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Implementing Energy Efficiency in Buildings

A compendium of experiences from across the world

International Conference on Energy Efficiency in Buildings (ICEEB 2015)

17 – 18 December, 2015, New Delhi



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Disclaimer

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MESSAGE

Yuri Afanasiev, UN Resident Coordinator and UNDP Resident Representative, India



The United Nations is supporting the global effort to address climate change by creating platforms and targets for national initiatives and actions. At the United Nations Sustainable Development Summit in September 2015, world leaders adopted the 2030 Agenda for Sustainable Development. This includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by the year 2030. Also under the United Nations umbrella, the global climate change fraternity recently met for the 21st edition of the Conference of Parties (COP21) in Paris, where governments of different nations deliberated on their Intended Nationally Determined Contributions (INDC) amongst other climate change issues.

India's INDC, promoted by the Ministry of Environment, Forest and Climate Change, is a balanced and comprehensive attempt to work towards a low carbon emission pathway, while simultaneously endeavoring to meet other developmental challenges the country faces today. UNDP is committed to supporting the Indian government in its effort to create low-emission climate resilient development strategies.

Given that India is urbanizing faster than most countries in the world, the need for both new residential and commercial buildings across the country, especially in cities, is escalating. India is expected to increase the building stock by nearly three times the existing building stock by 2030. Hence, there is no better time than the present for India to integrate energy efficiency and conservation into its efforts towards sustainable development.

In this context, UNDP is collaborating with the Ministry of Power, Government of India, to implement the UNDP-GEF-BEE project 'Energy Efficiency Improvements in Commercial Buildings,' in recognition and support of the intent of the Bureau of Energy Efficiency, Ministry of Power to operationalize the Energy Conservation Building Code (ECBC) across Indian states. This initiative will also enhance the institutional capacities of State Designated Agencies (SDAs) to expand the compliance regime of ECBC and demonstrate model energy efficient commercial buildings in different climatic zones of the country.

I commend the joint efforts of UNDP-GEF-BEE, in organizing the 'International Conference on Energy Efficiency in Buildings' (ICEEB 2015) as a platform for different countries to share their experiences, learning and best practices in implementing energy efficiency in the building sector. This conference is an optimal opportunity for the international community to learn from each other and understand how to assimilate energy based initiatives into building climate resilient infrastructure in an environment of rapid growth and urbanization.

My best wishes for a successful ICEEB 2015!

MESSAGE

Susheel Kumar, Additional Secretary, MoEFCC, Government of India



Recent reforms in India to strengthen the development in the country indicate promising opportunities towards poised GDP growth that India aspires for. Four key campaigns initiated by the Indian Government that are particularly appealing for foreign investors and entrepreneurs alike are the 'Make in India', 'Clean India', 'Digital India' and 'Skill India' initiatives. However, to realise these ambitions, it is widely agreed upon that sustainability and low carbon growth needs to be at the heart of all initiatives. As a result, the development and implementation of innovative clean technologies has been increasing in importance and offers great opportunities.

The unlocking of this potential is essential to meet national goals of access to energy for all, reduced vulnerability to shocks in energy imports; and better urban air quality. Additionally, as a co-benefit, these actions also further mitigate greenhouse gas emissions. With the responsibility of lifting around 360 million people out of poverty and raising the standard of living of an even greater number of people, countries like India face daunting challenge of simultaneously address climate change and development needs.

Further to eight mission under India's National Action Plan on Climate Change (NAPCC), at the recently concluded COP-21, India's ambitious Intended Nationally Determined Contributions (INDCs) played a significant role projecting India as a global leader. India plans to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level. Even though at the helm of development, to achieve the above contributions, India is determined to continue with its on-going interventions, enhance the existing policies and launch new initiatives many priority areas including promoting energy efficiency in the economy, notably in industry, transportation, buildings and appliances. Urgent efforts to reduce GHG emissions need to take place against the backdrop of a growing energy demand and urbanisation in India.

Hence, India's INDCs commit to put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation. Government recognizes and commits towards, developing climate resilient urban centers and in recent times Government of India has launched a number of schemes for transformation and rejuvenation of urban areas including - Smart Cities Mission for 100 cities, Atal Mission for Rejuvenation and Urban Transformation (AMRUT) for around 500 cities and semi urban areas and National Heritage City Development and Augmentation Yojana (HRIDAY). All these developments will adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.

At this critical juncture MoEFCC being operational focal point of GEF, was happy to allocate GEF support to UNDP and Bureau of Energy Efficiency project 'Energy Efficiency improvements in Commercial Buildings' to operationalizing ECBC in Indian states. Bureau of Energy Efficiency, Ministry of Power shouldered the responsibility of implementing the project and MoEFCC values the partnership with UNDP-GEF in sharing the expertise, bringing the international perspectives and experiences. I express my appreciation and wish the International Conference on Energy Efficiency in Buildings (ICEEB 2015) a grand success.



MESSAGE

Ajay Mathur, Director General, Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India and National Project Director, UNDP-GEF-BEE project "Energy Efficiency improvements in Commercial Buildings"



I am pleased to see the lead taken by India for hosting this 'International Conference on Energy Efficiency in Buildings'. This provides a platform to share experiences from other similar projects being implemented across the world under the United Nations Development Program. I am equally pleased to see the participation of experts from other countries that have come all the way to share their experiences, knowledge and best practices on implementation of building energy efficiency programmes. I congratulate the Project Team along with the UNDP Project Office, India for having taken up this initiative.

Rapid growth in the economy and urbanization will lead to enormous demand for buildings and consequently energy in India in the coming year. The building sector is expected to increase five-fold from 21 billion square feet in 2005 to 104 billion square feet in 2030. Studies show that two-third of commercial and high-rise residential structures that will exist in 2030 are yet to be built. Such rapid expansion presents an opportunity to make a significant contribution to both energy savings and tackling climate change.

Addressing climate change is a key national priority for India, and the country has voluntarily taken responsibility to respond to this challenge. India has declared a voluntary goal of reducing the emissions intensity of its GDP by 33–35 per cent by 2030, compared to 2005 levels in the Intended Nationally Declared Contribution (INDC) submitted to UNFCCC. This can be achieved through promoting energy efficiency in sectors such as buildings, industries; by lowering the emission intensity in the transport sector and increasing non-fossil based electricity generation. Currently, the building sector accounts for about 35% of the country's energy consumption, and therefore the role of the building sector towards energy efficiency and energy conservation are imperative.

Over the past few years, Bureau of Energy Efficiency (BEE) has taken up several initiatives to promote energy efficiency in the building sector including the formulation of the Energy Conservation Building Code (ECBC). The code which is primarily for the design of energy-efficient commercial buildings is in the initial stages of implementation across the country. Given the federal structure of governance in India, while the code has been developed and promulgated by the Central Government, its enforcement lies with the State governments and urban/rural local bodies through notification within their states as per the regional requirements.

Many challenges and opportunities confront India as it pursues policies to unlock the full potential of energy efficiency in the country. During the process of adoption of the code at states, urban and semi-urban areas, it has been experienced that the integration of the provisions of the code in to the existing state regulatory framework and bye-laws is the best way of providing the enabling framework for its enforcement. The UNDP-GEF funded project on "Energy Efficiency improvements in Commercial Buildings" is providing assistance to Government's own initiatives in a comprehensive and integrated approach.

I am convinced that platforms like ICEEB 2015 provide excellent opportunities to interact and gather experience from different participating countries and learn of the innovative approaches to overcome the challenges that limit energy efficiency investments. The Project Management Unit set up as part of the ongoing UNDP-GEF project will gainfully learn from various UNDP initiatives across the world, make course corrections, if required and incorporate features relevant for implementation to India.

I wish the deliberations a great success and convey my best wishes to all for the festive season.



MESSAGE

Jaco Cilliers, Country Director, United Nations Development Programme, India



UNDP is actively involved in global efforts towards climate change mitigation, especially in assisting many transformational changes in the lowering of carbon emissions. Energy efficiency is a low hanging fruit which is often overlooked but has enormous potential to cut down and limit emissions. UNDP is leveraging GEF funds to support cities, states, regional and national governments in speeding up adoption of policies that promote energy efficient buildings across the world.

In collaboration with the Bureau of Energy Efficiency, Government of India, UNDP is executing 'Energy Efficiency Improvements in Commercial Buildings,' to address informational, capacity, institutional and financial barriers, even as it uses a comprehensive and integrated approach to assist the Government in implementing and operationalizing the Energy Conservation Building Code (ECBC).

The Project is currently working to operationalize ECBC in new commercial buildings across the country. The objective will be achieved through institutional and technical capacity development, ECBC compliance demonstrations, fiscal and regulatory frameworks for energy efficient buildings and, information and awareness enhancement.

UNDP and its partners have created a wealth of knowledge through implementing several initiatives related to energy efficiency in buildings around the world. Projects in Thailand, Viet Nam, Armenia, Romania, Malaysia, Russia, Namibia, Morocco and Belarus provide good examples and learning which can be shared and replicated.

In this context, UNDP and the BEE-Ministry of Power is organizing the 'International Conference on Energy Efficiency in Buildings' (ICEEB 2015) in New Delhi to encourage networking, south-south and south-north exchange of knowledge, ideas and learning and, to share information, experiences and good practices. The ICEEB 2015 will also focus on aspects of policy making, fiscal support, designing and implementing energy efficient buildings at all levels of national, regional and urban local bodies.

We appreciate the UNDP-GEF-BEE joint initiative to collate the compendium of international projects, implementation experience and lessons learnt. This will be a strategic tool for the Indian stakeholders to learn, ideate, conceptualize and execute projects that are relevant and appropriate to the Indian context and align with the national agenda on energy efficiency.

We wish ICEEB 2015 is a grand success!



MESSAGE

Manuel Soriano, Senior Technical Advisor, UNDP Bangkok



Recognizing the importance of energy in economic development, and the negative impacts of the wasteful and inefficient use of energy, many countries in the developing world have considered energy efficiency as a cost-effective strategy in achieving their sustainable development objectives. In an era of increasing concern about climate change, sustainable development and energy security, serious efforts toward the efficient use of available energy resources to support economic development has become increasingly crucial. This essential concern is mirrored by the UN Secretary General's SE4All initiative and SDG #7 of the Sustainable Development Goals (target 7.3) calling for the doubling of the rate of improvement in energy efficiency globally by 2030.

As part of the UN family, the UNDP has a long history of developing and implementing energy efficiency projects in the major end-use sectors of developing countries. Among these major energy end-use sectors is the one on buildings (residential and commercial). According to the International Energy Agency (IEA), the buildings sector typically accounts for almost a third of final energy consumption globally and is an equally important source of CO₂ emissions. Energy requirements for space heating and cooling as well as hot water are estimated to account for roughly half of global energy consumption in buildings. End-uses in buildings such as space heating and water heating represent significant opportunities to reduce energy consumption, improve energy security and reduce CO₂ emissions. This is mainly because the energy provision for these end-uses is typically dominated by fossil fuels. Also, space cooling is growing rapidly in countries with very carbon-intensive electricity systems.

In assisting developing countries in their efforts to improve the efficiency of energy utilization in buildings, the UNDP support the development and implementation of projects that address and remove barriers to the widespread application of energy efficiency technologies and the practice of energy conservation measures in buildings. Such projects consist of a range of interventions that include capacity building, creation of enabling environments, financing, and knowledge sharing.

Capacity building, information, communication and education activities are crucial to integrating energy efficiency into the development frameworks of developing countries, in general, and in the buildings sector, in particular. Enabling environments to facilitate the widespread adoption and application of energy-efficiency measures in buildings can be created through supportive policies and regulatory frameworks. Examples of these are UNDP-GEF projects on Energy Efficiency in Residential and Commercial Buildings that include components on the development and implementation of Building Energy Efficiency Codes in countries such as Thailand, Malaysia, Morocco, Namibia, Russia, etc. In some of these projects, and as part of the policy/regulatory interventions that address the financial barriers through tailored assistance with regard to financial support and innovative funding mechanisms so that countries can benefit from energy efficiency technologies in buildings. Furthermore, knowledge sharing is an essential element in such projects through the provision of valuable platforms for disseminating information and exchanging knowledge.



The 'International Conference on Energy Efficiency in Buildings' (ICEEB 2015), is a noteworthy initiative under the Energy Efficiency Improvements in Commercial Buildings Project of the Bureau of Energy Efficiency, Government of India. It is a suitable forum not only for building practitioners and stakeholders from the various countries represented in this conference, but also for the UNDP, for knowledge sharing, exchange of ideas and lessons learned, networking, and South-South and South-North Cooperation on the application of environmentally sound technologies, such as those that improve the efficiency of utilizing energy in the design, construction and operation of buildings.

Article 4, paragraph 5 of the UNFCCC commits developed countries to "take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention." The sharing of experiences, knowledge and techniques in the application of energy efficiency in buildings is one practical step towards fulfilling such commitment that would lead to meeting climate change mitigation targets of countries. The ICEEB 2015 is viewed here as a useful vehicle to facilitate such practical step.

