Green Building Concepts and Policies

*The **Global Forum on Sustainable Energy (GFSE)** is a neutral multi-stakeholder platform which is facilitating international dialogue on energy for sustainable development by taking into accounts the special interests and challenges of developing countries. GFSE aims at the establishment of a sustainable world energy system from a social, economic and environmental perspective.*

GFSE contributes to both international discourse and information dissemination on sustainable energy. The multi-stakeholder platform plays a crucial role in facilitating sustainable energy projects by bringing together donors, investors and project developers. Their interaction creates new opportunities and enhances existing initiatives in the field of sustainable energy.

Introduction and Challenges

The global building sector is one of the main causes for fossil fuel consumption and GHG emissions: According to the IPCC, in 2010, 19% of total GHG emissions were attributable to the building sector. Considering the embodied energy of construction materials as well would render the building sector the prime emitter of greenhouse gases. Fossil fuel consumption in the building sector is much higher in developed countries (roughly 40%), whereas the majority of the energy consumed in the building sector of developing countries is biomass (mainly for cooking purposes). This will change substantially in the future with the expected increase in energy consumption overall, which is due to the rapid and continuing urbanization driven by population growth and rural to urban migration, the anticipated improvement in living conditions of developing countries and the anticipated shift from biomass to fossil fuels.

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Challenges for developed and developing countries in delivering on sustainable buildings will differ. The urban building stock in developing countries is expected to more than double by 2030, accompanied by a substantial rise in demand for energy services in buildings. An increase in the number of buildings is expected, together with a much greater use of electric and electronic appliances and air conditioning. This will put a strong focus on new buildings to meet rising demand for energy and housing and to prevent the lock-in effect in unsustainable structures, whereas most developed countries will more strongly focus on the refurbishment of the existing building stock. Cities struggle to satisfy the rising demand for affordable housing, urban infrastructure and services, which often leads to urban growth with slum and informal settlements and lacking access to clean energy. This leads to tensions between urban growth, climate change, poverty alleviation, the provision of affordable housing, access to quality residential services, clean energy and environmental conditions, which will have to be solved to ensure a more sustainable development of the building sector.

While many developed countries are located in cold climates, which require substantial heat energy demand, energy consumption for air conditioning is rising in (developing) countries with warmer climates. This is due to the need for living in more comfortable spaces, which is often negatively influenced by inappropriate architecture and the wrong thermal approach to comfort, such as over-cooled commercial buildings.

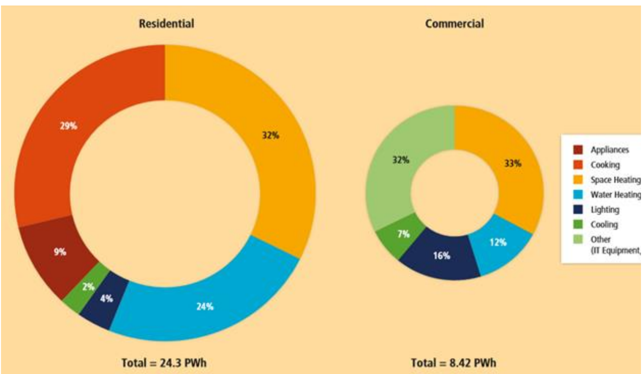
This makes clear that the challenge not only relates to sustainable building design, but also to behavioural change.

Main market barriers, which are universal to all economies, include a lack of visibility and perceived importance of energy cost signals, split incentives among developers/investors and building occupants, lack of information and knowledge about EE options and the complexity of building projects. Next to financial constraints, the lack of institutional capacity or coordination, and the lack of technical capacity and affordable technology can hinder the implementation of green building solutions.

The IPCC 5th Assessment report acknowledges that technological options, design practices and behavioural changes can achieve large reductions in building energy use (50-90% in new buildings, 50-75% in existing buildings). These measures can also yield economic co-benefits like the creation of jobs and business opportunities, and enhanced energy security. Social co-benefits may include a higher capacity of low-income households to pay their energy bills, increased access to energy services, improved indoor and outdoor air quality and increased comfort and health.

