous types of labels that are used around the world; it also includes the key details of the product in the label so that it allows the consumer to make an informed decision. The disadvantage for this type of labelling is that comprehensive media awareness is to be created in order to disseminate the correct message.

Figure 16. Comparative Labels of India and Thailand



The labels represent the standards that are met by the particular appliance/product.

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### 6.3.5. DIFFERENT REGIMES OF STANDARD AND LABELLING PROGRAMMES

There are different regimes adopted by governments around the world for setting standards and for their monitoring and evaluation. For the standards setting, governments usually follow a process of consensus and negotiation of standards that the industry can meet with reasonable increase in prices. Efficiency standards are kept usually as voluntary targets, and as the market transformation proceeds and the market is mature for such standards, they are introduced as standards. The European Union has had a very strict standards setting procedure for the last 14 years; manufacturers have an association called CECED, which represents the industry for policy and regulatory negotiations with the EU. THE CECED plays a very active role in getting the industry prepared for the next tier of techno-economically viable options for standards and it also conducts its own compliance monitoring program other than the compliance program of the member EU countries.

Standards that are set around the world are based on detailed market survey and research, appliances having the most impact and finding the techno-economically viable options for improving standards to be sold or procured in the market. Standards can be set using a top-down approach in which the reference point of technologies that are best in the market are taken for standards settings and reasonable time period is provided for manufacturers. This approach has been made famous by Japan and is known as the "Top Runner Program". Usually the trend is to take the top 25 per cent performers of the market in terms of energy performance and then standards are set through a series of techno-economic analysis and period of initiation. Some of the major characteristics of the Top Runner Program of Japan are:

- Top Runners set standards take into technological consideration as the potential.
- Standards are set on appliances parameters and for comparison.
- The compliance is through the corporate average rather than a per product compliance. This means that the weighted average of the efficiency of products sold in the market by a manufacturer is taken. Hence all products may not comply with the standard; however the weighted average should meet the standard. This gives flexibility to manufacturers due to manufacturing and market deviations.
- Usually adopted by mature and saturated markets.

The other recognized approach is the bottom-up approach in which standards are carefully planned by keeping the technology or international standards in mind. It is mostly a tier-based approach to reaching these standards so as to mitigate the effect of inflated prices of better products and technology. Usually this is used by countries where the SLP and the industry are not that mature, however they want to achieve best international standards. For example, this is the approach that was adopted by India in 2006: the government announced the voluntary SLP program for Air Conditioners and Refrigerators and the goal was to reach standards of Australia, China and US by 2012- 2014. The MEPS concept was introduced as voluntary in 2006 and was made mandatory in 2010 for household refrigerators, air conditioners, distribution transformers and tubular fluorescent lamps.

Following are some of the salient features of the Indian SLP:

- Standards and Labels are formed in discussions with the industry and are introduced as part of the voluntary labelling program.
- Once the market matures, the mandatory labelling procedure is notified by the government.
- The compliance is verified in the voluntary as well as mandatory regime with samples picked up randomly from the market for verification of label claims.

### 6.3.6. KEY FACTORS FOR EFFECTIVE PROGRAMME IMPLEMENTATION

It has been seen that SLP is a very effective tool for demand side management (DSM) used by the government in which the consumers is influenced to use energy efficient products. However there are various other policy options and key factors that can have an impact on the SLP. In order to demonstrate commitment to energy efficiency, various governments have made mandatory public procurement for their offices and services as per higher standards and labels of that country. Since most of the governments procure on a least-cost basis, the concept of life cycle cost is used to justify higher priced efficient appliances.

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The need for a strategic and prolonged consumer and media campaign for SLP is sometimes the backbone of the program as many countries have illustrated that the program's success is linked with it. Many Utilities have initiated efficient appliances replacement program in which SLP plays an integral part to identify and promote efficient appliances. Such program helps Utility to reduce the peak demand in different sectors and also can leverage financial mechanisms such as the Clean Development Mechanism (CDM).

### 6.3.7. THE FUTURE OF STANDARD AND LABELLING PROGRAMMES

With the urgency in international efforts towards clean and efficient technologies, The US through IPEEC (International Partnership for Energy Efficient Countries) has established a Super Efficient Appliance Deployment (SEAD) Program in which it seeks to transform the global market for high efficiency equipment and appliances-reducing energy consumption while simultaneously saving money for consumers.

SEAD's partner governments are working together to initiate voluntary activities for accomplishing the following:

- Raise the efficiency ceiling by pulling super-efficient appliances and equipment into the market through cooperation on measures like awards, procurement and incentives.
- Raise the efficiency floor by bolstering national or regional policies, like standards and labelling programs.
- Strengthen the foundations of efficiency programs by coordinating technical work to support these activities (Source: Clean Energy Ministerial).

This embarks the goal for higher efficiency appliances deployment other than SLP initiative, which cannot take place in a business as usual market.

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## 6.4. PASSIVE HOUSES

### 6.4.1. BACKGROUND

The passive house is a construction concept that is more than just a low-energy building. Passive design does not require mechanical heating or cooling which helps to make buildings comfortable, affordable and sustainable. Passive design can reduce the heat load in a room by more than 90 per cent with appropriate design of building envelope (roofs, walls, window, floor, etc.). Any competent architect can design a passive house by combining individual measures suitable to the local climate and guarantee multiple benefits in terms of affordability, comfort, quality, and ecology.

Unfortunately the era of cheap oil, easy availability of electricity and modern devices for heating, cooling and lighting have been detrimental to the cause of passive building design. As new technologies get introduced and people get wealthier progressively, there is a great emphasis on adopting mechanical methods to achieve human comfort. In most parts of Asia, air conditioning is now widely used and accepted, but houses are not designed to minimize the heat gain and to use air conditioning effectively. This can be noted by the fact that the moment the air conditioning system is switched off in majority of the modern air conditioned buildings, the occupants start feeling the discomfort almost immediately. Though architects learn about passive building design principles and practices in their formative years, majority of them hardly apply them in practice, putting greater emphasis on the modern materials and building aesthetics.

### 6.4.2. WHY CONSTRUCT PASSIVE HOUSES?

Passive buildings are affordable to construct and save money over their life time. Investments made on designing and the higher quality building components are largely offset by avoiding the need for investment in expensive active (heating/cooling and lighting) systems. Passive buildings are designed and are constructed at a reasonable cost to provide higher degree of comfort during both cold and warm months. Depending on the location and climatic context, passive houses are designed to minimize heat losses/gains and ensure a higher level of quality and comfort for end-users.

In cold climates, passive houses use solar passive designs, insulation, heat recovery, highly insulating windows, and other measures. In hot climates, passive buildings use solar protection through shading devices, proper size and quality of windows and the building's thermal mass to avoid the penetration of heat into the building during the day time when the ambient temperature rises.