Best wishes to the sponsors, organizers and participants of the ICEEB 2015 for a successful implementation of this collaborative and noteworthy endeavor of the Government of India and the UNDP.



FOREWORD

Preeti Soni, Assistant Country Director and Head (Energy and Environment), United Nations Development Programme, India

Sanjay Seth, Secretary I/C, Bureau of Energy Efficiency, Ministry of Power, Government of India and National Project Coordinator, UNDP-GEF-BEE project "Energy Efficiency Improvements in Commercial Buildings"



India is urbanizing faster than most countries globally, which is creating vast opportunities for the building construction industry in the country. Today, the building industry accounts for almost 34 percent of India's total energy consumption, making it one of the largest emitters of greenhouse gases (GHGs). The overall constructed area is projected to increase approximately 5 times - from 21 billion square feet in 2005 to about 104 billion square feet by 2030. Nearly

two-thirds of the building stock - commercial and high-rise residential structures - that will exist in 2030 is yet to be constructed.

Under the Energy Conservation Act (EC ACT) 2001, the Bureau of Energy Efficiency (BEE) developed the Energy Conservation Building Code (ECBC) in 2007 to promote energy-efficient technologies and measures in new buildings. Currently, ECBC is voluntary and India is still in the early stages of implementing the new code, which applies to commercial buildings with a connected load of 100 kW or 120 kVA. About 22 states in the country are at various stages of implementation of the code with 8 states.

As mandated by the EC Act 2001, BEE is continuously strengthening the institutional capacities of state-designated agencies (SDAs) to perform regulatory, enforcement, and facilitative functions in their respective states. However, energy efficiency opportunities continue to remain unexploited due to various challenges, such as (a) higher first costs; (b) lack of appropriate knowledge and capacities at various Government levels; (c) limited trained human resources; (d) inadequate information on energy performance of equipment; (e) financial, technical and transaction risks associated with the adoption of the new energy-efficient technologies; (f) split incentives, especially in the buildings sector. In order to translate energy-saving opportunities in buildings to tangible benefits, there is a continuous need for encouraging public policies, enhancing awareness, building capacities and adopting new trends and technologies.

To clearly outline the actions required to achieve energy efficiency in commercial buildings, a project titled 'Energy Efficiency Improvements in Commercial Buildings' was initiated in 2010 in partnership with the Ministry of Environment, Forest and Climate Change, Government of India, under UNDP-GEF funding. The project aims to address the barriers - informational, capacity, institutional and financial - that will help bring ECBC under the mandatory regime.

The project focuses on:

- **Strengthening** institutional capacities at various levels to implement ECBC and other energy efficiency programmes for commercial buildings;



- **Raising** awareness and developing technical expertise of key partners;
- **Demonstrating** compliance with ECBC in eight model buildings (with a total floor area of 1.47 million m²) in five climatic zones;
- **Formulating** fiscal and regulatory incentives for investors; and
- **Monitoring** and evaluation, knowledge sharing and learning.

The project investment could result in an annual direct carbon dioxide emission reduction estimated at 90.7 ktCO₂ or 181.4 ktCO₂ during the project duration assuming the buildings are operational for two years, and 2.27 million tonnes of CO₂ cumulatively over 25 years of its lifetime. The indirect emission reduction as a result of the capacity and institutional strengthening activities is estimated on a conservative basis (a) bottom-up approach results in 2,720,682 tCO₂ and (b) top-down approach results in 48,969,467 tCO₂ (as per 'Manual for Calculating GHG Benefits of GEF Projects').

So far, the project has achieved a better understanding of the challenges faced in enabling energy savings in commercial buildings. Other significant achievements include:

- **Developed** draft rules to support the enforcement of ECBC in the states;
- **Established** an institutional framework for supporting training and capacity building of key stakeholders in the states;
- **Developed** the process for establishing benchmarks for different categories of commercial buildings in various climatic zones;
- **Prepared** state-wise roadmaps for enhanced regulatory framework and to identify new fiscal incentives;
- **Supported** five demonstration projects for ECBC compliance;
- **Conducted** market assessment of energy efficient material.

The journey of the project has been challenging but also result-oriented. More details on this project are presented in this compendium. Hope they are useful and put to use effectively.



ACKNOWLEDGEMENTS

Editors of this compendium like to express our salutation and deep appreciation to all the experts, authors, speakers (National and International), without their timely submission of write-ups, articles and discussion papers, it would not have been possible to produce this compendium.

We would like to thank the GEF Official Focal Point (OFP) India, Ministry of Environment, Forest and Climate Change and Department of Economic Affairs, GEF Political Focal Point for selecting and supporting this project amongst the many proposals. We would like to thank to GEF for funding this project. We would like to acknowledge all the members of the Project Steering Committee of UNDP-GEF-BEE Project on Energy Efficiency Improvements in Commercial Buildings for their guidance in implementing the project.

We like to thank the previous National Project Director, Ms. Jyothi Arora, Joint Secretary, Ministry of Power, National Project Coordinators Mr. Saurabh Kumar, and Ms. Abha Shukla for their guidance. We also would like to thank all the previous staff of Project Management Unit.

We deeply appreciate the leadership of contribution of staff of the Project Management Unit (PMU), Mr. Karan Mangotra, Ms. Shabnam Bassi, Mr. Abdullah Nisar Siddique, Assistant Project Managers, Mr. Hareesh Nair, Finance Assistant, Mr. K K Nair, for guiding and supporting Financial aspects in implementing the project. We would like to thank Dr. Ajay Mathur, Director General, Bureau of Energy Efficiency and National Project Director of UNDP-GEF-BEE Project on Energy Efficiency Improvements in Commercial Buildings for his leadership.

We would like to place our sincere gratitude to the staff of UNDP regional office and UNDP Headquarters for their timely support, due diligence in preparing the proposal, annual reports, etc. We would like to thank all UNDP senior management associated with this project in past and present.



ACRONYMS

BEE	Bureau of Energy Efficiency
BEEP	Building Energy Efficiency Project
BEI	Building energy intensity
BESM	Building Energy Simulation Model
BMA-CPD	Department of City Planning, Bangkok Metropolitan Administrator
BMC	Bright Management Consulting Co., Ltd.
BSEEP	Buildings Sector Energy Efficiency Project
CARBSE	Centre for Advanced Research in Building Science and Energy
CBEEC	Commercial Building Energy Efficiency Center
CEA	Certified Energy Auditors
CEM	Certified Energy Managers
CFCs	Chlorofluorocarbons
CoP	Coefficient of Performance
CPWD	Central Public Works Department
DEDE	Department of Alternative Energy Development and Efficiency
DPT	Department of Public Works and Town & Country Planning
DSM	Demand Side Management
ECA	Energy Conservation Act
ECB	EcoCommercial Building Program
ECBC	Energy Conservation Building Code
ECMs	Energy Conservation Measures
EE	Energy Efficiency
EEICB	Energy Efficiency Improvements in Commercial Buildings
EMEER	Efficient Management of Electrical Energy Regulations
EMIS	Energy Management Information System
ENSOP	Engineering Solution Provider Co., Ltd.
EPC	Energy Performance Contract
EPEEF	Environmental Protection and Energy Efficiency Fund
EPI	Energy Performance Index
EPPO	Energy Policy and Planning Office, Ministry of Energy
EPU	Economic Planning Unit
ESA	Electricity Supply Act
ESCOs	Energy Service Companies
EU	European Union
FAR	Floor Area Ratio
FDFA	Federal Department of Foreign Affairs
GBCNA	Green Building Council of Namibia
GEF	Global Environment Facility
GHG	Green House Gas
GRIHA	Green Rating for Integrated Habitat Assessment
HVAC	Heating, Ventilation and Air-conditioning
IEA	International Energy Agency
IGBC	Indian Green Building Council
IGEA	Investment Grade Energy Audits
IIF	India Insulation Forum



INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
KPI	Key performance Indicators
LEED	Leadership in Energy and Environmental Design
LMRC	Lucknow Metro Rail Corporation
MELs	Miscellaneous Electric Loads
MEPS	minimum energy performance standards
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power
MoUD	Ministry of Urban Development
NBC	National Building Code
NEEMP	National Energy Efficiency Masterplan
NEEP	Namibia Energy Efficiency Programme
NMSH	The National Mission on Sustainable Habitat
NSI	Namibian Standards Institute
ONEP	Office of Natural Resources and Environmental Policy and Planning
PCD	Pollution Control Department
PDEC	Passive draught evaporative cooling
PEECB	Promoting Energy Efficiency in Commercial Buildings in Thailand
PWD	Public Works Department
QA	Quality Assurance
REDs	regional electricity distributors
REEEI	Renewable Energy and Energy Efficiency Institute
RSRDC	Rajasthan State Road Development and Construction Corporation Ltd.
S&L	Standards and Labelling
SAVE	Sustainability Achieved via Energy Efficiency
SCP	Sustainable Consumption and Production
SDA	State Designated Agency
SDAs	State Designated Agencies
SEC	Specific Energy Consumption index
SEC	Specific Energy Consumption Index
SEDA	Sustainable Energy Development Act
SEM	Systematic Energy Management methodology
tCO ₂	tonnes of Carbon dioxide
TCPO	Town and City Planning Organisation
TERI	The Energy and Resources Institute
TGB	Thai Green Building Institute
TGO	Thailand Greenhouse Gas Management Organization (Public Organization)
TPA	Third Party Assessor
ULBs	Urban Local Bodies
UNDP	United Nations Development Programme
UPERC	Uttar Pradesh Electricity Regulatory Commission
UPNEDA	Uttar Pradesh New and Renewable Energy Development Agency
UPSDA	Uttar Pradesh State Designated Agency
VOC	Volatile Organic Compounds
VRV	Variable Refrigerant Volume



PREFACE

SN Srinivas, Butchaiah Gadde, Sanjay Seth, Vittalkumar Dhage

The International Energy Agency (IEA) recognizes that buildings are the largest consumers of energy worldwide (40 per cent) and will continue to be a source of increasing energy demand in the future. Globally, the sector's final energy consumption doubled between 1971 and 2010 to reach 2794 million tonnes of oil equivalent (Mtoe), driven primarily by population increase and economic growth. Under current policies, the global energy demand of buildings is projected by the IEA experts to grow by an additional 838 Mtoe by 2035 in comparison to 2010. The building sector is the largest contributor to global greenhouse gas (GHG) emissions. Existing buildings represent significant energy-saving opportunities because their performance level is frequently far below current-efficiency potentials.

Enhancing energy efficiency in buildings is one of the priority areas recognized by the Government of India. To fructify this vision, Bureau of Energy Efficiency (BEE) notified the Energy Conservation Building Code (ECBC) in 2007 under the provisions of the Energy Conservation Act 2001. UNDP joined hands with BEE in designing and implementing a path-breaking project—'Energy Efficiency Improvements in Commercial Buildings' with a focus on operationalizing ECBC in Indian states with financial support from Global Environment Facility (GEF). International conference on Energy Efficiency in Buildings (ICEEB) is being organized under the aegis of this project. ICEEB intends to collate experts, exchange the lessons and broadcast expertise through mutual knowledge sharing and networking. Hence, we are glad to compile the knowledge in a form of a conference compendium.

This compendium, especially brought out during the occasion of 'International Conference on Energy Efficiency in Buildings' held at New Delhi, comprises a theme paper and 20 discussion papers by project managers of UNDP-GEF projects across globally and other expert practitioner in implementing energy efficiency in buildings across the world.

The compendium has four sections, each dedicated to topics that cover energy efficiency in buildings.

1. Challenges and barriers in the implementation of building energy codes – experiences and international collaborations
2. Policy, regulation and its impact on implementation, including international experiences
3. Benchmarking, technical, quality assurance, measurements, verifications, compliances and funding
4. Perspectives and case studies from stakeholders

Each discussion paper provides an abstract, introduction or background to the project, explains the project components and partners, gives details on the status of implementation, describes the positive quantifiable impacts with supporting data, facts, charts, issues, concerns, challenges faced and strategies implemented to overcome such concerns, issues and challenges with special focus on lessons learnt. It is envisaged that project stakeholders in India would benefit by networking and learning about projects and experiences across the world from the narrative of this compendium. We hope this compendium would contribute knowledge and provide interesting ideas and concepts that can be taken to the next level of implementation!

THEME PAPER: TOWARDS 'BUILDING' ENERGY EFFICIENCY

SN Srinivas, Butchaiah Gadde, Sanjay Seth, Vittalkumar Dhage

Abstract

World-wide, it is seen that energy efficiency in buildings is a major area to cut carbon dioxide. While there are barriers, there are significant opportunities. The paper enumerates the efforts of Bureau of Energy Efficiency in promoting energy efficiency in buildings through a number of initiatives. The paper describes the initiatives of building codes, star labeling, concept of Energy Service Company, etc. Despite these initiatives, only 1% of total building stock is energy-efficient, hence the paper presents challenges in implementing these initiatives and opportunities that exist to address the challenges. It also lists the support from bilateral and multilateral support to BEE in making the buildings more energy efficient.