Holistic approaches will be necessary to find suitable solutions for the built environment, which do not only address resource and energy efficiency, but also environmental, ecological and health safety and resilience to natural disasters. Such approaches will also need to include issues of affordability, social justice, as well as cultural and economic aspects. Furthermore, the energy system of cities will have to adapt to the new conditionalities: stronger use of renewable energy, a growing number of small-scale interconnected energy production and consumption units and a "smarter" urban network.

The design of inclusive policies and strategies will require the involvement of all stakeholders of the building sector during all stages of a building's lifecycle.



World Building Final Energy Consumption by End-Use in 2010 (source: IPCC, 2014)

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Green Building Design Principles

Moving towards better, more climate-responsive building design and construction can ensure energy efficiency and limitations to GHG emissions for decades to come and avoid lock-in effects. Sustainable, green or efficient building design describes the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building's lifecycle. Thus, sustainable buildings should be designed based on holistic approaches involving resource efficiency, energy efficiency, pollution prevention, harmonisation with the environment and applying integrated and systemic approaches.

The building design process should strive for providing maximum comfort for building dwellers while simultaneously minimising the necessary primary energy consumption. This design process, moving from architectural design to mechanical systems design followed by the building construction, should thus integrate energy expertise from the start. Planning strategies may first focus on minimising the amount of energy needed to provide high thermal and visual comfort through appropriate architectural design. Based on this, the energy efficiency of mechanical systems (like heating, ventilation and AC, domestic hot water production, artificial lighting etc.) and their appropriate control is addressed, and the remaining primary energy demand can be supplied with renewable energy sources or by substituting fossil fuels with low-carbon electricity. On-site generation of renewable energy can significantly reduce the environmental impact of the building, and – in the case of "zero-energy buildings" – can render a building independent from grid-supply. Depending on the site's potential, renewable energy technologies used include solar PV and solar thermal systems, mini wind turbines, biomass and biofuels (mostly for cooking), and in certain cases mini- or small hydropower.

When applying **bioclimatic or passive building design**, the architectural features of the building take advantage of local climatic resources to provide a comfortable indoor climate, thus reducing energy consumption for mechanical heating or cooling. So-called bioclimatic charts are tools to help analyse the climate of a particular place, in order to identify suitable cooling or heating techniques on the basis of outdoor climatic conditions.

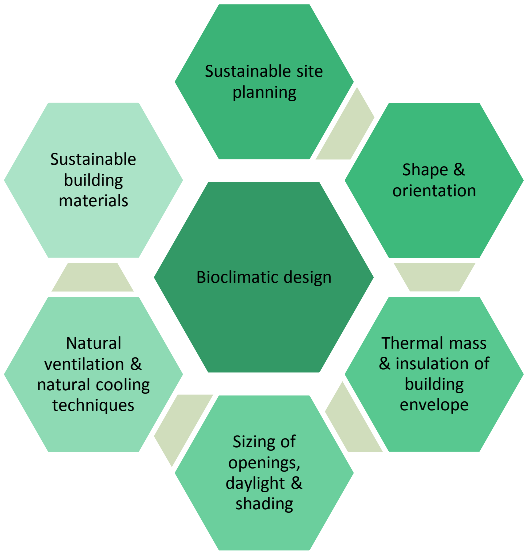
Sustainable site planning begins with assessing a site's capability to provide natural resources (light, air water, etc.) and the extent to which existing natural systems will be required to support the new development. This plays an important role in optimising the energy efficiency of the urban layout.

Building shape and orientation are important first choices in the design process and have great impact on thermal and visual comfort, as well as on energy consumption. Moreover, the **thermal mass and insulation of the envelope**, together with the **sizing of openings** are crucial factors. **Natural ventilation**, or the intentional airflow through building openings designed for this purpose without mechanical means, can affect the energy balance and comfort of the building and the health of its dwellers. Taking advantage of **daylight** is important to provide visual comfort, reduce the use of conventional energy and diminish thermal gains indoors caused by artificial lighting. Optimal **sun-shading** blocks solar radiation while allowing an external view and daylight and breeze to enter. **Natural cooling techniques** may either make use of the adiabatic humidification process (evaporative cooling), or exploit the low temperature of the subsoil.