The embodied energy associated with the materials needed to construct a passive building is quite insignificant in comparison with the energy that is saved over the building's life time operation. Thus passive houses are energy-frugal, leaving sufficient energy resources for all future generations without causing any environmental damage.

### 6.4.3. DESIGNING FEATURES OF PASSIVE HOUSES

Passive houses are designed to suit the local climate. Climatic zones can be classified into specific categories such as hot and dry, warm and humid, moderate, cold and composite. The types of simple and practical passive design features that buildings can adopt to suit the local climatic zone in order to make structures energy-efficient are described below (MNRE & TERI, date unknown).

#### Passive building design features for hot and dry climate:

- Appropriate building shape and orientation
- Insulation of building envelope
- Massive structure
- Air locks, lobbies, balconies, and verandas
- Weather stripping and scheduling air changes
- External surfaces protected by overhangs, fins, and trees

- 
- Pale colours and glazed China mosaic tiles
  - Windows and exhausts
  - Courtyards, wind towers, and arrangement of openings
  - Trees, ponds, and evaporative cooling

#### Passive building design features for warm and humid climate:

- Appropriate building shape and orientation
- Roof insulation and wall insulation
- Reflective surface of roof
- Balconies and verandas
- Walls with glazed surface protected by overhangs, fins, and trees
- Pale colours and glazed china mosaic tiles
- Windows and exhausts
- Ventilated roof construction, courtyards, wind towers, and arrangement of openings
- Dehumidifiers and desiccant cooling

#### Passive building design features for moderate climate:

- Appropriate building shape and orientation
- Roof insulation and east and west wall insulation
- Walls facing east and west, glazed surface protected by overhangs, fins, and trees
- Pale colours and glazed china mosaic tiles
- Windows and exhausts
- Courtyards and arrangement of openings

#### Passive building design features for cold climate:

- Appropriate building shape and orientation
- Use of trees as wind barriers
- Roof insulation, wall insulation, and double glazing
- Thicker walls
- Air locks and lobbies
- Weather stripping
- Darker colours
- Sun spaces, greenhouses and Trombe walls

#### Passive building design features for composite climate:

- Appropriate building shape and orientation
- Use of trees as wind barriers
- Roof insulation and wall insulation
- Thicker walls
- Air locks and balconies
- Weather stripping
- Walls, glass surfaces protected by overhangs, fins, and trees
- Pale colours and glazed china mosaic tiles
- Exhausts
- Courtyards, wind towers, and arrangement of openings
- Trees and ponds for evaporative cooling
- Dehumidifiers and desiccant cooling

## Method for investigating a Passive House solution

Everyone wishes to live in a comfortable indoor climate. No solution will last which does not contribute to a better indoor climate. Passive Houses should be well known as the most comfortable homes in any region and within all climates.

The solution should be simpler than what is presently used in conventional buildings and contemporary technical systems. Only affordable solutions will be attractive in comparison to customary technologies like air conditioning systems using forced air.

It is not necessary that the solution shift from conventional energy demands to solutions that might be very expensive, like the Zero Energy House. It is sufficient to minimize energy use with simple systems from conventional sources. As a general rule, if the energy consumption is between a tenth and a quarter of current consumption levels, the savings from conserved energy is enough to pay for the extra construction costs.

1. Use passive technologies such as insulation, shading, sub-soil heat exchangers and high efficiency appliances to reduce the peak load demand.
2. If comfortable indoor climate conditions differ greatly from outdoor conditions, use a ventilation system with energy recovery to maintain a high indoor air quality without the need of huge heating or cooling demands.
3. There will be a certain point in the cooling/dehumidification demand so that with lower demands, there will be an appreciable simplification of the active technology needed. This defines the Passive House Solution in your climate!

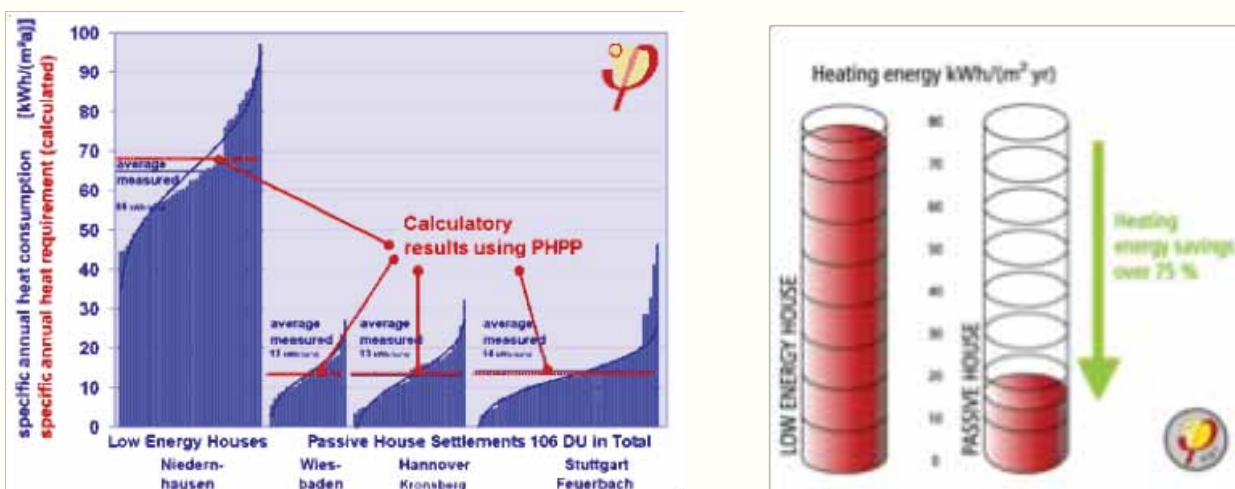
Source: Feist, Wolfgang et al (2004) Passive House Planning Package

### 6.4.4. SCOPE FOR SAVING ENERGY WITH PASSIVE HOUSES

Passive Houses allow for energy savings of up to 90 per cent compared with typical central European buildings and over 75 per cent compared with average new constructions (Passipedia.passiv.de). Passive Houses use far less fossil fuel for heating than typical low-energy buildings. Similar energy savings have been demonstrated in warm climates where buildings require more energy for cooling than for heating.

The vast energy savings in Passive Houses are achieved by using especially energy efficient building components (insulation, glazing, etc.) and a quality ventilation system. Figure 17 shows the consumption values measured in low-energy houses and in Passive Housing estates.