Key words: *Centre for Advanced Research in Building Science and Energy (CARBSE), Urban Local Bodies (ULBs), Bureau of Energy Efficiency (BEE), Intended Nationally Determined Contributions (INDCs), National Mission for Enhanced Energy Efficiency (NMEEE), National Building Code (NBC), Central Public Works Department (CPWD), National Mission on Sustainable Habitat (NMSH), Energy Service Companies (ESCO), Investment Grade Energy Audits (IGEA), International Energy Agency (IEA)*

I. IMPERATIVE OF ENERGY EFFICIENCY IN EMISSION REDUCTION

Between now and 2030, energy efficiency can reduce the global cost of limiting warming to 2 °C programme by up to \$2.8 trillion in comparison to a more energy-intensive pathway. A new report 'How Energy Efficiency Cuts Costs for a 2 °C Future' funded by ClimateWorks and the research by a consortium of groups led by Fraunhofer ISI, analyses how energy efficiency policies and programs in Brazil, China, Europe, India, Mexico and the US can reduce the cost of economy-wide decarbonization by up to \$250 billion per year for these regions, with no net cost to society through 2030.

The potential annual savings of the energy-efficiency pathway vary from nation to nation. Annual savings range from 0.1 to 0.4 percent of annual GDP and are not sensitive to macroeconomic shifts or to changes in fuel price. In addition, the economic benefits of energy efficiency can help eliminate energy poverty. Recent research by the World Bank shows that the world can achieve universal access to electricity through investments of between \$40 billion and \$100 billion annually. The \$250 billion saved in the regions studied could help finance this critical goal.

China, Brazil and Mexico have already begun the process of 'leapfrogging' toward less energy-intense economies and are currently realizing avoided lock-in costs and related economic benefits. As part of the global commitment to limit warming to 2 °C, building codes and retrofits in the US could also save roughly \$20 billion annually, compared to other emissions reduction pathways.



There are significant opportunities in India to improve energy efficiency. Few sectors are currently subject to best practice efficiency standards. India can prioritize efficiency gains while strengthening its economy and making decarbonization more affordable.

II. TOWARDS ACHIEVING ENERGY EFFICIENCY IN BUILDINGS IN INDIA

The Energy Conservation (EC) Act of 2001 provides the framework for energy efficiency imperatives in India followed by the National Mission for Enhanced Energy Efficiency (NMEEE) in 2008. India's Intended Nationally Determined Contributions (INDC) aim to reduce the emissions intensity of our GDP by 33–35 per cent by 2030 from the 2005 level; mandates promotion of energy efficiency in the economy, notably in industry, transportation, buildings and appliances; as well as development of climate-resilient infrastructure.

Over the past few years, BEE has introduced initiatives to promote design of energy-efficient commercial buildings based on ECBC; energy conservation in buildings and municipalities through performance contracting by ESCOs; adoption of energy-efficient consumer appliances through energy labelling; market transformation towards energy-efficient appliances through demand side management programmes; energy efficient motors; and enhanced focus on energy-efficiency investments in industry due to energy data reporting and benchmarking practices.

III. ENERGY EFFICIENCY IN NEW COMMERCIAL BUILDINGS

The Energy Conservation Building Code (ECBC) was developed by BEE for new commercial buildings in May 2007. It establishes minimum requirements for energy-efficient design and construction for buildings with a connected load of 100 kW or greater or a contract demand of 120 kVA or more, and provides guidelines for building design, including the envelope, lighting, heating, air-conditioning and electrical systems.

The state governments have the flexibility to modify the code to suit local or regional needs and notify them. It is important to note that while the ECBC has been developed by BEE, its enforcement lies with the state governments and urban local bodies through notification within their states. About 22 states in the country are at various stages of implementation of the code with eight states and union territories (Rajasthan, Odisha, Uttarakhand, Punjab, Karnataka, Andhra Pradesh, Telangana and UT of Puducherry) being notified and have adopted the code.

Consequent to the notification by the states for the mandatory adoption of the code, integration of the provisions of the code into the bye-laws would provide an enabling framework for its enforcement. The National Mission on Sustainable Habitat (NMSH) was launched by the Ministry of Urban Development to promote energy efficiency as a core component of Urban Planning. The NMSH stresses the need for awareness, incentives for wide-spread adoption of energy-efficiency programmes, promoting a mix of voluntary guidelines and mandatory rules for energy efficiency in buildings, and capacity building of state and city-level bodies for implementing and enforcing these rules. In view of this, model building bye-laws to mandate minimum energy standards for residential and commercial buildings/ complexes as per National Sustainable Habitat parameters on energy efficiency have been framed and circulated by the Ministry of Urban Development for their integration into the existing government orders. Simultaneously, an addendum to the National Building Code (NBC) 2005 has been finalized by including a chapter on sustainable building design, namely, 'Approach to Sustainability', so that it is adopted in all future



constructions, including the same in the rate schedules of the Public Works Department/construction agencies. Similarly, amendments in the Central Public Works Department (CPWD) Schedule of Rates and Plinth Area Rates have been carried out to incorporate energy-efficiency aspects. Developing various standards like NBC, ECBC, BEE rating programmes for appliances and existing buildings have been encouraging steps in this direction. The market-driven voluntary Green Building Rating programmes such as LEED and GRIHA, have significantly transformed the way buildings are designed. Green Buildings have the potential to save 40 to 50 percent energy vis-à-vis the conventional practices.

The target for the 12th plan period is that 75 per cent of all new commercial buildings are constructed compliant to ECBC. The 12th plan period proposes to support several activities like adoption and facilitation for ECBC implementation, development of test standards for building components, creation and augmentation of building material test facilities, creation of a cadre of professionals through a testing & certification programme to check compliance to ECBC, etc. The process of ECBC update in view of technological advancement, market change in regard to energy demand and the supply scenario has been initiated.

IV. ENERGY EFFICIENCY IN RESIDENTIAL BUILDINGS

Electricity consumption in residential buildings is expected to increase seven-fold during the period between 2012 and 2032, and the residential sector will become the largest consumer of electricity in the country with a 36 per cent share of the total electricity consumed in 2032. The Design Guidelines for 'Energy-Efficient Multi-Storey Residential Buildings' have been developed with the objective of providing comprehensive information on how to design energy-efficient multi-storied residential buildings. These guidelines will be used by the persons/agencies involved in the regulation, design and construction of multi-storied residential buildings in urban areas such as private and government sector developers and builders, architects and other design professionals, and urban local bodies.

V. ENERGY EFFICIENCY IN EXISTING BUILDINGS

The scope for energy-efficiency improvements in buildings is immense. However, there are various factors that discourage the large-scale enhancement of energy efficiency in buildings:(a) lack of awareness amongst building owners and managers about the specific interventions that could lead to greater energy efficiency;(b) non-availability of appropriate delivery mechanism to capture future energy savings because of energy efficiency and energy conservation measures. Energy savings are determined by comparing energy baseline with energy consumed after implementation of energy efficiency measures. Energy audit studies have revealed a savings potential to the extent of 40 per cent in end uses such as lighting, cooling, ventilation, refrigeration, etc. Energy cost savings resulting from energy efficiency measures directly benefit building owners and occupants over the life cycle of the building.

It has been seen, time and again, that energy conservation in such buildings can be achieved through well-known interventions, which are cost effective as well. However, the implementation of these interventions is hampered by institutional, procedural and process barriers, particularly the inability of building managers to assess and guarantee energy savings due to these interventions. In order to address this institutional barrier, BEE has taken up the task of institutionalizing energy efficiency services and of promoting energy efficiency delivery mechanisms, such as the development of a market for ESCOs, which address the risks perceived by building owners. ESCOs provide a business model through which the energy-savings potential in existing buildings can be captured and the risks faced



by building owners can be addressed as well. The performance contract-based payments for energy savings achieved through the interventions carried out by ESCO ensure that savings are achieved and that payments by the building owners to ESCO are related to the achievement of these savings. In order to create a sense of credibility amongst the prospective agencies that are likely to secure the services of ESCO as well as the financial institutions, BEE does an accreditation exercise for ESCOs through a process of rating these applicants in terms of success in the implementation of energy-efficiency projects based on performance contracting, availability of technical manpower, financial strength, etc.

With an aim to overcome the barriers for achieving energy efficiency in existing facilities on the performance contracting mode, BEE has introduced a scheme for implementing energy efficiency in the existing central government buildings through the ESCO mode. The approved scheme provides for funding of Investment Grade Energy Audits (IGEA) being arranged by central government agencies/ state designated agencies.

In order to promote a market pull for energy efficient buildings, BEE developed a voluntary star rating programme for buildings, which is based on the actual performance of a building, in terms of energy usage in the building over its area expressed in kWh/sqm/year. This programme rates buildings on a 1–5 star scale, with 5-star labelled buildings being the most energy efficient. Star labels for office buildings used during daytime, business process outsourcing (BPO) organizations, shopping malls and hospitals have been developed accordingly.

VI. PERSISTENT CHALLENGES

Although significance of energy efficiency in the sector of Indian buildings has been well established in the last few years, it has still not become an integral part of the construction of energy efficiency in the building sector in India. At present, the stock of energy-efficient buildings in India comprises about 1 per cent of the total building stock.

One of the key factors hindering the growth of energy-efficient buildings in India is the general apprehension of the building industry that these buildings do not make business sense. The increment in the initial capital cost incurred towards constructing an energy-efficient building is the biggest deterrent in allowing large-scale adoption of such practices by the construction industry. However, strategies that are integrated in the building and services design; and energy-efficient equipment that are installed to improve the energy performance of buildings, contribute towards some increment in the initial investment cost of energy-efficient buildings, when compared to initial investment costs of conventional buildings. It is this increment in cost that usually shadows all the benefits of such buildings and discourages the management boards/ developers/ owners in making the extra investment to make energy-efficient buildings. These costs are likely to fall significantly over time as the building materials become locally manufactured and the scale of economies drive down the cost.

VII. OPPORTUNITIES THAT EXIST TO ADDRESS THE CHALLENGES

Many challenges and opportunities confront India as it pursues policies to unlock the full potential of energy efficiency in buildings across the country. During the process of adoption of the code at states, urban and semi-urban areas, integration of the provisions of the code in to the bye-laws would provide an enabling framework for its enforcement. There has been momentous bilateral and multi-lateral support in the journey of implementing the ECBC. UNDP-GEF funded 'Energy Efficiency Improvements in Commercial Buildings' project assisting BEE in implementing and operationalizing the



ECBC, through an integrated approach in selected states and cities. UNDP across the world supporting many governments in projects related to energy efficiency in buildings. A paper in this compendium provides an update on some of the UNDP-GEF projects focusing on energy efficiency and energy generation in the buildings sector and their contribution to reduced greenhouse gas (GHG) emissions. UNDP-GEF energy efficiency projects in the buildings sector are being implemented in India, Malaysia and Thailand in Asia and the Pacific and their focus areas.

Many projects have attempted to address policy formulation scenario and contributed towards country's legal, regulatory and institutional strengthening for energy efficiency policies. Case studies on Romania, Belarus and Namibia have been extensively discussed in the compendium. Apart from the regulatory scenario, a few learnings and actions taken towards addressing the challenges, barriers predominantly picked from UNDP projects across the world, along with working concepts and ideas suggested by authors are listed below.

a. Overcoming lack of market demand for EE buildings

There is an apprehension that energy efficiency and business would not go together. Energy efficiency needs its visibility in terms of bringing real value to the investment. Improving energy efficiency is a process of change as it requires changing attitudes to energy use. Complex interrelationships among multi stakeholders and an environment with several variables, shifting goals and targets make EE more challenging to implement.

Building owners tend to delude EE during building design and construction due to the presence of a strong first cost bias as developers seem to believe that they don't directly gain from the initial investments towards energy efficiency. Lack of awareness regarding existing opportunities, information and techniques on the energy savings potential in buildings is also one of the causes.

While addressing **financial barriers**, Srinivas, in his paper, identifies that they play a significant role in limiting energy-efficiency investments mainly due to lack of financial incentives for energy-efficient equipment. Energy Efficiency of buildings is not given due consideration in funding and incentives from the government. Revision of regulatory framework is required regarding duty relaxation, incentives and tax benefits. Also financing energy efficiency is not too lucrative for financial institutions due to uncertainty about returns. There is a need for innovative financing schemes to promote EE in buildings. There can be lack of awareness of the short amortization cycle and/or the lack of incentives for investors and contractors to build ECBC compliant buildings and/or lack of awareness that low energy bills can be a powerful marketing argument for future rental contracts. High costs of borrowing money can be a strong impediment to incremental funding in efficiency that would be offset by future savings of energy costs.