About 40% of the raw materials and energy produced worldwide are used in the building sector, so the choice of construction materials plays a decisive role. **Sustainable building materials** positively affect both the thermal performance and the environmental impact of the building: the heat flow rate through the building and its time lag, the energy storage capacity and the embodied energy of the building. Using traditional materials bears the advantages of plentiful supply, low environmental impact and costs, good reaction to the climate and the fact that the materials can be handled by local skilled labour.

However, the production of the basic building materials for most modern buildings, cement, steel, glass, aluminium and baked bricks, have very high environmental impacts, consume the most energy and cause the majority of GHG emissions in the construction sector, because their production requires the processing of mined raw materials at very high temperatures. One significant challenge, which is sometimes overlooked, is the fact that people prefer to use "modern" and "fashionable" building materials (such as metal roofing, cement blocks and cement plaster as wall building materials).

Therefore, the challenges not only relate to a change in the design process, but also the need to induce a change in the mentality of architects, builders and final building users.



Policy Options

Well-designed policy measures can help boost markets for building efficiency by breaking down or bridging barriers, and can align the interest of all actors to implement cost-effective energy efficiency options at each stage of a building's lifecycle. Depending on local conditions, some policies may be more appropriate than others to achieve priority targets on energy efficiency. In most cases, various policy instruments should be combined in an effective policy package, considering criteria like the level of enforcement of mandatory requirements, the level of expertise of local building professionals, the building ownership situation and the importance of the self-build sector as well as the performance of utilities and regulators.

Policy design should take into account that long-term, easily understandable policies provide more investment security, relevant stakeholders should be involved in policy design and implementation, policies should be regularly evaluated and if needed, adapted, and low-income households should be especially supported.

Options for governments to improve energy efficiency in buildings are often grouped into categories, namely building energy efficiency codes (including standards and labelling), targets, awareness, incentives, utility programmes and capacity building.

Mandatory building energy efficiency codes (BEECs) and **standards** are regulatory tools that establish minimum levels of energy efficiency for different building types, and may comprehensively cover the design and construction of all energy systems. These may be complemented with energy efficiency standards for major appliances and equipment. Compliance enforcement remains the biggest challenge to implementing BEECs. Both in developed and in developing countries enforcement remains uneven and inconsistent due to differences in local government political and resource support, robustness of the enforcement infrastructure and conditions of the local construction market.

Energy efficiency improvement targets are cost-efficient and effective ways to achieve energy savings by engaging the whole sector. These can be directed towards building efficiency, public procurement or other areas and can take the form of EE standards or EE obligation schemes etc.

Policies and measures to increase **awareness** can help improve market transparency and enable building owners, tenants and operators to make informed energy management decisions. These may include public awareness campaigns, competitions, audits, rating and certification programmes, or performance certificates.

Financial incentives can comprise measures such as rebate programmes, tax incentives, grants, revolving loan funds, government risk mitigation guarantees or energy performance contracting.

Utility programmes offer another policy option, due to the easy access to building energy data and the relationship with owners and tenants through the billing cycle that utilities possess.

Capacity building measures, either through direct technical assistance within the government, or through workforce training programmes in the market, are crucial policy measures to ensure sustained development of the building sector.

To overcome persisting market barriers, several studies recommend expanding and strengthening political support for EE, improving the effectiveness of government supervision of the building construction sector, developing technical and engineering capacity of the building supply chain and bridging the gap in incremental cost financing for compliance with BEECs.

Conclusion and Recommendations

Collaborative action between decision makers, architects and building efficiency experts will be needed to ensure a holistic and sustainable development of the building sector and to create an effective energy efficiency policy for the built environment.

Opportunities for collaboration include the design of an energy efficiency policy for the built environment, including nationally appropriate mitigation actions (NAMAs) or intended nationally determined contributions (INDCs) and low-carbon development strategies, performance tracking to assess the energy savings at building level and the policy itself, policy interventions to incentivize integrated building design, and better and new forms of engagement with the investor community to design scalable, replicable financing models with particular attention to developing and emerging economies.

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