Figure 17. Energy consumption of low-energy houses and passive housing estates (source: <http://www.passiv.de/>)





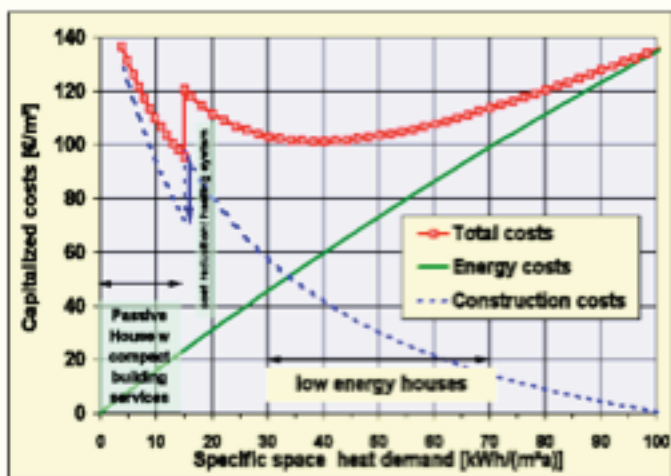
#### 6.4.5. PASSIVE HOUSE STANDARD AND ECONOMICS

Asian developing countries can learn from the initiatives taken by Europe to popularize passive houses. The European Parliament made a resolution on 31 January 2008 to implement the Passive Houses Standard as a sustainable construction standard by all member states by 2011. Further, the European Parliament and the Council decided in 17 November 2009 to set 2020 as a deadline for all new buildings to be nearly zero energy buildings.

The Passive House is the world leading standard in energy-efficient construction: A Passive House requires as little as 10 percent of the energy used by typical central European buildings – meaning energy savings of up to 90 percent. Owners of Passive Houses are barely concerned with increasing energy prices. Passive Houses require less than 15 kWh/ (m<sup>2</sup>yr) for heating or cooling (relating to the living space). The heating/cooling load is limited to a maximum of 10 W/m<sup>2</sup> and primary energy use may not exceed 120 kWh/ (m<sup>2</sup>a). Passive Houses must be airtight with just the required air change rates. In warmer climates and/or during summer months, excessive temperatures may not occur more than 10 per cent of the time.

As newer buildings are increasingly airtight, ventilation through joints and cracks alone is not sufficient to provide for fresh indoor air. Opening the windows as recommended is not adequate. Fresh air is not merely a matter of comfort but a necessity for healthy living. Ventilation systems are therefore the key technology for all future residential buildings and retrofits.

Let us compare the economics of a passive house in comparison that of a low energy house. The construction cost of the low energy house tends to increase as efforts are made to reduce its energy demand. There is always an economic trade-off where the total costs are found to be the lowest. However in the case of passive houses, when the demand for energy becomes very low, the cost of heating system reduces a lot. As a result, a house with passive design is able to achieve higher energy savings than a low energy house without necessarily incurring higher costs.



#### 6.4.6. STRATEGIES TO OVERCOME THE BARRIERS TO PASSIVE ARCHITECTURE

What actually are the main barriers to the adoption of passive architecture? While countries in the region are growing rapidly, the construction or building industry is not evolving or developing fast enough to factor in the many new technologies. If we compound this with the need to follow architectural trends set by developing nations without really understanding why certain movements or "styles" are adopted, then we have a major aesthetic and environmental problem.

The vernacular architecture has been developed over many centuries, therefore particularly fine-tuned to our climatic needs. Not only can it assist with modern passive techniques, but it can and should be applied directly at any available opportunity. There is therefore a pressing need for us to look at the traditional and vernacular designs that produced inherently low-energy buildings. Similar to the initiatives of Europe, we need to introduce passive houses standard according to the climatic zone and carry out sensitization and capacity building programs for all stakeholders associated with the building sector.

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## 6.5. STABILIZED EARTH ARCHITECTURE \*\*

### 6.5.1. BACKGROUND

Building with earth is nearly as old as man and earth as a building material has been used all over the world since millennia. According to UN-Habitat estimates, about 1.7 billion people around the world live in earthen houses, representing about half of the population in developing countries, and at least 20 per cent living in urban and suburban areas.

The world's oldest earthen building is about 3,300 years old: the Granaries of the Ramasseum in Egypt, which was built with sun dried bricks (adobes) by Ramses II during the 19th dynasty, around 1,300 BC. It can still be seen a few kilometres from the western shore of the Nile, opposite Luxor.

In India, the oldest earthen building is Tabo Monastery, in Spiti valley – Himachal Pradesh. It was also built with adobes and it has withstood Himalayan winters since 996 AD.

The Compressed Stabilized Earth Block (CSEB) is a new development since the 1950s, as it combines the ancestral techniques of sun dried brick and rammed earth.

The soil stabilized with either cement or lime is slightly moistened, poured into a steel press and then compressed either with a manual or motorized press. The stabilization with cement or lime allows the block to have a higher compressive strength and water resistance, and provides the scope for using thinner walls and building higher.



Ramasseum, Egypt, ~1300 BC



Tabo Monastery, HP, India, 996 AD

Africa has seen the widest development and implementation of CSEB since the 1960s. India and South Asia have also undertaken considerable research and development for the use of CSEB since the 1970s.

### 6.5.2. WHY CONSTRUCT WITH COMPRESSED STABILISED EARTH BLOCK (CSEB)

With the population growth in developing countries, there is a rising demand for housing which is highly energy intensive. As the era of cheap fossil fuel is behind us and we are increasingly aware of the adverse impacts of fossil fuels on the global environment, there is an urgent need to look for alternative construction materials that can meet the present challenges. The CSEB happens to be one of those construction materials that promise huge benefits to all. Some of the unique features of CSEB are elaborated below:

- **CSEB allows local resource management:** Ideally, CSEB is produced at the construction site or in surrounding areas. Thus, it will save transportation, fuel, time and money. If planned in advance, quarries resulting from sourcing soil on site can be converted into rainwater harvesting tanks, wastewater treatment systems, reservoirs, basement floors or landscaping features. This can be beneficial for the development of the place, provided the planning is judiciously done. It is an appropriate building material that can very well adapt to the local needs of the local population: technical, social, cultural and behavioural.