Miroslov discusses implementation of energy efficiency **economic instruments**. His paper identifies best practices and successes from Croatian building EE project and how they were transferred to the Malaysian context, namely, Energy Management Information System, financing and incentive mechanism ideas. Differences in approaches towards overcoming barriers, implementation experiences and lessons learned are enumerated. Main source of public EE financing in Croatia is the Environmental Protection and Energy Efficiency Fund (EPEEF), which is a polluters pay facility envisioned to incentivize take-up of EE in a wide variety of sectors, from transport to building, household, commercial sector and industry, and EE and Renewable energy (RE) projects. With regard to the current Energy Efficiency Action plan for Croatia, and in line with the international experience on EE financing, the conclusion

is that public funds itself cannot drive EE in the building sector towards creating a critical mass on the market. At the end of the day, EE has to be a viable business case in order to leverage private financing, using public finance to cover risks. This lesson learned was implemented in Malaysia, and the focus of the work in the economic instrument project component focused on the commercially operated project-base financing schemes. Described pathway offers a smoother transition for the building EE sector with market driven and sustainable schemes that are harmonized with energy-efficiency policy development and tightening of energy requirements for the building sector.

Kevin describes how Malaysian BSEEP project is strategically demonstrating creation of a novel EE fund led by the private sector to handhold such investments. The project is also working towards the development of a dedicated credit line with a local government-owned bank for energy service companies, developing a gross floor area incentive for local councils to achieve energy efficiency compliance, while assuring revenue to the local council.

b. Non-availability of energy-efficient building materials and related technology barriers

Situations of non-availability of energy-efficient equipment/materials in the local marketplace as most energy-efficient equipment and materials are imported, often ends up with the imposition of high cost mark-ups and duties. The importance of EE building materials have also been stressed in Mr Abdullah's paper.

Understanding the need of the hour, 'Energy-Efficient Building Materials', the IEA had conducted a study in 2013, identified the countries across the globe (as studied) and have realized the importance of energy-efficient building materials. It has started various policies to push the respective countries to ensure availability of such materials. The study clearly indicates that only one-third of the listed countries (study conducted by IEA) have established markets/matured markets for the building materials. Analysis also shows that the market of energy-efficient building materials in countries like India, Brazil, China, Mexico, Middle East, Russia and South Africa lies at the initial stage. An original study by Abdullah's team identifies that though flyash brick is cheaper and a better alternative than conventional brick, it is yet to make its mark as a commercially viable option.

Demand–supply gap assessment, the current capacity of the AAC block manufacturers and suppliers is 5 million cubic metres in India. Out of this, approximately 35 per cent caters to the commercial market (as assumed in the analysis above). This leaves the manufacturer with a capacity of 1.75 million cubic metres for the commercial real estate sector. Thus, new capacity addition will be required in 2016–17 under the moderate scenario and in 2015–16 in the optimistic scenario.

In case of insulation material, it was highlighted during a stakeholder consultation that companies producing or supplying insulation material in India are mostly operating at 50 per cent capacity utilization. Abdullah's paper mentions that the demand for insulation material is construction driven and hence, the market is confined to the west and north in India.

Bhaskar Natarajan's paper identifies major challenges in skilled human resources. The **skills, knowledge and technical expertise** of the workforce including consultants is not up to the required level, therefore institutional inability exists in enforcing, implementing and regulating energy efficiency. There are very few technical experts and consultants providing building energy-efficiency-related services. This forces many teams to hire international consultants at a high cost, affecting the choices around design and construction.



Mr Abdullah's paper recognizes that equipment testing/certification and programmes for standards, and testing equipment for energy-saving features of building materials and equipment are not in place.

Mr Jirayut emphasizes on the outcome of one of the key project component **Awareness Enhancement on Building EE Technologies and Practices** under Promoting Energy Efficiency in Commercial Building, PEECB Project in Thailand.

c. Approaches to building energy code compliance

In India ECBC is **yet to see a mandatory regime** as a compliance measure and thus its adoption immediately is not compelling enough. A paper by Dr Rajan Rawal and his team talk about work carried out by Centre for Advanced Research in Building Science and Energy (CARBSE) at CEPT University, Ahmedabad, about developing a **Tiered Approach for Building Energy Code Compliance**.

In the Tiered Approach to ECBC compliance, Tier 1 includes those requirements of ECBC that are easy for market adoption, have a high energy savings potential and are enforceable through the current building permit process. Tiers 2 and 3 include additional measures of ECBC that are more difficult to implement or enforce, given the current practices, and have a lower potential for energy conservation. This reduces the burden on ULBs to enforce requirements that are too technical in nature. Further, the Third Party Assessor Model for ECBC Compliance and Enforcement shows the way to facilitate the implementation and enforcement of ECBC in the country, given the lack of manpower or expertise of the local governments.

d. Financial feasibility of green building investments

A study conducted by TERI to investigate the financial feasibility of green building investments by evaluating the economic impacts of incorporating various energy-efficiency strategies in commercial buildings revealed that the incremental capital investment for a green building is recovered with paybacks of one to three years. The cash savings accrued from these green buildings not only compensate for this initial cost increment but provide benefits to the owners/occupants throughout the life time of the building.

VIII. CONCLUSION

To translate energy-saving opportunities in buildings to tangible benefits, there is a continuous need to encourage public policies, enhance awareness and capacity building, and adopt new trends and technologies.

With components of strengthening institutional capacities and knowledge sharing, platforms like ICEEB 2015 provides excellent opportunities to interact to gather experiences from different countries, learn from each other and throw light on overcoming the challenges that limit energy efficiency investments.

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SECTION I

Challenges and Barriers in Implementing
Energy Conservation Codes—Experiences
and International Collaborations



1. ENERGY-EFFICIENCY IMPROVEMENTS IN COMMERCIAL BUILDINGS IN INDIA

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Abstract

India is poised with a growth rate of 8–10 per cent in the building sector. In the building sector, commercial buildings space accounts for 33 per cent. The total emissions due to already existing commercial building space was estimated to be about 73.77 million tCO₂ annually, as in 2010. It is estimated that energy conservation interventions in new buildings can reduce 20–50 per cent energy consumption (fossil fuel use as well as electricity) by incorporating appropriate design interventions like building envelope, lighting, heating, ventilation and air-conditioning (HVAC) systems. BEE developed Energy Conservation Building Codes to encourage energy efficiency in buildings. However, compliance to ECBC was voluntary since some of the barriers limited their implementation. UNDP and BEE designed a project in 2012 'Energy Efficiency improvements in commercial buildings in India' with support from GEF to overcome the barriers identified to enable compliance to ECBC and be ready to take them from the voluntary to mandatory regime. The paper presents the progress made till now and the lessons learnt.

Key words: Energy Efficiency, Commercial Buildings, Energy Conservation Building Codes (ECBC), Energy Performance Index (EPI), tonnes of Carbon dioxide tCO₂, Bureau of Energy Efficiency (BEE), United Nations Development Programme (UNDP), Global Environment Facility (GEF), Energy Conservation Act (EC Act 2001).

I. INTRODUCTION

Over the years, electricity use has increased significantly in the commercial sector. Globally, building sector is responsible for 40 per cent energy use. The annual energy consumption in the commercial buildings in India is in excess of 200 kWh per square meter per year. Air-conditioning and lighting are the two most energy consuming end-use applications within a building. This has led the Government of India to include them as 'designated consumers' under the Energy Conservation Act (2001). 'Designated consumers' as identified by BEE are energy-intensive industries or similar establishments recognized under the EC Act (2001). Buildings having connected load of 100 kW and above or contract demand of 120 kVA and above are defined as commercial buildings (as per amendment of the Energy Conservation Act 2001 in the year 2010).

The building sector is the second largest employment provider next to agriculture. Its size is expected to reach 60 billion USD in 2010 and commercial real estate market was to reach 12 billion USD. The building construction industry at present contributes about 10 per cent of the GDP, and is expanding rapidly at over 9 per cent per year, spurred largely by the strong growth in the services sector.

The building industry alone is also one of the biggest emitter of GHG in India. Electricity consumption in the building sector in India is 7 per cent of the country's total electricity consumption. In the building sector, commercial building space accounts for 33 per cent. The building sector is growing at 8–10 per cent annually.



There are vast opportunities to reduce electricity consumption and increase energy efficiency within commercial buildings. It is estimated that new buildings can reduce between 20–50 per cent energy (fossil fuel use as well as electricity) consumption by incorporating appropriate design interventions in the building envelope, lighting, heating, ventilation and air-conditioning (HVAC) system.

Despite these enormous opportunities, only a fraction of the building stock has adopted energy efficiency measures. Hence, UNDP and BEE analysed the barriers that are limiting the efforts to increase use of energy efficiency which are described in the following section.

II. BARRIERS LIMITING INCREASING ENERGY EFFICIENCY IN COMMERCIAL BUILDINGS IN INDIA

Identifying the importance of building sector, especially commercial buildings, the Government of India has developed ECBC. This was made voluntary, as many barriers identified were to be addressed before they are mandated. The barriers identified at the baseline (2010) are as mentioned below.

A. Policy and institutional barriers

- **Absence of mandatory standards:** ECBC was developed by the Government of India to encourage increasing energy efficiency in commercial buildings. However, this was voluntary. There were no minimum energy performance codes for most buildings and building components in any of the building bylaws.
- **Absence of policy guidelines for building bylaws:** Municipalities are entities that are responsible for building plan approvals. Most municipalities do not have a uniform and practicable building energy codes. Municipalities and states do not have clear guidelines for developing and implementing building energy-efficiency programmes and policies.
- **No structure for ECBC implementation:** There are no institutional structure at the national, state and local levels for handling ECBC administration and enforcement, and hence not ready to be made mandatory yet.
- **Lack of government champions due to knowledge gap:** There is lack of knowledge about benefits from energy efficiency in buildings among politicians and policy makers at all levels. 'Success stories' have not yet been disseminated widely. Not many governmental agencies have made energy efficiency mandatory in their own buildings.

B. Technical and managerial capacity barriers

- **Strong first cost bias:** The building market is diverse and characterized by fragmentation into various players. The complexity of interaction among these participants is one of the barriers to energy efficient buildings. For example, building owners tend to underinvest in energy efficiency during building design and construction. The developers do not gain from the initial investments in building energy efficiency.
- **Lack of awareness of energy savings opportunities:** There were no energy use baselines for most building types. Building designers and owners are unaware of energy-efficiency opportunities and techniques. Information on energy-saving potential in buildings is also not available. Building audit methodologies need to be improved.

- **Lack of technical expertise:** There are very few technical experts and consultants providing building energy efficiency related services. This forces many builders to hire international consultants at a high cost impacting the choices around design and construction.

C. Materials and technology barrier

- **Non-availability of energy efficient equipment/materials in the local marketplace:** Most energy-efficient equipment and materials are imported, often with high cost mark-ups and duties imposed.
- **Lack of equipment testing/certification:** Programmes for standards and testing equipment for energy-saving features of building materials and equipment are not in place.

D. Finance barriers

- **Lack of financial incentives for energy-efficient equipment:** Energy-efficiency of buildings is not given due consideration in funding and incentives from the government. Revision of regulatory framework is required regarding duty relaxation, incentives and tax benefits. Also, financing energy efficiency is not too lucrative for financial institutions due to uncertainty about returns. There is a need for innovative financing schemes to promote EE in buildings.
- **Lack of awareness:** The lack of awareness of the short amortization cycle and/or the lack of incentives for investors and contractors to build ECBC compliant buildings and/or lack of awareness that low energy bills can be a powerful marketing argument for future rental contracts.
- **High cost of borrowing money:** This can be a strong impediment to incremental funding in efficiency that would be offset by future savings of energy costs.

III. PROJECT OBJECTIVES AND TARGETS

Thus, the project was designed to address the barriers outlined above, with the goal to reduce GHG emissions from new commercial buildings through compliance with ECBC. The project objective is to operationalize the ECBC for new commercial buildings. The project targets are given as below:

1. Reduce 110 GWh of energy consumption annually, thereby reduce 90,689 tCO₂
2. Reduce 181,379 tCO₂ during the project period
3. 2.27 million tCO₂ cumulatively over 25 years of their lifetime.
4. Indirect emission reduction as a result of the project capacity and institutional strengthening activities is estimated on a conservative basis as per Manual for Calculating GHG Benefits of GEF Projects
 - bottom-up approach results in 2,720,682 tCO₂ and
 - top-down approach results in 48,969,467 tCO₂



IV. RESULTS

A. Strengthening institutional capacities to enact and enforce ECBC for commercial buildings

The target for BEE is to make ECBC mandatory by 2017. BEE sets up the guidelines, while implementation is done at the state through state-designated agencies. In many states, the state nodal agencies established for promoting renewable energy act as state-designated agency for promoting energy efficiency.

