

Green Energy and Technology

Nilesh Y. Jadhav

Green and Smart Buildings

Advanced Technology Options

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*To my loving wife, Dipti, as she sacrificed
the most while I tried to balance several
commitments while finding time to write
this book.*

Preface

A safe, comfortable, and sustainable built environment is highly desirable as we spent most of our time in offices, factories, or homes. With the rapid urbanization movement throughout the world, it is predicted by the United Nations that 66 % of the population will live in urban areas or cities by 2050. Urbanization can be seen as a boon as well as a key threat to world sustainability. While on the one hand it offers opportunities such as better health, greater access to social services, and enhanced living options, it may also lead to rapid sprawl, pollution, and environmental degradation, if not planned well. It is hence essential to focus on urban sustainability and a sustainable built environment, with green and smart buildings as one of the most important keys to sustainable urban living.

While sustainability and sustainable development is a very broad topic, it is often viewed as consisting of three main elements: economic development, social development, and environmental protection. These three elements are equally important and often intricately linked to each other. It is noted that ‘green’ is sometimes mistakenly associated with the overzealous and inordinate support and advocacy of the aspect of environmental protection, while completely ignoring economic and social development aspects of sustainable development. This is not, however, the purpose of using the word ‘green’ in the title of this book. Although environmental protection will appear to be the primary goal of the technology solutions discussed in this book, the economic and social aspects of development and adoption of these technologies cannot be ignored.

The word ‘smart’ is also an overused term these days with the advent of smartphones and other smart devices. These devices enable users to take automatic control of their surrounding conditions in lightning speed without much human intervention. Smart buildings of the future would incorporate business objectives, user preferences, and sustainability goals seamlessly in building operations, while providing an exceptional experience to the building occupants and other stakeholders.

The specific focus of this book is on buildings. Understandably, buildings are part of a larger ecosystem of building estates and cities. However, the focus of this book is on the building itself and how technologies can help enhance its overall

sustainability performance. Building systems cover very broad topics, and there are in-depth publications and books on each of these topics separately. The attempt here is to provide an overview of advanced technology options for green and smart buildings without going into in-depth discussions in each area.

As an author of this book, I sincerely hope that this book will provide valuable reference and motivation on adopting, developing, and further improving through research, the effectiveness of green and smart building technologies. Along with many of the challenges facing humanity today, climate change is an important one and the building sector could do its part by adopting green and smart buildings. With the wide range of technologies and their benefits described in this book, green and smart buildings should become a norm without any further excuses. I definitely wish that my children and the next generation in general should live, work, learn, and play in buildings that are good for them, good for the economy, and good for the environment.

Singapore

Nilesh Y. Jadhav

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Chapter 1

Introduction

The building sector is the largest contributor to global greenhouse gas (GHG) emissions. Buildings use about 40 % of global energy, 25 % of global water, 40 % of global resources, and they emit approximately 30 % of GHG emissions. These emissions are set to double by 2050 if we carry on business as usual (UNEP 2014). The energy used by the building sector continues to increase, primarily because new buildings are constructed faster than old ones are retired. Electricity consumption in the commercial building sector doubled between 1980 and 2000, and is expected to increase another 50 % by 2025 (EIA 2005).

Other important facts:

- The building sector is estimated to be worth 10 % of global GDP (USD7.5 trillion) and employs 111 million people.
- Residential and commercial buildings consume approximately 60 % of the world's electricity.
- Energy consumption in buildings can be reduced by 30–80 % using proven and commercially available technologies.

Figure 1.1 shows that the buildings present the most impactful and also economical mitigation potential for GHG emissions globally.

Greenhouse gas emissions from buildings primarily arise from their consumption of fossil-fuel based energy, both through the direct use of fossil fuels and through the use of electricity which has been generated from fossil fuels. Significant greenhouse gas emissions are also generated through construction materials, in particular insulation materials, and refrigeration and cooling systems. Broadly speaking, energy is consumed during the following activities:

1. manufacturing of building materials ('embedded' or 'embodied' energy)
2. transport of these materials from production plants to building sites ('grey' energy);
3. construction of the building ('induced' energy);
4. operation of the building ('operational' energy); and
5. demolition of the building (and recycling of their parts, where this occurs).

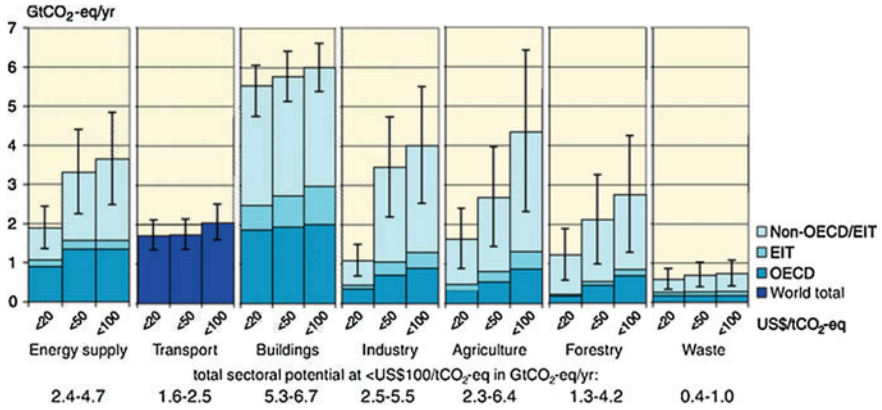


Fig. 1.1 Estimated economic mitigation potential by sector using technologies and practices expected to be available by 2030 (IPCC 2007)

Though figures vary from building to building, studies suggest that over 80 % of greenhouse gas emissions take place during the operational phase to meet various energy needs such as Heating, Ventilation, and Air Conditioning (HVAC), water heating, lighting, entertainment and telecommunications (Junnila 2004; Suzuki and Oka 1998; Adalberth et al. 2001). A smaller percentage, generally 10–20 %, of energy is consumed in materials manufacturing and transport, construction, maintenance and demolition.

Given these facts, it's imperative that significant actions be taken towards adoption and growth of green buildings, which can lead to significant reduction in GHG emissions especially during the operational phase of the building. Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving productivity
- Reducing waste, pollution and environmental degradation.

There are various definitions of a 'Green Building' and how it performs compared to any other building. One of the most comprehensive definition that I have come across and that will be used as a guideline for this book is as follows:

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. (US EPA 2014)