\*\* This section is mainly based on information and photos available from: Auroville Earth Institute (<http://www.earth-auroville.com/>)

- **CSEB is energy efficient and eco-friendly:** CSEB requires only a little stabilizer (thus little fuel for it); in India, the energy consumption for a m<sup>3</sup> of CSEB is about 10 times less than a m<sup>3</sup> of country fired bricks. Unlike the production of fired bricks, firewood is not required to produce it. Hence building using CSEB can prevent the depletion of forests which otherwise suffer due to short-sighted development and mismanagement of natural resources.
- **CSEB technology is affordable and provides job opportunity:** CSEB production is generally cheaper than fired bricks or concrete blocks because of the scope to produce locally, using a natural resource. It only requires semi-skilled labour. CSEB technology can be completely transferred to an unskilled and unemployed person through an intensive and hands-on training for a week or two. When CSEB is produced manually, jobs can be created because the labour cost can represent about 60 per cent of the cost of the building.
- **Flexible production scale:** Equipment for CSEB is available from manual to motorized machinery ranging from village to industry scale. Considering the context and scale of a project the choice of relevant equipment is crucial for smooth proceedings of work.
- **Strength, Dimensional uniformity and flexibility:** CSEBs are strong enough to be used for load bearing structure; they can withstand the load of 4 floors without concrete columns. Arches, vaults and domes can replace concrete beams and slabs, thus bringing the overall cost below conventional structures. Furthermore CSEBs do not necessarily need to be plastered. They have consistent dimensions and their accuracy and regular dimension saves mortar for laying the blocks. CSEBs can be made in many different types and sizes.
- **Social acceptance:** CSEB has a demonstrated ability to adapt itself to various needs: from low income to wealthy individuals or governments. Its quality, regularity and finish allow a wide range of final products.

It is possible to use a natural resource like the soil and still develop a sustainable habitat in a harmonious way. First of all, topsoil should be scraped away and re-used later for agriculture or gardens. Quarries can be used later on for rainwater harvesting, wastewater treatment, basement floors, swimming pools, landscape design, etc.



*Biological wastewater treatment*



*Basement floor*



*Rainwater harvesting*

CSEBs are usually produced locally with manual presses. Therefore the labour component is very high and it explains why CSEBs are cheaper than expensive industrialized materials.

Many countries have adopted earth construction techniques and CSEB in particular. The Sri Lankan Standard Institution published a standard on the production and use of CSEB. New Zealand and Australia have also standards related to earth techniques which include compressed stabilized earth blocks. The Bureau of Indian Standard is also preparing a new standard on CSEB.

In USA the State of New Mexico has published standards including CSEB and other earth techniques. Several other states are also using CSEB and other stabilized earth techniques. Contractors are building with CSEB in Colorado, Texas and New Mexico and the demand is increasing in other US states.

CSEBs can resist disasters. The Auroville Earth Institute has developed a system which is based on reinforced masonry with compressed stabilized earth blocks that are hollow interlocking. The masonry with these blocks is reinforced at the critical points with reinforced cement concrete. This technology has been used extensively in Gujarat (India) for the rehabilitation after the 2001 earthquake. With a six-month technical assistance from the Auroville Earth Institute, the Catholic Relief Services built 2,698 houses and community centres in 39 villages, employing more than 2,000 people.



MINE House – Istanbul, Turkey



AUM House – New Delhi



AUM House – Khavda, Gujarat

### 6.5.3. RESEARCH BY THE AUROVILLE EARTH INSTITUTE (AVEI)

The Auroville Earth Institute (AVEI), a non-profit organization based in Tamil Nadu, India has done extensive applied research and development on CSEB and various stabilized earth techniques which are being disseminated and used worldwide. Founded in 1989 by the Housing and Urban Development Corporation (HUDCO), Government of India, AVEI promotes and transfers earth-based technologies, which are energy and cost effective. One of the aims of the Auroville Earth Institute is to give people the possibility to create and build by themselves their own habitat, while using earth techniques. Its objective is to demonstrate that building with earth can be synonymous of modern, eco-friendly, economical, endogenous and safe habitat. The AVEI is part of a world network and is today the representative and resource centre for Asia of the UNESCO Chair “Earthen Architecture, Constructive Cultures and Sustainable Development”.

The technology developed by the Auroville Earth Institute has been approved by:

- The Government of Gujarat, India, (GSDMA) as a suitable construction method for the rehabilitation of the zones affected by the 2001 earthquake in Kutch district. It is allowed to build up to 2 floors.
- The Government of Islamic Republic of Iran (Housing Research Centre) as a suitable construction method for the rehabilitation of the zones affected by the 2003 earthquake of Bam. It is allowed to build up to 2 floors (8 metres high).
- The Government of Tamil Nadu, India, (Relief and Rehabilitation) as a suitable construction method for the rehabilitation of the zones affected by the Tsunami of December 2004.

### 6.5.4. BUILDING WITH EARTH IN AUROVILLE

Auroville is a universal township in the southern part of India that aims at promoting human unity. The development of this township is respectful of natural resources and the environment. The earth architecture in Auroville attempts to link the ancestral tradition of raw earth buildings and the modern technology of stabilized earth. In this context, the Auroville Earth Institute shows how stabilized raw earth can be used as a building material, from foundation to roof and without depleting natural resources. Most of the projects are built with compressed stabilized earth blocks. The following pictures display examples of houses, apartments and public buildings in and around Auroville.



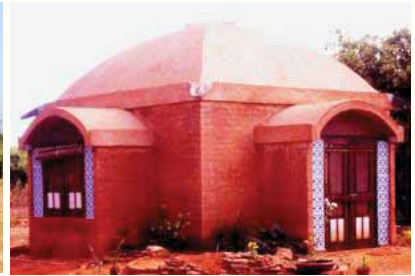
## HOUSES



Dana community



Auromodele community



Cost effective house at Vikas



House, Auroville Earth Institute



Samasti community



New Creation Field

## APARTMENTS



Kailash youth centre



Row housing at Prayatna



Djaima community



Vikas community with 4 floors



Vikas community



Staff quarter

Vikas Community was a finalist for the "2000 World Habitat Award".



## PUBLIC BUILDINGS



Visitors Centre



School at Udavi



Electronic workshop



School at Marakanam



Solar kitchen



School at Pondicherry

The Visitors Centre of 1200 m<sup>2</sup> was granted the "Hassan Fathy Award for Architecture for the Poor" in 1992.

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## 6.6. ECO-RESORTS \*\*

### 6.6.1. INTRODUCTION

Tourism represents the single largest and continuously evolving economic sector in the world. According to estimates of the World Tourism Organization (WTO), the tourism sector employs up to 10 per cent of the World's workforce and accounts for 10 per cent of global domestic product. However, tourism activities and business providing tourism services have negative impact on the environment, such as excessive consumption of water and unsustainable use of energy, waste generation, loss of bio-diversity, marine pollution, etc.

Experience has shown that energy and resource management in hotels and resorts makes good economic sense as it allows cutting down the operating cost and the frequency of maintenance. In addition, improved resource efficiency can help in environmental compliance, higher productivity and greater equipment reliability. It is also proven that resource management investments have low risks as they provide attractive returns on investment and improve the hotel's profits and cash-flow position. Lastly, good energy management practices help to improve the service quality, enhanced customer satisfaction and improved corporate image.