- **ECBC Cells:** ECBC cells at the state level are being proposed to strengthen local institution capacities and actions to implement ECBC. The ECBC cell consists of a team of about four skilled manpower two engineers and two architects, stationed at SDAs for a period of one to two years, who assist the state to evaluate the current guidelines and help them identify the gap to strengthen and comply with ECBC. With support from the project, four states have made ECBC mandatory. ECBC roadmaps were prepared with project support for 16 states. Roadmaps consisted of financial incentives that can spur the ECBC market and the regulatory framework to implement ECBC. Further to support implementation of ECBC in these states, ECBC cells are proposed for 12 states to facilitate the process of notification.
 1. States where ECBC has been notified (8 nos.): Rajasthan, Odisha, Uttarakhand, Andhra Pradesh, Telangana, Punjab, Karnataka and the Union Territory Puducherry.
 2. States which have amended ECBC for their states (11 nos.): Uttar Pradesh, Kerala, Gujarat, Tamil Nadu, Haryana, Chhattisgarh, Maharashtra, West Bengal, Himachal Pradesh, Bihar and Madhya Pradesh.
 3. States which are targeted to notify ECBC by the end of the 12th Plan Period: All States.
- **EPI Benchmarking:** Energy Performance Index (EPI) is a number that indicates overall energy performance of a building. EPI can be used to benchmark the performance of a building. This can be a very useful tool for building developers to assess how their buildings are performing and take corrective actions, and for the authorities who need to ensure that the buildings they approve comply with ECBC. At the baseline year, only a broad EPI was established. However, India being diverse in terms of climatic zones and category of buildings, it was necessary to establish EPI for different scenarios. Data was collected from 1160 commercial building from different climatic zones, namely, warm and humid, composite, hot and dry, and moderate. The EPI established for four different climatic zones for different building categories are presented in Table 1.1 below.

Table. 1.1 EPI for different building categories (kWh per square meter per year)

Type	Warm & humid	Composite	Hot & Dry	Moderate	Simple average
Office building, less than 50% Air-conditioning area	101	86	90	94	93
Office building with more than 50% Air-conditioning area	182	179	173	179	178

Type	Warm & humid	Composite	Hot & Dry	Moderate	Simple average
Shopping mall	428	327	273	257	321
BPOs	452	437	-	433	440
Hotels – up to 3 star	215	201	167	107	173
Hotels – above 3 star	333	290	250	313	297
Hospitals	275	264	261	247	262
Institutes	150	117	106	129	126

Source: Shabnam et.al. (rounded off to whole number)

The project has also envisaged to inventorize all buildings having connected load of 500 kW and above. Parameters like energy consumption will be assessed, which will help make them ECBC compliant and increase awareness of developers while developing future buildings.

B. Enhancing technical capacity and expertise of local building practitioners and service providers

As part of this outcome, it was envisaged to train energy auditors [1,000 nos.] who provide knowledge inputs to make ECBC compliant buildings, manufacturers to use testing to improve their building performance [75 products] and train other stakeholders such as architects, building professionals, developers and contractors, etc. [1,500 nos.]. It was also envisaged to develop energy service companies, certification schemes, accredited building energy auditors and establish a registry of all these. It was envisaged to develop training curricula with School of Planning and Architecture, National Institute of Design and the Indian Institute of Management (19 such institutes). It also envisages to conduct pilot training as per curricula developed and make post-training assessments. Till date the following have been achieved:

- **Master trainers:** A master training scheme was developed under the project to create a pool of technical experts called master trainers. The master trainers are not only trained to support planning process but also to support implementation of ECBC. Three institutes, namely, CEPT University, Ahmedabad, Gujarat; Indian Institute for Information Technology, Hyderabad; and Malaviya National Institute of Technology, Jaipur have been identified to impart the master training. The states of Andhra Pradesh and Maharashtra have identified the need to institutionalize training and capacity-building activities within their states to create state-specific cadre of professionals, and the project is providing this support.
- **Training energy auditors:** BEE established the concept of energy auditors in the country. They are expected to act as energy counsellors, carrying out energy audits, providing recommendations to industry and other establishments on improving energy efficiency. There are two categories of energy counsellors—energy managers and energy auditors. Both have to appear for an exam conducted by BEE, three papers are common for both categories; however, energy auditors have to clear an additional paper. The BEE provides certification to those who qualify in these exams and

they are called Certified Energy Managers (CEM) and Certified Energy Auditors (CEA), respectively. There are about 10,000 CEMs/ CEAs. The project is making use of the skill set available in promoting building energy efficiency. Against a target of training 1000 energy auditors, till now, 413 have been trained under the project on ECBC. A short duration training covering orientation to building energy, updates on guidelines will suffice as they already are well versed with energy efficiency aspects.

- **Awareness programmes:** As building energy efficiency aspects are fairly recent, it is important to create awareness with all stakeholders, namely, property managers, architects, building professionals, developers and contractors, municipal authorities, etc. In this regard, several programmes have been conducted and more are planned in the coming months. The project has created awareness to about 300 personnel in 10 programmes against the targeted 1500 in 50 programmes. In addition, the project has also trained 15 persons as trainers. These programmes have been pan India, first set of programmes have been conducted in the following states, namely, Andhra Pradesh, Bihar, Chandigarh, Chennai, Gujarat, Maharashtra, Puducherry, Raipur, Thiruvananthapuram, Tripura, Uttarakhand and Uttar Pradesh.
- **Market Assessment of Energy Efficient Building Materials:** To increase the building manufacturers to make use of product testing results in improving their building material products, the study reviewed 17 building materials. Objective of this activity was to develop key performance indicators (KPI) for building materials for the assessment of building materials market in India under the following categories: a) wall material, b)insulation, c)fenestration, d)hvac, e)lighting, f) solar heater. The draft reports for the building materials such as the autoclaved aerated concrete (AAC) blocks have been completed. Three KPIs were identified; they are:
 1. Technical specifications/ test standards
 2. Market structure/size/forecast
 3. Cost-benefit analysis

Table 1.2 provides partial information on different KPIs for different building materials.



Table 1.2 KPI description for different building materials [situation in India]

#	KPI – 1 Technical specifications/ test standards	KPI – 2 Market structure/size/forecast	KPI – 3 Cost-benefit analysis
1	Autoclaved Aerated Concrete Blocks (AAC Blocks) -	1.22 million cubic metres in 2012-13 in commercial sector Total market 3.5 million cubic metres 50% organized market Used both in residential and commercial Compounded Annual Growth Rate (CAGR) 10% from 2008 to 2010, 5% in last 3 years owing to slow down in market Demand is 5 million cubic metres.	-
2	Fly ash bricks -	15 million tonnes of flyash per year [from 40 major thermal power plants] Confined to eastern and south eastern region of India	INR 8 to 10 per brick. Cheaper than clay bricks.
3	Hollow clay bricks -	Highly unorganized market Not popular among commercial real estate sector	-
	Insulation materials - – Wall & roof	0.53 million m ² in 2013-14 50% of Existing capacity production. Market is in west and northern India	-
	Polyurethane foam (PUF) Extruded Polystyrene Foam (XPS)		
4	Fenestration/ glass -	1.19 billion USD (Global 75 billion USD) 1.5 lakh MT per month 130 to 140 manufacturers in India, 30% organized sector	-
5	Cool roof/ reflective coatings -	INR 22 to 35 per square feet Less than 5% of commercial buildings use reflective coatings Less than 1% of reflective coatings produced are used in commercial buildings.	-



#	KPI – 1 Technical specifications/ test standards	KPI – 2 Market structure/size/forecast	KPI – 3 Cost-benefit analysis
6	HVAC Room air-conditioner (RAC) i.e. split and window air-conditioners	3.3 million in 2013-14 (CAGR 12.9% since 2005-06) Likely demand is 7 million in 2020-21. Sale of chillers is about 2000 in 2015 Likely demand for chillers in 2019-20 is 7000 units	-
7	Heating water Temperature of water required 60 to 80 degree Celsius. Flat plant solar collector (FPC) Evacuated tube collector (ETC) 100 liters per day can reduce 1500 units of electricity annually 1000 SWHs of 100 LPD can shave 1 MW peak load	8 million m ² in 2012-13. 6 million m ² in 12th FYP and 8 million m ² in 13th FYP Total cumulative plan 20 million m ² by 2022	-
8	Lighting CFL increased from 67 million in 2005-06 to 500 million in 2013-14.	Accounts for 17 to 20% of world's energy costs. Energy saving potential is 60 to 70% through efficient lamps, high performance luminaries, electronic drivers, controls etc.	-
9	Light controls Deployed by large users, more than 500 square meters.	-	Revenue in year 2012 was 2.50 billion INR Likely revenue in year 2017 is 4.06 billion INR
10	Electrical power & motors Transformers	56,458 single phase and 37,162 3 phase transformers in 2006-07. CAGR 34%	-
11	Motors Copper rotor motors are energy efficient, costs more but are 2 to 3% more energy efficient.	-	-

Source: Siddiqui et.al.

C. Pilot ECBC compliant buildings

Out of the eight demo buildings that were to be taken up in the five building categories, proposals were received from various states. Four buildings listed below met the criteria for demo buildings and have been selected based on the eligibility criteria. The status of initiation of work for these is as under: 1) Roads and Bridges Development Corporation, Kochi (shopping mall category, warm and humid climatic zone), 2) Judicial Court Complex, Mohali, (office building category, composite climatic zone), 3) Academic Block in SMS Medical College, Jaipur (institutes and IT parks category, hot and dry climatic zone), 4) K.K. Guest House, Bangalore (hotel category, warm and humid climatic zone).

Feasibility reports providing the building owner with three energy-efficient design options for seven pilot projects have been submitted. The design options have been chosen by the building owner for five pilot projects.

The projects are as follows:

1. Academic Block in SMS Medical College, Jaipur
2. K.K. Guest House, Bangalore
3. Divisional HQ and laboratory facilities for Food and Drug Administration at Moshi, Pune
4. Dhanvantri OPD block, SMS Hospital, Jaipur
5. Medical college building, Gulbarga, Bangalore

These buildings are expected to provide continuous data and learnings of ECBC interventions so as to help other potential builders get a first-hand exposure.

D. Enforcement of fiscal incentive and regulatory frameworks

Integrating energy conservation into new buildings are expected to face increased upfront costs, although many analyses indicate that the increased costs are paid back during the lifetime of the buildings, as it reduces energy consumption and thereby energy costs. The project aimed to identify the requirement of rebates, tariff discounts, accelerated depreciation, tax incentives, with regulators and utilities. In addition, the project was expected to explore financing schemes with banks to encourage investments in energy-efficiency interventions in buildings sector.

A study to analyse the current regulatory and fiscal incentives framework has been initiated in 16 states (states that had moved ahead with ECBC implementation in the 11th Plan Period). The draft report for all the 16 states has been prepared and stakeholder consultations have been conducted in 11 states. Also, the state of Maharashtra has devised a green building incentives scheme.

E. Enhancing information and awareness

The project website is now in place <http://eecbindia.com/>. The showcasing product under the website is the ECBC Mobile Application that makes ECBC much more readable and user-friendly while making it easy to carry and to refer. Seven feasibility reports of the demonstration projects and 16 draft state-specific ECBC roadmaps can be downloaded from the project website.



V. CONCLUSION

The growth of commercial buildings is increasing at 8 per cent per year, and as in base year 2010, the GHG emissions contributed to 73 million tCO₂, which is approximately 5% of total GHG generated from India. Analysts predict the cumulative area of buildings will triple in the next 15 years by 2030. Thus, it forms an important emergent sector to consider under climate change mitigation actions.

The initiative aims to facilitate increased energy efficiency in commercial buildings. Government of India's Energy Conservation Building Codes aim to promote energy efficiency in buildings, however, awaiting addressing of barriers, the codes were voluntary. The project identified barriers limiting compliance to ECBC. These are—policy and institutional barriers, technical and managerial capacity barriers, materials and technology barriers and finance barriers.

The most significant development through this project till date has been the institutionalization of the training activities within the state. To develop institutional capacities and make skilled manpower available to comply with ECBC, the following actions have been undertaken. The project supported 16 states in developing ECBC roadmaps, establishment of ECBC cells in 12 states to increase technical capacities. Four ECBC cells have been established. Each ECBC cell comprises four personnel, two engineers and two architects. The concept of master trainers was developed and 59 master trainers were trained. Three institutes have been identified that will impart the training. The institutes are—CEPT, Ahmedabad; IIIT, Hyderabad and MNIT, Jaipur. In addition, three more institutes are identified for imparting institutional training, namely, Rachna Sansad Institute of Architecture in Maharashtra, Energy Management Centre in Kerala and Ela green Buildings & Infrastructure Consultants in Chhattisgarh. It seems identifying more such institutions in other states can benefit larger number of people and increased action in ECBC compliance.