This section provides review of three resorts which have invested time and resources in developing a sustainability attitude aimed at generating business benefits.

### 6.6.2. EVASION RESORT, PHUKET, THAILAND

In 2000, Six Senses Resorts and Spas acquired the Phuket Island Resort, a 3-star property that had been operating since 1972 in Rawai beach on the south eastern side of Phuket Island, Thailand. Six Senses decided to carry out the redevelopment of the property, now known as Evasion Resort, with least environmental impact in order to reposition the property as an environmentally responsible resort destination. The combination of strategic redevelopment and environmentally sound operating practices have resulted in better energy, water and waste management, and higher profitability of the resort.



To start with, Six Senses decided not to demolish the 28-year structure but retrofit the building and replace the equipment, thus avoiding the negative environmental impacts related to building demolition and landfill of debris, manufacturing and transporting building materials and constructing new buildings. Some of the designing strategies adopted during the redevelopment of the resort in order to lower the energy consumption are summarized below:

\*\* This section is mainly based on information and photos available from: WWF, Horwath HTL and HICAP (2010). Towards the Business Case for Sustainable Hotels in Asia.

- Eliminating the need for air conditioning and lighting during day time in public spaces throughout the year by creating open air structures in public spaces;
- Reducing the energy demand by designing open style bathrooms that create the feeling of more space and use natural light effectively;
- Lowering the air conditioning load by using UV-protection films on windows;
- Incorporating a water feature in the lobby that doubles as a design element and provides insulation for meeting facilities below, thus reducing their air conditioning needs;
- Adopting open kitchen design that maximizes natural ventilation and lighting, and redesigning the kitchen with refrigerators built into the wall, which creates a better working environment and reduces the air conditioning needs of the kitchen by allowing the heat of refrigeration to be dissipated directly outdoors;
- Installing an energy monitoring system and replacing major equipment in order to reduce the energy requirements of the resort considerably. The energy monitoring system which controls timers for lighting, pumps and other systems has resulted in 10 per cent savings in energy use;
- Replacing the split air conditioners by a centralized mini-chiller system has reduced the energy consumption by 510,000 kWh per year. With an initial investment of US\$130,000, the new system saves electricity worth US\$44,000 per year, giving a payback period of 3 years;
- Installing energy efficient compact fluorescent lamps for garden lighting to minimize the energy consumption, improve the resort ambiance and reduce light pollution that can affect wildlife;
- Commissioning solar water heaters on top of the main building in order to heat water for showers without using gas or electricity;
- Installing heat pumps in the pool villas to extract heat from the ambient surroundings to heat water in villas and independent units.

The resort has installed the first biomass absorption chiller in Thailand. Garden waste is burned to provide clean air conditioning for the resort's general store.

The resort's experience shows that significant changes can be made to older buildings that can improve efficiency and reduce waste and costs. The installation of new resource efficient equipment in the resort is found to be economically viable and environmentally sensible. Some of the economic benefits of equipment installed to reduce energy and water consumption are summarized below.

| Item                         | Investment  | Annual savings    | Payback   |
|------------------------------|-------------|-------------------|-----------|
| Energy monitoring system     | US\$11,000  | About 10 per cent |           |
| Quantum heat recovery        | US\$9,000   | US\$7,500         | 1.2 years |
| Centralized mini chiller     | US\$130,000 | US\$44,000        | 1.8 years |
| Energy efficient light bulbs | US\$8,500   | US\$17,000        | 6 months  |
| Biomass absorption chillers  | US\$115,000 | US\$41,000        | 2.8 years |
| LPG boilers for laundry      | US\$27,000  | US\$17,000        | 1.6 years |

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### 6.6.3. SONEVA FUSHI RESORTS, KUNFUNADHOO ISLAND, MALDIVES

Maldives is an Island Nation comprising of almost 1,900 atolls, south of Sri Lanka in the Indian Ocean. The main sector of economy for this small nation of 0.3 million people is tourism and fishing. As one of the low sea level countries which is the first expected to face the challenges of climate change and rising sea levels, Maldives has announced its ambition to be a carbon neutral country. Maldives has many resorts and hotels and tourism is one of its main economic drivers. There is a lot of activity happening in terms of energy efficiency efforts and adoption of sustainable practice in resorts with the help of special agency funding and projects.

The Soneva Fushi is one of the resorts of Maldives located at the Baa Atoll which strives to adopt sustainable practices. It addresses social and environmental concerns and uses sustainability indicators to identify areas for improvement and necessary action plans. The resort is designed to have low impact on the environment. It has installed solar panels and has been conducting experimentation with deep sea water cooling. The resort also acts as an advisor to the World Bank for the Maldives Environmental Management Project and the Atoll Ecosystem Conservation Project to protect the marine environment, develop sustainable tourism and improve waste management techniques in the Maldives.



Some of the sustainable design features adopted by Soneva Fushi are summarized below:

- The landscape was kept intact to have minimum impact on the island's flora and fauna. Buildings were built around trees to avoid removal of trees.
- Buildings height is limited to 2 stories to minimize the visual impact on the island, shade buildings and maximize sun exposure for trees.
- Pathways are kept narrow to reduce tree removal and are made of sand to avoid concrete. A floating platform in the ocean accommodates sea planes to avoid destruction of the island's coral reef.
- Stilted piers are built to preserve the coral reef and encourage the natural flow of water and sand around the island.
- Sustainable materials and durable and fast growing bamboo, drift wood, palm leaves and other waste wood on the island are used for signage, furniture and fences.



- Open air structures in public spaces provide natural ventilation and light and eliminate the need for air-conditioning of public spaces and supplemental lighting during the day. Open air bathrooms offer natural ventilation and light.
- Producing drinking water on site reduces plastic bottle imports and waste produced by the resort. In 2008 the resort completely eliminated bottled water imports and reduced wastage of approximately 250,000 bottles per year.
- Other ways of recycling and sustainable purchasing practices are pursued.

Despite the measures taken up by the resort, cooling and heating represent 50 per cent of the resort's energy consumption, and 85 per cent of total energy is produced by diesel fuel. Although diesel use has been relatively stable and the resort has improved its efficiency in energy consumption per guest-night, cost savings are not directly associated due to fluctuations in energy costs. Without implementing energy savings tools including the following, annual cost increases would have been more pronounced.

The major energy saving measures taken up by Soneva Fushi and the challenges faced are summarized below:

**Heat recovery:** Where water used to be heated with 20 electrical water boilers, a heat recovery system now uses waste heat from the diesel generators and the laundry system to heat water.

**Pilot program to create biogas:** Using organic waste to create biogas reduces solid landfill waste and produces gas for kitchen use. The resort is faced with difficulties in efficiently storing and distributing the biogas.

**Pilot program for deep sea water cooling:** Deep sea water cooling would be a cost effective and environmentally friendly way to cool the resort. Energy consumption for cooling can be reduced by 90 per cent compared to other hotels. Although the resort invested substantially in this program, operational and maintenance issues of the distribution system prevented the pilot program from continuing.

**Pilot program of photovoltaic solar panels:** The panels cost US\$ 300,000 with a payback period of 7 years based on current energy costs. The current yield is 3 per cent of energy used at the resort. The vegetation cover of the island preserves the ecosystem, cools the resort and offsets carbon emissions. Large tracts of the island's rich landscape would need to be cleared to facilitate the electricity generation from solar panels and may also have other adverse impacts on the island.

Soneva Fushi is planning to become a zero carbon resort by 2012; the resort's goal is to eliminate use of diesel for everything except its emergency generator; resorts in all islands use captive power generating units for electricity. The resort would calculate the total carbon footprint to its resort by the guests and would try to offset it.

#### **2012 Zero Carbon Strategies of Soneva Fushi Resort**

- Replacement of less efficient air conditioning units
- Reduction of lighting energy load by 75 to 80 per cent by replacing existing inefficient lamps by long-lasting LEDs, thus reducing energy and maintenance costs
- Installation of building management system (BMS)
- Further increased use of photovoltaic solar panels
- Use of biofuel and alternative fuel sources derived from renewable biomass products in the resort.
- Lowering of water use and increasing of rainwater catchments

#### 6.6.4. OUR NATIVE VILLAGE, HESSARGATTA VILLAGE, BANGALORE, INDIA

Our Native village is a small holistic resort initiated by a family without prior hospitality experience near Bangalore, southern India. Aimed at promoting a healthy lifestyle by nurturing the mind, body and soul of guests, the resort was designed to be self-sufficient with few impacts on the environment, adopting the 5 pillars of sustainability: energy, water, waste, architecture and the food chain. The resort happens to be in a location with limited water and energy supplies, hence greater efforts were made to assess the potential for self-sufficiency at the designing stage.

First of all, energy use at Our Native Village is kept to a minimum thanks to the use of open-air spaces, natural lighting and ventilation, passive cooling, proper insulation, etc. Because of the elevation, the resort always experiences a slight wind that naturally cools the resort. High energy consuming electrical amenities are avoided, such as air conditioning, television, hair dryers, minibars, etc.



A microclimate survey identified alternative forms of energy appropriate for the site. Solar photovoltaic panels of 6.3 kVA capacity are used to produce about 20 per cent of the energy needs of the resort. Electricity generated in excess during the day time is stored in a battery bank for use when there is no sun. A wind turbine has been installed with a capacity of 3.3 kVA and it starts functioning with a minimum wind speed of 20 km per hour. The wind turbine produces roughly another 20 per cent of the resort's electricity. During periods of high winds, the generated energy is stored in a battery bank for its use during low-wind periods.

##### Low impact design strategies of Our Native Village

An assessment of the site's topography revealed that siting the resort on high ground would be beneficial to capture the wind and harvest the rain water. A large portion of the land is preserved to farm organic produce for the resort. Here are some of the unique features of the resort:

- All bricks were made manually on site from the clay that was excavated for the building foundations. Clay was mixed with 5 per cent cement and 5 per cent quarry dust and bricks were sundried before being used in construction. This resulted in zero greenhouse gas emissions related to the production and transportation of these building materials.
- Stone and wood were locally sourced and all wood was left untreated to avoid the use of toxic materials emitting volatile organic compounds (VOCs).
- All rooms are oriented towards the west. Use of wide windows in the west and narrow windows in the east funnel air through guestrooms to maximize ventilation and eliminate the need for air conditioning.
- An open-air dining area uses natural light and ventilation.
- A 100 per cent natural swimming pool uses aquatic plants that absorb nutrients, maintain water quality and create a natural swimming environment. As a result, the pool is clean and clear, and does not require chlorine or other chemicals for water treatment.

The resort has adopted underground biogas digesters which are fed with cow dung, kitchen waste, and de-oiled cakes that are a waste by-product from the non-edible oil seed industry.

Methane formed in these digesters is used in the kitchen as cooking gas, meeting 70 per cent of the gas needed for the kitchen and 40 per cent of the energy for the resort. Annual savings are estimated to be 60 per cent in comparison with the regular LPG usage. Excess biogas is fed to a biogas generator on-site to produce electricity. Left-over slurry from the digester is converted into organic fertilizer and used in the farm.

On the whole, the production of renewable energy, use of rainwater tanks and adoption of waste management system have helped to lower the costs of the resort in an environment where declining water resources and rising energy costs create new challenges. By generating 70-80 per cent of its energy demand and 70 per cent of its cooking gas demand, Our Native Village has been able to better manage the long term operating costs to a great extent.



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## 6.7. GREEN INDUSTRIAL BUILDING \*\*\*

### 6.7.1. INTRODUCTION

The MAS Intimates Thurulie is a textile industry that has constructed its production unit in Thulhiriya, Sri Lanka. The company used to be a State-run textile mill known as the Thulhiriya Textile Mill established back in 1968. After being taken over by a private holding "MAS", the new production unit was established. The company is one of the suppliers to Marc & Spencer's and some of its franchises in Asia. The production unit was conceived with the idea of being built as a sustainable construction and to serve as a unique place where ecology, environment and performance would be taken as the main objectives for the construction of the unit. The factory houses a work force of about 1,300 employees and covers an area of 10,000 ft<sup>2</sup>.



### 6.7.2. SALIENT DESIGN FEATURES

MAS Intimates Thurulie claims to be one of the world's first clothing factories to be running on sustainable energy or carbon-neutral sources. The unit was built in the reserved deer park and recreational area and the abandoned units of the fabric park was not used and careful planning was done for site selection keeping in mind the vegetation, solar orientation, etc.

Here are some of the salient Features of MAS Intimates Thurulie Textile Unit:

- The Construction is based on the principles of environmental ethics and a green and ecologically balanced outdoor environment has been created to provide stress-free and work-friendly indoor environment.
- The unit was constructed keeping in mind the USGBC (US Green Building Council) standards for green building and is platinum LEED (Leadership in Energy and Environmental Design) certified; thus it conforms to the highest levels of energy and environmental standards.
- Only Renewable and Carbon neutral Energy Sources are used; the building is designed to use 25 per cent less energy compared to similar factories.
- Efficient Water Management enables the factory to keep its potable water consumption to about half in comparison with similar industries.
- It is a lean production unit, hence it has several compartments till the finished products that are designed for efficiency and comfort of workers.