The project has supported fine-tuning EPI. EPIs at the baseline provided an average number of 210 kWh/m²/year (with range of 200 to 400 kWh/m²/year for different categories, at times going up to 600 kWh/m²/year). A sample of 1,160 buildings were covered. There is significant difference in EPI for different categories of buildings. For a given type of building, the EPI varied but to a lesser extent in different climatic conditions. The four types of climatic conditions covered were warm and humid, composite, hot and dry and moderate. The following are the average EPIs in kWh per m² per year:

1. 93 kWh/m²/year for office buildings using less than 50 per cent air-conditioning [range 86 to 101 for different climatic zones]
2. 126 kWh/m²/year for hospitals [range 106 to 150 for different climatic zones]
3. 173 kWh/m²/year for hotels up to 3 star category [range 107 to 215 for different climatic zones]
4. 178 kWh/m²/year for office buildings using more than 50 per cent air-conditioning [range 173 to 182 for different climatic zones]
5. 262 kWh/m²/year for hospitals [range 247 to 275 for different climatic zones]
6. 297 kWh/m²/year for hotels above 3 star category [range 250 to 333 for different climatic zones]
7. 321 kWh/m²/year for shopping malls [range 257 to 428 for different climatic zones]
8. 440 kWh/m²/year for BPOs [range 433 to 452 for different climatic zones]



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2. CHALLENGES IN IMPLEMENTATION OF ECBC IN INDIA

- *Bhaskar Natarajan, Deputy Chief of Party – EE, USAID PACE-D TA Programme*

Abstract

In order to reflect the saving potential of ECBC in construction practices, significant contribution from developers, design professionals, end users and government bodies is essential if the savings are to be achieved. There are a number of agencies involved that will have to play an important role for implementation of ECBC in India. The first step in the implementation process is to notify ECBC as mandatory for all buildings in areas for which these bodies are responsible. Besides mandating, the information on how compliance is to be undertaken, who is the agency for ensuring compliance, the process of compliance, including documentation for compliance, all these factors need to be included in the notification. Enforcement of ECBC, first, requires that information on the code. The notification, the process, including all forms and tools for compliance are available to all stakeholders. Mandating ECBC across the nation will require a robust institutional infrastructure to support the progress of ECBC adoption.

I. INTRODUCTION

Building energy efficiency is a priority area for the Bureau of Energy Efficiency (BEE). Since buildings use account for about 35 per cent of total electricity demand in India, it is imperative that all steps are taken to ensure that this sector consumes the energy in an efficient and sustainable manner. Energy Conservation Building Code (ECBC) was promulgated in 2007 and compliance was on a voluntary basis. BEE has now initiated the task of mandatory implementation of ECBC 2007 across the country and under the 12th Plan, BEE has set a goal of 75 per cent ECBC compliant new commercial buildings.

ECBC implementation can potentially change the construction practices in the country. In order to reflect the saving potential of ECBC in construction practices, significant contribution from the developers, design professionals, end users and government bodies is essential if the savings are to be achieved. Proper enforcement policies, strategies and procedures are crucial to ensure gradual shift of current practices to ECBC compliant practices in a spirit of cooperation and partnership with the building industry.

II. IDENTIFICATION OF STATE LEVEL ECBC IMPLEMENTATION CHALLENGES

There are a number of agencies involved that will have to play an important role for implementation of ECBC in India. Some of them are:

1. Urban Development Department
2. State Designated Agency, under the EC Act

3. Renewable Energy Department
4. Development Authority (s)
5. Municipal/ Urban Local Bodies
6. Public Works Department (PWD)
7. Electricity and Energy Department
8. Buildings developers operating in the state
9. Engineers, architects, sustainability organizations

The ECBC has been notified under the EC Act for which the BEE and the SDAs are the key regulatory agencies. However, since all buildings activities come under the purview of the housing and urban development departments, and municipal, urban and other local bodies, it is these bodies that have to notify the ECBC for compliance in their respective areas. Hence, the first step in the implementation process is to notify ECBC as mandatory for all buildings in the areas for which these bodies are responsible. Again, simply notifying ECBC as mandatory is not enough; these need to be coupled with information on how compliance is to be undertaken, who is the agency for ensuring compliance, the process of compliance, including documentation for compliance—all need to be included in the notification. These need to be issued after an extensive consultation process, wherein the attempt is to take all stakeholders on board for the implementation of ECBC.

Even though ECBC was notified in 2007, only a handful of states have issued notifications requiring all new constructions to comply with ECBC, as notified in the state. Even in these states, there has been no process notified for compliance at the state level. Compliance forms, authority to check compliance and other related aspects are not clear. There have been no forward steps from the building industry to take up compliance to be able to realize energy-efficiency gains in the buildings. Obviously, there are challenges to the implementation of ECBC due to which there has been little or no off-take for compliance to the codes.

Enforcement of ECBC, first, requires that information on the code; the notification, the process, including all forms, tools for compliance are available to all stakeholders. With web-based information being the primary channel for dissemination of this information, there is also a need for all documents being made available in print forms from the government agencies, even if it costs to own a copy.

All stakeholders need to be completely familiar with the code and compliance process. Towards this, the respective government agencies would need to organize several stakeholder meetings to inform all the stakeholders about their roles in the compliance process. Figure 2.1 identifies the various technical assistance and capacity building needs for ECBC compliance.



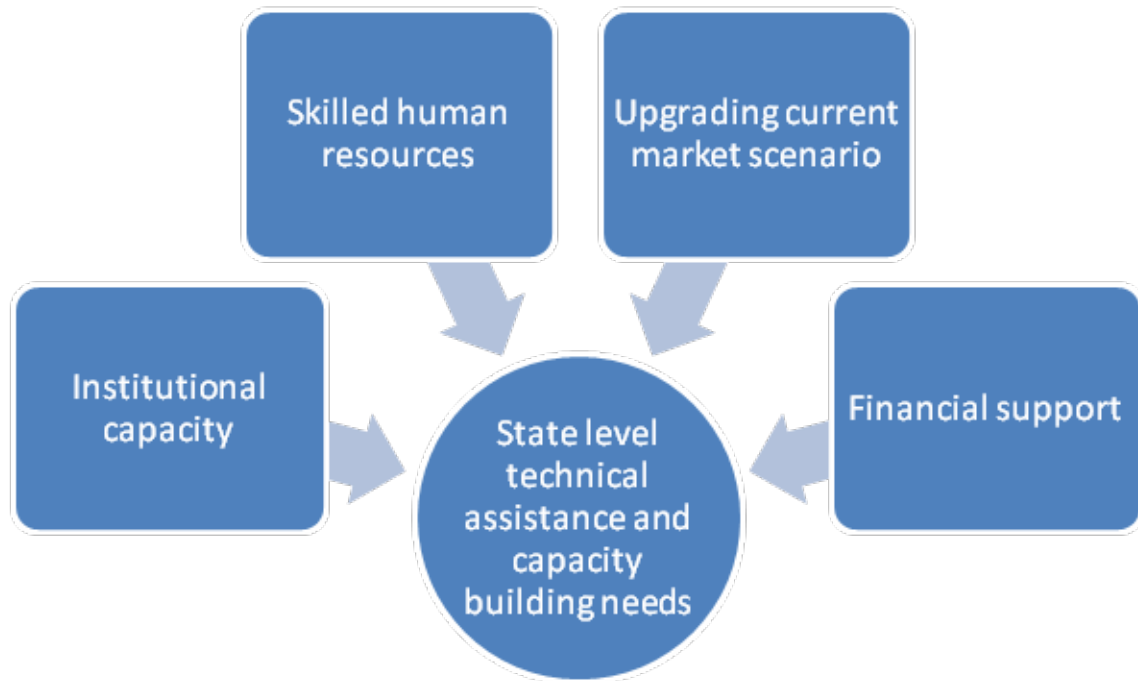


Figure 2.1: State-level technical assistance and capacity-building needs

III. INSTITUTIONAL CAPACITY

Mandating ECBC across the nation will require a robust institutional infrastructure to support the progress of ECBC adoption. The entire institutional infrastructure needs can be subdivided into three major tasks for developing capacity for implementation, enforcement and compliance (Figure 2.2).

1. Enforcement: Enforcement of a code refers to the development of the legal provisions to mandate the code on the building industry as a law, identification of the roles and responsibilities of each department included in the enforcement process, and development of rules and regulations to streamline the process of ECBC compliance. The onus of enforcement is on the designated state and local government bodies. The major challenges in enforcement of ECBC are:
 - a. Need for strategic enforcement plan to streamline the compliance procedure and define the rules and regulations
 - b. Training, tools and resources for skilled human resources. The training has to be comprehensive, and specific to the state's requirements and climatic zone.
2. Compliance: Compliance of a code refers to the process followed by the building industry to ensure ECBC compliant development. The onus of ECBC compliance is on the building industry and designated local government bodies. Designated state government agencies may support the local government in required fields. The major challenges in ECBC Compliance could be:
 - a. Limited enforcement of energy conservation code due to administrative and legislative issues
 - b. Limited incentives to general public and developers to opt for energy-efficient technologies



- c. Limited outreach and education to the general public to understand the significance of energy efficiency in buildings and integrate the concept of life cycle cost analysis within the design process by decision makers
- d. Lack of post-construction verification and unavailability of building performance database of ECBC compliant buildings to suggest amendments in the Code as per requirement.



Figure 2.2: Institutional capacity challenges

IV. SKILLED HUMAN RESOURCES

Skilled human resources are the key to ECBC implementation, enforcement and compliance. Knowledge sharing, outreach, awareness and training will be required to formulate policies, design ECBC compliant buildings, incorporate strategies and to evaluate compliance. Skilled human resources could be divided into three basic categories as shown in Figure 2.3.



Figure 2.3: Skilled human resources category

1. **First Party:** The First Party includes the parties/ consultants responsible for designing and constructing ECBC compliant buildings. Knowledge of ECBC is essential to enable the parties to incorporate the standards of ECBC into the design and also, if allowed by state government, to self-certify the compliance. First Party includes members from associations, manufacturers, architects, engineers, contractors, facility managers, developers, and end users.
2. **Second Party:** The Second Party includes parties responsible for the implementation and enforcement of the ECBC code. It includes central, state and local government bodies. Knowledge of ECBC is very essential for these parties to implement ECBC specific to the respective state's requirements as well as enforce the standards in the respective state.
3. **Third Party:** The Third Party includes parties/ consultants that act on behalf of the state and local government bodies to certify ECBC compliance in a construction. The Third Party can also include members who are accredited by statutory body through certification exam(s).

The major challenges in developing skilled human resources are:

- a. Identification of desired skills sets required for First Party, Second Party and Third Party
- b. Inadequate training structure
- c. Lack of accreditation programmes to ensure compliance checks
- d. Limited energy code training (workshops, seminars, webinars, etc.) and compliance tool training
- e. Limited provision of educational material, and training resources (internet, webpage, guide manuals etc.) available to code officials, accredited professionals, and general public

V. UPGRADING CURRENT MARKET SCENARIO

The design of energy-efficient building requires better design strategies and knowledge of advanced energy-efficient technologies. This would change the current construction practices, increase the initial investment cost and would require advanced technologies to support ECBC compliance. Thus, it is required to understand the existing market and plan the gradual phase out of energy intensive technologies and phase in of energy-efficient building techniques and technologies.

It is well understood that without a strategic plan to gradually upgrade the existing market, the ECBC compliance rate will be low. Thus, it is vital to support the building industry to meet the compliance criteria set by BEE and ensure increase in stringency of ECBC with time. Challenges in upgrading the market scenario are as follows:

1. Limited understanding of the current construction practices in each state
2. Limited understanding of advanced technologies and their advantages
3. Limited interests in the general public towards energy-efficient technologies at additional cost

VI. FINANCIAL SUPPORT

ECBC implementation, enforcement and compliance require substantial investment for developing infrastructure, institutions, awareness programmes, training campaigns, programme administration

expenses and promotional incentives. Financial support could be provided to develop institutional capacity, develop skilled human resources, and gradually upgrade the prevailing market scenario. The major challenge in providing financial support is the need for sufficient funds and incentives to support institutional capacity development, skilled human resources development and upgrading current market scenario.

Financial support could also be by way of either incentives for compliance which could be by way of allowing extra building space being allowed to be constructed, or could be a penalty for non-compliance. The incentive and the penalty need to be sufficient to enable the builders to take up the compliance of ECBC or high enough to deter the builders from paying the penalty.

VII. CONCLUSIONS

ECBC compliance is a must if the country is to realize the gains from implementation of ECBC. At present, ECBC has been made mandatory in selected states, and these are just statutes to mention in the books, with no real efforts at taking steps to enforce the code.

Information on ECBC, compliance process, and the benefits of ECBC are extremely crucial to the success of ECBC compliance. The relevant government agencies need to undertake a massive information and outreach activity and to reach out to all stakeholders. The government agencies have to take help from the technical institutions in the state in this outreach process. It is the only way that the state can realize the benefits from the code being made mandatory.