\*\*\* This section is mainly based on information and photos available from: Holcim Foundation for Sustainable Construction (2009). MAS Intimates Thurulie: Clothing Factory in Sri Lanka ([www.holcimfoundation.org/mas](http://www.holcimfoundation.org/mas)).

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The construction of the MAS Intimates Thurulie had been made on the account of sustainable construction which is hard to be adhered to such as to follow the principles of:

- Practices and ideas that are simple, cost-effective and are broad-based
- Ethical standards and social equity
- Ecological quality and energy conservation
- Economic performance and compatibility

Sri Lanka is a country in the tropical belt and remains hot and humid during most parts of the year. MAS Intimate Thurulie had planted around 400 trees, doubling the amount on the site. The unit was constructed with minimum ecological disturbance in order to maintain the species and the intricate ecological balance of the place. The vegetation encompassing the industry allows it to reduce the indoor temperature by 1 to 2 degree Celsius. The plantation of the species on the project area is carefully selected to avoid conflicts and can sustain without human interference and thus it reduces the use of water.

The MAS Intimate unit boasts of green manufacturing standards and recycled plastics and metals used during production. Also the thread cones are paper based which is recycled. However, the supply chain sustainable practices are not transpired through its energy intensive distribution networks; they have shown immense ways towards sustainable practices and have good capacity building and information dissemination systems.



### 6.7.3. THREE-POINT PHILOSOPHY OF THE DESIGN TEAM

In order to realize a sustainable design, a 3-point philosophy was adopted by the design team: respect for the site, respect for users, and respect for eco-systems. The building is energy efficient and provides a comfortable indoor climate, a challenging combination in the tropics. The heat island effect around the building is controlled by shading, covering parking areas, and by using lighter and reflective paving around the building. The facility incorporates an anaerobic digestion system for sewage treatment.

The factory cost US\$2.66 million, including the cost of green designing as well as the solar photovoltaic system. The additional cost of this unit is 25 per cent higher in comparison with a similar conventional unit during the time of construction; however, according to initial estimates, the low operating costs and practices would pay back the incremental investment within 5 years.

### Sustainable approach pursued by the factory

MAS Intimates Thrulie was designed to achieve low energy consumption by a combination of passive building designing principles and energy-efficient equipment. Following are some of the features adopted for achieving spectacular results in the factory:

- 1. Passive Cooling:** Since it is in a tropical climate, cooling is achieved by using passive cooling methods of design and lowering the thermal gradient. The additional cooling required is provided by secondary active systems. Thermal roof load index is reduced by using green roofs and cool roofs using reflective materials having reflectivity up to 80 per cent. Solar panels covering about 200 m<sup>2</sup> of roof area generate electricity. Controlled fenestration and shading are provided; ventilation is used to reduce the thermal index. The solar orientation is also used to minimize the effect of heating and improve daylighting in production areas.
- 2. Indoor Thermal Comfort:** The air flow is about 40 air changes per hour and the average indoor temperature is about 3 degrees Celsius lower than the outside temperature. The relative humidity is kept under control by humidistats and recommended standards are kept in mind to achieve the desired comfort level.
- 3. Construction Material:** The external walls are made of compressed stabilized-earth blocks, manufactured 40 km from the factory. Thus the energy needed for making and transporting the materials for the walls is very low. Roofing is zinc-aluminum imported from Australia. Windows use imported plate glass and aluminum frames. Bamboo based window blinds are used. Construction was carefully managed to minimize environmental impact. Topsoil was segregated during excavation and reused later. Stabilizing plants, silt traps, rainwater ponds were used to prevent soil erosion during construction. Much of the construction debris was used in the sub-base for paving on the site, and special mechanisms were introduced to recycle construction waste, which reduced the amount of waste that went into landfills.
- 4. Energy Efficiency:** Since the overall effort is focused on reducing the thermal load, the overall capacity of the equipment and appliances is low. Energy Efficient T5 lamps are used for lighting and the sewing machines are mounted with LED lighting for precision lighting on the needles. Other lighting requirement is supplemented by daylighting.
- 5. Water Management:** The unit uses rain water harvesting for its water usage and collects the green roof water and also uses gravitation fed tanks, thus avoiding the need for pumps. Efficient use of water is assured through good design and efficient utilities.
- 6. Renewable Energy:** Ninety per cent of the energy consumed by unit comes from hydropower and the remaining 10 per cent is from 25.6 kW of solar photovoltaic panels on the roof top. Since the company does not operate on weekends and holidays, it has entered into a net metering arrangement with the power company so that it gets credited for the electricity it generates and feeds into the grid.

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## 6.8. GOLCONDE: AN INTERESTING EXAMPLE OF TROPICAL ARCHITECTURE \*\*\*

### 6.8.1. INTRODUCTION

*“In one of the most remote parts of India, one of the most advanced buildings in the world was constructed under the most demanding of circumstances concerning material and craftsmen. The reinforced concrete structure was completed primarily by unskilled volunteers with the most uncertain of supplies, and with virtually every fitting custom-fabricated. Yet this handsome building has a world stature, both architecturally and in its bio-climatic response to a tropical climate 13 degrees north of the equator. It has the reputation of being the most comfortable building in Pondicherry, although it has no mechanical cooling system.*

- “Solar World” Congress, Perth (1983)



Golconde, located in Pondicherry on the southeast coast of India, needs no introduction. The name “Golconde” is the French rendering of Golconda, the famous diamond mine in Hyderabad, India, because the building was constructed with a donation from the Nizam of Hyderabad. People who understand architecture have acclaimed this construction in concrete widely. Designed by Antonin Raymond and George Nakashima in 1935, the building serves as a modern and up-to-date multi-story dormitory accommodating some 30 disciples of Sri Aurobindo's Ashram (spiritual hermitage). The work for this first high-strength reinforced concrete building in India commenced in 1936 and took 6 years to get completed, partly due to the lengthy and complicated construction process during the Second World War. The fundamental principles of architecture – simplicity, economy, directness and closeness to nature – were consciously and consistently observed in the designing and construction of Golconde.

\*\*\* This section is mainly based on documents and photographs stored in the Archives of Sri Aurobindo Ashram and displayed at an Exhibition on Golconde held at Pondicherry in October 2011.



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### 6.8.2. HISTORY OF THE CONSTRUCTION OF GOLCONDE

The history of the construction of this building has no analogy with others where a big number of labour forces work under the supervision of engineers and contractors to build a large structure in the shortest possible time. The building however, had on the contrary, a slow growth and almost an organic one, where the individuals working there poured in their love and dedication to develop a concrete structure. They were few in number – a handful of labourers working in harmony with a number of engineers, supervising from divergent walks of life. The outcome has been a very different and beautiful building that is a solution of great simplicity which, at the same time, provides great possibility of comfort and economy.

When designing the building just before the Second World War, the architect of this building has set down the base of a new architecture founded on the principles and not on the established mental customs. While gaining from the practical experience acquired in the ancient buildings of Pondicherry, the architect has tried to translate them into materials that are offered by the modern world. The local climatic conditions are taken into consideration and the building structure is given the most logical shape dictated by the local conditions.



### 6.8.3. ARCHITECTURAL ASPECTS OF THE BUILDING

The great simplicity of the construction gives style and elegance to the building while keeping the cost down. The building has four floors, including a basement with only half below the ground level. Its two long staggered wings are set at an angle on the narrow plot, thereby making the most of rather limited space. Seen from the air, it looks like a bird in flight. Each wing consists of a series of single rooms that are strung out along a north-facing gallery, which runs the length of the building. On both the north and south sides, the entire building surface is equipped with large operable horizontal louvers to afford protection from the sun and from violent winds and rain, while allowing for ventilation with the fullest current of air which is south to north in summer and north to south in winter. As the sun never enters the building directly and brings its heat with it, the rooms are always cool and do not need any mechanical ventilation.

The body of the building is reinforced concrete, left natural except for the native white plaster on the end blank walls. The building achieves the architectural distinctions by thorough integration of plan, structure and final design. The fundamental principles of architecture – simplicity, economy, directness and closeness to nature – were consciously and consistently observed.

The staircases are centralized so that they are in direct communication with the entrance. Due to the angle given to the house that is surrounded by high walls, the gardens have interesting forms. Enclosed on all sides, they become peaceful cloisters where one can walk and relax happily.



View of front garden



View of entrance from the basement

#### 6.8.4. GOLDCONDE'S LOW ENERGY FEATURES

The many innovations in the structure of the building include independent columns and footings in high strength reinforced cement concrete (R.C.C.) with all concrete surfaces left form-finished without plaster. The floor consists of well-polished layered limestone found in several places in India. Roof and slabs are laid on R.C.C. frame and cantilevered for corridors. The lines of the building were so beautifully designed, with roof made of large and thin precast curved cement-concrete tiles with a ventilated air space over the concrete slab deck and the ends sealed with perforated concrete tiles, that the whole is truly a masterpiece of architecture. The double thickness was important because of the almost continual intense heat of the tropics: the convection of air keeps the roof and the top floor rooms as cool as the ones below.

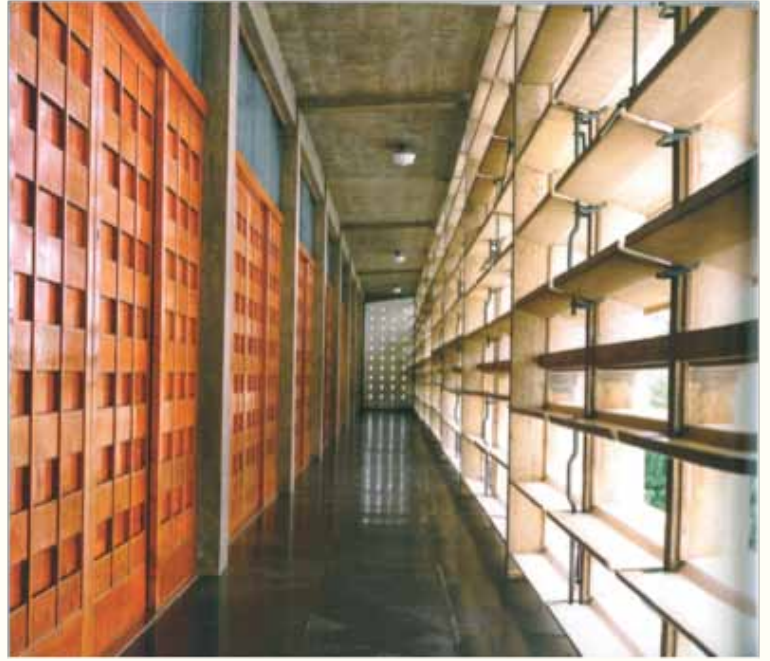
Rooms are separated from corridor by sliding doors that allow air to circulate freely when open. They have staggered slats which allow ventilation even when doors are closed. Topmost part of all doors is a skylight with sliding glass panes which also allow for wind movements.

The way of making both faces of the building openable was to have sides with louvers, which could be fully opened, half opened or closed by a series of simple commanding bars. In the south side, these louvered opening were directly into the rooms, and on the north side, there was first the entrance sliding doors into the room and then a corridor, the full length of the wing and the louvered openings. This is how the rooms are kept cool, the year round, and even in the hot weather. The continuous wide window-ledge, which runs throughout all the rooms, can be used for sitting, sleeping, or as a table or shelf.

The walls of the rooms from east to west walls are of brick work, covered with the famous Chettinad plaster made from lime of sea shells and mixed with milk and curds and jiggery. The final finish is pure white and smooth that is known as egg-shell finish. These walls are an asset in tropical humid region because they reflect more light and the rooms are better illuminated with natural light. Unlike cement, there is less heat in the room. The walls do not lose any of their gloss over long time span.

The rooms of the inmates are provided with a ceiling lamp for general lighting and a desk-top lamp for task lighting. The rooms were initially not equipped with ceiling or table fans for ventilation. But over the years construction activities around the town and hard surfaces have contributed to urban heat island effects; as a result, some rooms are provided with table fans that are used only when it is really necessary. Rooms do not have any other electrical loads.





The special quality of Golconde is to bring out the natural beauty of things used wherever possible. The simple landscaping of the surrounding garden, with its trees and grass and shallow pools, carries out the effect of coolness that is realized structurally in the building itself. The high protecting wall around the entire plot not only provides seclusion but holds in the air that is cooled by the plants, green lawn and shallow pools of the attractively landscaped garden, and keeps out the heat of the surrounding heat islands of unshaded streets.



To further the cooling current of air in summer, as often there is no movement of air at all, the garden on the northern side of the building was left rather bare whereas the garden space available in the southern side was planted with many trees and shrubs, providing lots of greenery and shades. With the sun shining fully on the northern area, the air in this area became much hotter than that on the southern side. Hot air rising in the northern side drew in the air from the cooler and shaded south and thus set up a convection current of air. By these means, the rooms at Golconde were always cool and did not require any mechanical ventilation.



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### 6.8.5. CONCLUDING REMARKS

The conceptual force of Golconde's design solution remains radical even by the standards of today. In articulating an unambiguous stance towards minimal resource consumption, the building champions a unique aesthetic. The story of Golconde – in both design and construction – remains quintessentially international. Having outlived its designers, it celebrates their ideals of a progressive vernacular modernism, simultaneously resonant in the local and universal context.

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