3. ANALYSIS OF ENERGY EFFICIENCY IMPACTS IN SELECTED COMMERCIAL BUILDINGS IN KERALA: UNDER THE ECBC FRAMEWORK

- **Narayanan AM**, Head-Energy Efficiency Division, Energy Management Centre, Dept of Power, Govt. of Kerala

Abstract

About 240 commercial buildings were surveyed with reference to energy efficiency in Kerala and out of this, 30 buildings were checked for ECBC (Energy Conservation Building Code) compliance. A wide bandwidth of Energy Performance Index (EPI) is observed. Ratings with respect to energy efficiency and environmental friendliness such as Leadership in Energy and Environmental Design (LEED), Green Rating for Integrated Habitat Assessment (GRIHA) and Star labelling are already in practice in the state's building sector but only in countable cases. Had ECBC been implemented, 15–40 per cent EPI reduction would have been possible in the commercial building sector of state. Implementation of ECBC for commercial buildings with contract demand of 100 kVA and above is expected to result in substantial energy intensity reduction in the state's commercial building sector

Key words: Energy Efficiency, Commercial Buildings, Energy Conservation Building Code (ECBC), Energy Performance Index (EPI)

I. INTRODUCTION

A detailed study to establish a baseline database, primarily focussing on EPI on selected existing and upcoming commercial buildings in the state that fall under the Energy Conservation Act (EC Act, 2001) has been conducted.

A concerted effort was taken to understand energy usage in selected commercial buildings to assess the energy-saving potential and plan strategies to ensure enhanced energy efficiency of the state as well as to arrive at appropriate intervention in existing and upcoming buildings.

The scope of the study included getting a general overview of the buildings sector in the state with geographical locations of the major existing, ongoing and future building projects and the expected region-wise growth in the build area across the state.

There has been exponential decadal growth of commercial buildings in the state of Kerala. Analysis shows aggregate growth of commercial buildings, in the contract demand of 100 kVA – 200 kVA band and above is about three times in the last 10 years, i.e., about 12 per cent compounded annual growth rate (CAGR) (refer Figure 3.1).



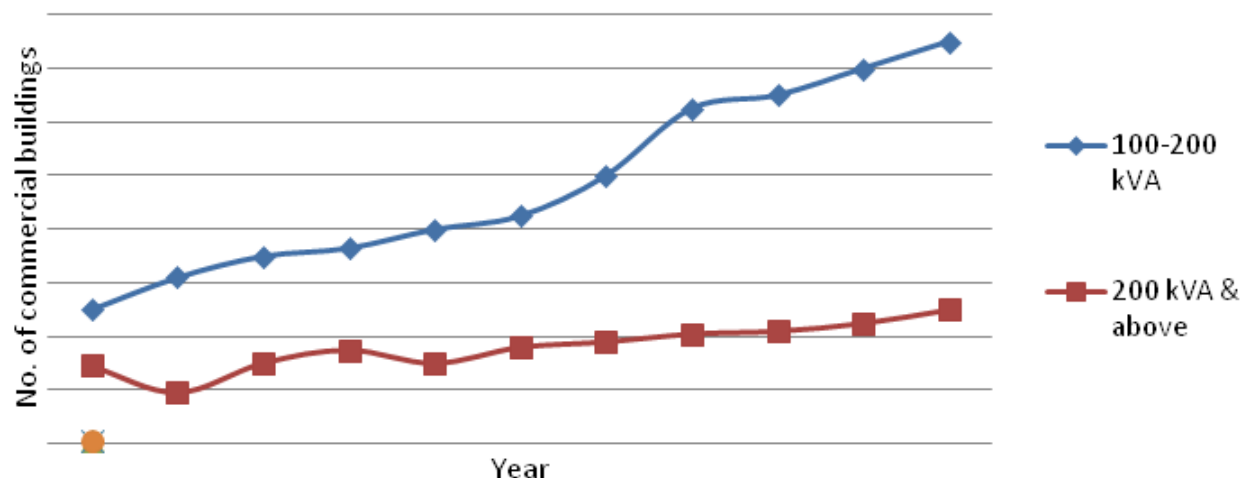


Figure 3.1: Growth profile of commercial buildings in Kerala with different bands of contract demands (based on sample survey)

The above growth has triggered rapid increase in energy consumption in the commercial building sector. The share of energy consumption of commercial sector in the total consumption of the state is about 15–20 per cent.

The study was conducted with the objective to evaluate energy efficiency of selected buildings or building complexes with a broad basis of ECBC in 240 such buildings (refer Table 3.1), spread out for various purposes, followed by the evaluation of the necessity of implementation of ECBC in the state. An ECBC compliance check was broadly conducted for a sample of 30 buildings.

Table 3.1: Building category selected for the study, by building application/use

#	Category of building	Number of building
1	Hospital	58
2	Hotel	55
3	Office Building	33
4	IT Building	22
5	Shopping Centre	44
6	Airport	5
7	Educational Institutions	23
		240

II. SOME PERTINENT REMARKS ON FIELD STUDY PHASE

Data collection for this project was rather straightforward, requiring interaction with key governmental agencies (mainly the state electricity board, electrical inspectorate and local self-government), as well as building owners.

Major challenges faced during the study included varying levels of organization of the data; assimilating, archiving and sharing the data; and limited understanding of the importance of energy-efficiency interactions of various equipment and system

A list of stakeholders identified for the study included:

- Building owners
- Local Self Government Institutions (LSGIs/ULBs)
- State Electrical Inspectorate
- Builders
- Public Works Department (PWD)
- Power Distribution Licensees
- Building Maintenance Engineers
- Facility Users
- Facility Owners
- Facility Managers
- Architects
- Equipment Suppliers
- Builders / contractors

The building components having a strong bearing on energy consumption as per ECBC reviewed in the study are given in Table 3.2.

Table 3.2: ECBC compliance parameters

Building Component	Parameters
Building Envelope	<ol style="list-style-type: none"> 1. Insulation materials and their R- values 2. Fenestration U factors, SHGC, Visible light, transmittance 3. Air leakage 4. Overheating and side fin details 5. Envelope sealing details
Lighting	<ol style="list-style-type: none"> 1. Automatic shut off for lights 2. Space Controls; day light utilisation 3. Dimmers 4. Photo sensors 5. Separate control for luminaries 6. Tandem wiring/layout w.r.t task 7. Energy Efficient lighting (all components)



Building Component	Parameters
Electrical Power Distribution system	<ol style="list-style-type: none"> 1. Energy efficient transformers/cabling 2. Additional metering /loss calculation 3. Energy efficient motors/other end users
Proper metering system	<ol style="list-style-type: none"> 1. kWh & kVA 2. Power factor 3. Phase current 4. Neutral current 5. Current harmonics
Power factor	<ol style="list-style-type: none"> 1. Average system power factor ; controls 2. APFC provisions
HVAC System	<ol style="list-style-type: none"> 1. Time clock provisions 2. Dead band of 3 °C provided/CoP/EER 3. IPLV and controls; VFDs/VAV/VRF etc. 4. Insulation for piping and duct working
Service Water Heating	<ol style="list-style-type: none"> 1. Utilising solar water heating 2. Specifying heating equipment efficiency 3. Reuse 4. Insulating hot water storage tanks and pipe lines 5. Reducing standby losses 6. Reducing heat and evaporation losses in heated swimming pools

III. SALIENT STUDY FINDINGS

Unlike in the industrial sector, the commercial building sector lack trained technical manpower who can manage energy systems efficiently. Lack of proper data collection and management in energy use is an issue prevailing in this sector, even though there are a few exceptions. Similarly, at the design and construction stage and commission phase, energy efficiency is very rarely considered as a parameter to be optimized in many commercial buildings.

Highest concentration of commercial buildings falling under the definition of buildings given in ECBC was found in certain urban centres.

The EPI of the selected buildings was computed based on the data collected. Comparisons of EPI of buildings in various categories, namely, offices, hotels, hospitals, shopping complexes, IT buildings, airports and educational Institutions, reveal a wide bandwidth of EPI among buildings of the same nature of business and activities.



Table 3.3: EPI bandwidth of surveyed buildings

#	Sector	EPI
1	Hotel	206 – 364
2	Hospital	66 – 338
3	Office	65 – 152
4	Shopping Mall	77 – 349
5	Airport	169 – 329
6	IT Park	72 - 312

Based on BEE’s building energy star rating programme, the present star rating of these buildings were determined considering their percentage of air conditioned area and operating hours. It may be noted that only four buildings out of 30 selected buildings are falling in the five-star category.

Comparing the results of ECBC compliance check and EPI computation, it can be understood that apart from complying with parameters as per ECBC, factors like multiple mixed use activities within the same building (for example, some shopping malls have Cineplex and others use shopping cum office complexes), have distinct impact on EPI. Further divergence in EPI across buildings irrespective of their ECBC compliance rating is the different levels of air-conditioned area.

There are two buildings in the lot which have obtained Leadership in Energy and Environmental Design (LEED) rating and one has applied for Green Buildings Rating System India (GRIHA) rating.

Based on the detailed energy auditing experiences and the data obtained from the selected 30 buildings, it is estimated that there exists 15–25 per cent savings potential in the commercial buildings in various categories, namely, hospitals, hotels, office buildings, IT buildings, shopping centres, airports and educational institutions (refer Table 3.4).

Table 3.4: Energy-saving potential

Category	Major Energy Saving Areas	Saving Potential
Hospital	Lighting	20 %
	Power factor improvement	
	HVAC	
	Pumping system	
	Service water heating	
Hotel	Lighting	20 %
	HVAC	
	Pumping system	
	Service water heating	



Category	Major Energy Saving Areas	Saving Potential
Office Building	HVAC Lighting Power Factor Improvement	25 %
IT Building	HVAC Lighting Power factor improvement Pumping system	25 %
Shipping Centre	HVAC Lighting Electrical motors Power Factor Improvement	20 %
Airport	Lighting Electrical motors HVAC Pumping system Power Factor improvement Compressed Air system	15 %
Educational Institution	Lighting HVAC Pumping system	15 %

IV. STUDY INFERENCES

Salient points that emerged from the study, facilitating energy efficiency enhancement programmes and projects of commercial buildings in the state, are highlighted below.

A. Surveys, Analyses and Data hosting

- Conduct periodically, say, once in three years, survey of representative samples of commercial buildings in the state and present the finds in 'Building Characteristics Tables'; i.e., information on energy-related building characteristics in commercial buildings
- Provide online reports of such surveys, increasing transparency of best practices in energy efficiency
- Observe the energy demand vis-à-vis energy price elasticity, and relate with activities/use of building space, market behaviour/market economy and income distribution

- Benchmarking energy efficiency in EPI (modified) methods, suitable to building types

B. Evaluate the potential regarding the following:

- Tax incentives and/or tariff incentives for targeted energy-efficiency benchmarks
- Renewable energy (RE) integration
- Net zero building design
- Dematerialization; waste-minimization; zero-discharge; 100 per cent recycling
- Carbon neutral concept in commercial complexes
- Building rating-sellers edge; image /brand building by EPI as parameter; comfort; building operating cost
- Identify impact of the growth of miscellaneous electric loads (MELs)— [mainly attributed to increased service demand for entertainment, computing, and convenience] —offsetting some of the efficiency gains made through technology improvements and minimum energy performance standard (MEPS) of appliances.
- Centralized monitoring of energy efficiency of public buildings and buildings owned by a single group/company/entity
- Micro-grid and distributed generation

C. Prepare and publish energy-efficiency design and operation templates for buildings coming under same type of/typical activities:

- Example: hospitals
- Energy use of hospitals depends on how the building facility format is laid out and how the operation and maintenance is carried out; how many people such as employees, patients, and visitors occupy the buildings daily; and how the sophisticated air-conditioning (HVAC) systems, laundry, medical and lab equipment uses, sterilization, computer and server, food service etc. are energy intensive; how energy consumption is monitored and accounted is also important

D. Template for major energy consumption centres:

- Example: lighting in commercial buildings
- Lighting is a major consumer of electricity in commercial buildings and energy savings through use of energy-efficient light sources, luminaire, advanced control technologies, day light maximization, etc., are important factors.

E. Issues to be raised

- Core and Shell buildings; main building owner/occupier has no control over energy consumption by 'occupants'; initial design may have least focus on energy-efficient design as building users are 'unknown'
- Creating demand for energy efficiency in commercial building sector



- Market trends in rating of buildings such as LEED, GRIHA, S&L (standards and labelling)
- Capacity building in energy efficiency of commercial buildings requirement—new construction; retrofits;
- Capacity building at LSG/ULB/UDD; builders/architects; proponents
- Traditional [indigenous] architecture
- Linkage of business growth to energy costs
- Commercial sector, in turn commercial building vs. states GDP and land use
- Drivers of investment in energy efficiency and preferred government policies

V. CONCLUSION

The benefits to be gained from energy-efficient buildings include improved productivity, better temperature control ventilation and indoor quality, etc., which may also be factored into in business cost calculations of the impact of energy-efficiency investments.

Outreach to building industry stakeholders—business leaders, government offices and non-governmental organizations—is an important feature.

The study was done in the context of 'normal' economic growth and depending on the overall growth and development of economy, demand for commercial building space may vary. Normally, investments in commercial buildings are considered like investments that offer long-term returns.

This study attempted a comprehensive inventory of current and future building stock and analysed the impacts of consumer preferences and behaviours, designs and technologies, and policies on energy consumption.

The study approaches include building energy codes, labelling and reporting mechanisms, energy pricing and evolving energy-efficient designs and technologies that use passive and active approaches. Passive designs include natural ventilation, use of daylight, building's shape and orientation, thermal mass, solar gains, shading, etc.

Many of the energy conservation measures identified as part of ECBC compliance parameters can be incorporated at the design stage. Some of the energy-efficiency measures, mainly other than building envelope related, can also be technically feasible to implement as a retrofit measure.

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4. STATUS AND CHALLENGES IN THE IMPLEMENTATION OF ECBC CODE: CASE STUDY OF UTTAR PRADESH ELECTRICITY REGULATORY COMMISSION (UPERC) BUILDING

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Abstract

An ambitious goal of 75 per cent ECBC compliance for new buildings has been envisioned by BEE, under the 12th plan. One of the first immediate steps would be to notify ECBC as mandatory for all buildings at state level. In this context, ECBC code has been drafted by the drafting committee for Uttar Pradesh according to its composite climate and after becoming SDA, UPNEDA has further reviewed the code as directed by the government and the ECBC code is in its final stage of notification. The study of UPERC building has been carried out in the light of ECBC code and the study has put forth three options along with full life cycle cost analyses and the best feasible option can be chosen by the building owner. Further challenges in implementation have also been outlined.

I. INTRODUCTION

The EC Act 2001, amended in 2010, empowers the state government under Section 15 to adapt Energy Conservation Building Code (ECBC) in consultation with the Bureau of Energy Efficiency (BEE) to suit the regional and climatic conditions. Rules made by BEE specify and notify ECBC with respect to the use of energy in buildings or in a complex, being a designated consumer to comply with the provisions of the ECBC.

In exercising the above-mentioned provision, the state government amended the ECBC in Uttar Pradesh (UP). UP lies in composite climatic zone, i.e., it has high temperature in summers and low temperatures in winter, low humidity in summer and high in monsoons, high direct solar radiation in all seasons except diffused radiation on monsoons. Hence, keeping in mind these climatic conditions, ECBC has been amended accordingly.

II. STATUS OF ECBC NOTIFICATION

Under the provisions of the Energy Conservation Act-2001 Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) has been designated to function as the Uttar Pradesh State Designated Agency (UPSDA), with effect from 3 July 2015, prior to which, the UP Power Corporation was looking after the work of UPSDA.



Government of Uttar Pradesh constituted a draft committee of concerned departments, i.e., UPPWD, UPRNN, UP Jal Nigam, Rural Engineering department and UP Power Corporation (erstwhile UPSDA) to amend the ECBC. After nominating UPNEDA as SDA, the first ECBC cell of the country has been established in UPSDA (UPNEDA) on 28 July 2015.

ECBC code has been drafted by the drafting committee for Uttar Pradesh according to its composite climate and after becoming SDA, UPNEDA has further reviewed the code as directed by the government in consultation with the ECBC cell. Now ECBC code is in the final stage of notification at the government level and is expected to be notified very soon. After notification, adoption of ECBC has to be ensured by the UP Housing Board, urban local bodies and 23 local development authorities of the state.

III. AWARENESS ACTIVITIES

Workshop cum one-day training programme on Green Building, including various aspects of energy-efficient building, was organized by UPSDA & IGBC at Lucknow in the presence of stakeholders, builders, architects and concerned government organizations in the area of construction and civil development. For the officials of UPSDA, an orientation programme regarding ECBC code and the ways for its implementation was organized in UPNEDA HQ to sensitize project officers of UPNEDA offices of all districts of Uttar Pradesh. Workshops are also being organized jointly by urban development department and UPNEDA regarding smart cities and energy-efficient buildings to create awareness among prospective stakeholders, developers, vendors and officials of state governments, as well as officials of Lucknow Metro Rail Corporation (LMRC).

IV. PROPOSED BUILDINGS FOR ECBC COMPLIANCE

ECBC cell of UPSDA is working on identification and data collection of government, institutional and commercial proposed building. The brief of some of the identified government buildings are as follows (see Table 4.1).



Table 4.1: Government Buildings Identified for ECBC Compliance

#	Name of Proposed building	Location	Total Area (sqm)	Covered Area (sqm)	Agency	Remarks
1	Construction of Police Emergency Management & Research Institute	7/13 Gomtinagar Extension near Shaheed path, Lucknow	32,500	10,000	UPRNN	
2	Construction of High level Cancer Institute	Chak Ganjaria City, Sultanpur Road, Lucknow	404,740 (100 acres)	125,059 (ground coverage -41,737)	UPRNN	Outpatient deptt./ Emergency 3 floor, Radiology 2 flr, Operation Theater/ICU 4 floor, Inpatient Department 9 floor, Radiation Oncology/ Nuclear medicine-3 flr, Administration-3 floor
3	Construction for Hospital Building in State Ayurvedic College	Lucknow		12,542 (plinth area)	UPRNN	G+4
4	Construction of (i) Academic Block & (ii) Hostel Block for Indian Institute of information Technology (IIIT)	Chak Ganjariya City, Sultanpur Road Lucknow (U.P.)	202,343 (50 acres)	27,000 (Plinth area)	UPRNN	G+6 (Academic+ Hostel Block)
5	Construction of Police Bhawan (Signature Building)	Sector-7 Gomti Nagar, Extension Lucknow	39,244		UPRNN	B1+B2+(G+9)

In addition to the above under UP Technical Education Department, five government polytechnic buildings in different districts of the state are proposed to be constructed with the provisions of ECBC code.



CASE STUDY - 1. UPERC BUILDING

Uttar Pradesh Electricity Regulatory Commission (UPERC) office building will be the first ECBC compliant under construction office building in the state. The details of the building are as follows.

Project :	UPERC Office Building, Lucknow
Location :	Vibhuti Khand, Gomti Nagar, Lucknow
Total Project Area :	5288 sqm
Number of buildings and designation:	Single building
Type of building :	Office Building
Climate :	Composite
Occupancy	5 Days a week, Daytime occupancy

The study of UPERC building has been carried out in the light of ECBC code to make the building most energy efficient. As an outcome of study, three options have been worked out. The best feasible option can be chosen by the building owner. These options along with full life cycle cost analysis are explained as follows:

Component	Option 1: As-is case	Option 2	Option 3
Wall	1. Outside plaster 15 mm 2. External AAC wall 200 mm 3. Inside Cement Plaster 12mm 4. XPS Insulation 50 mm	1. Outside plaster 15 mm 2. External Fly Ash wall 230 mm 3. Inside plaster 12 mm 4. XPS Insulation 100 mm	1. Outside plaster 15 mm 2. External Clay Brick wall 230 mm + 100mm cavity +230 mm clay brick wall 3. Inside plaster 12 mm
Roof	1. RCC roof Slab 125 mm 2. PUF Insulation 50mm thick 3. Suitable water proofing membrane 4. Screed Plaster 40mm 5. Internal Ceiling Plaster 6mm	Landscaped terrace 1. RCC Slab 2. PCC 75 mm 3. Water Proofing sheet 4. Gravel 100 mm 5. Geo fabric membrane 6. Sweet Soil	1. RCC roof Slab 2. PCC 40mm (1:2:4) 3. 50mm screed 4. Tile 20mm
Glass	SKN 744II	Planitherm - Mint Green (PLT TG) Planilux	Envision 765II, Planilux (Clear Glass)
HVAC	VRV system for the entire building	Radiant cooling with Chilled Beams for the entire building	Chilled Water System
Lighting	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area
Renewables	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)
EPI	67.7 kWh/m ² /year	81.9 kWh/m ² /year	90.7 kWh/m ² /year
Savings	51%	41.5%	35.1%

COST ANALYSIS:

Component	Base Case	OPTION 1	OPTION 2	OPTION 3
WALL	230mm Brick Wall Volume = 640 cu m Rate = Rs 5667.55/cu m Cost = 36,27,232 Rs [Ref: DSR 2014 6.4.1]	1.AAC Wall 200 mm 2.XPS Insulation 50 mm AAC Volume = 640 cu m Rate = Rs 6386.95/cu m Cost = 40,87,648 Rs [Ref: DSR 2014 6.32.1] XPS Area = 2469.4 sqm Rate = 480 sqm Cost = 11,85,312 [Ref: Market Rates]	1.Fly Ash Wall 230 mm 2.XPS Insulation 50 mm FLY ASH Volume = 640 cu m Rate = Rs 5697.25/cu m Cost = 36,46,240 Rs [Ref: DSR 2014 6.38] XPS Area = 2469.4 sqm Rate = 480 sqm Cost = 11,85,312 [Ref: Market Rates]	230mm Brick Wall + air gap + 230mm Brick Wall Volume = 1280 cum Rate = Rs 11335.1/cu m Cost = 72,54,464 Rs [Ref: DSR 2014 6.4.1]
ROOF	150 RCC Roof No insulation	PUF Area = 713 sqm Rate = 508 Rs/sqm Cost = 3,62,204 [Ref: Market Rates]	150 RCC Roof + Terrace garden No Insulation	150 RCC Roof + 20mm Tile Area = 2469.4 sqm Rate = 300 Rs/sqm Cost = 7,40,820 Rs
GLASS	ET 150 Area = 373 sqm, Rate = 1300 Rs/sqm Cost = 4,87,500	SKN 744III Area = 373, sqm Rate = 3100 Rs/sqm Cost = 11,62,500	PLT TG Area = 373, sqm Rate = 2500 Rs/sqm Cost = 9,37,500	ENVISION 765 Area = 373 sqm, Rate = 3100 Rs/sqm Cost = 11,62,500
HVAC	VRV System Tonnage = 112 TR Rate = 65,000 Rs/TR Cost = 72,80,000 Rs [Ref: CPWD Plinth Area, E & M]	VRV System Tonnage = 112 TR Rate = 65,000 Rs/TR Cost = 72,80,000 Rs [Ref: CPWD Plinth Area, E & M]	Radiant Cooling System Tonnage = 100 TR Rate = 1,20,000 Rs/TR Cost = 1,20,00,000 Rs [Ref: CPWD Plinth Area, E & M]	Chilled Water System Tonnage = 100 TR Rate = 1,05,000 Rs/TR Cost = 1,05,00,000 Rs [Ref: CPWD Plinth Area, E & M]
Lighting Cost	18,56,000 Rs	30,44,600 Rs	30,44,600 Rs	30,44,600 Rs
SPV Plant Cost	0	Area = 71 sqm Rate = Rs 125,000/sqm Cost = 88,75,000	Area = 71 sqm Rate = Rs 125,000/sqm Cost = 88,75,000	Area = 71 sqm Rate = Rs 125,000/sqm Cost = 88,75,000
Cost Of Occupancy Sensors	0	Rate = 4447 Rs/Unit Cost = 25* 4447 = 1,11,175 Rs [Ref: DSR 2014]	Rate = 4447 Rs/Unit Cost = 25* 4447 = 1,11,175 Rs [Ref: DSR 2014]	Rate = 4447 Rs/Unit Cost = 25* 4447 = 1,11,175 Rs [Ref: DSR 2014]
Overall Energy consumption	956.25 x 10 ³ KWH/Yr (9,56,250 units)	557.02 x 10 ³ KWH/Yr (5,57,020 units)	594.7 x 10 ³ KWH/Yr (5,94,700 units)	620.3 x 10 ³ KWH/Yr (6,20,300 units)
Overall Cost	1,32,50,732 Rs	2,61,08,439 Rs	2,97,99,827 Rs	3,16,88,559 Rs
Extra Cost Incurred	0	1,28,57,707 Rs	1,65,49,095 Rs	1,84,37,827 Rs
Saving/annum	0	27,94,610 Rs	25,30,850 Rs	21,34,650 Rs

PAYBACK PERIOD

OPTIONS	Energy Savings (KWH/Yr)	Money on Electricity bill saved Each Yr (Rs)	Extra Cost Incurred (Rs)	Payback Time (Years)
Option 1	399.23 x 10 ³ (51%)	27,94,610	1,28,57,707	4.6
Option 2	361.55 x 10 ³ (41.5%)	25,30,850	1,65,49,095	6.5
Option 3	335.95 x 10 ³ (35.1%)	21,34,650	1,84,37,827	8.6

CASE STUDY - 2. Lucknow Public School

- Role of Green Schools in improving the quality of Education and in imparting environmental values in students

Benefits of Green School:

These benefits to the schools can be broadly categorized under performance, pedagogy, community and responsibility.

PERFORMANCE

Student's Performance & Building's

Fresh air, daylight, improved indoor environment enhances the performance of students

Water efficiency, energy efficiency and post monitoring improves building performance

PEDAGOGY

Science & Art of Education

Eco-sensitivity is both a passion and science Children get sensitised to environmental aspects

COMMUNITY

Help to Educate the grater community

Knowledge sharing within the school helps in reaching out to parents and nearby communities.

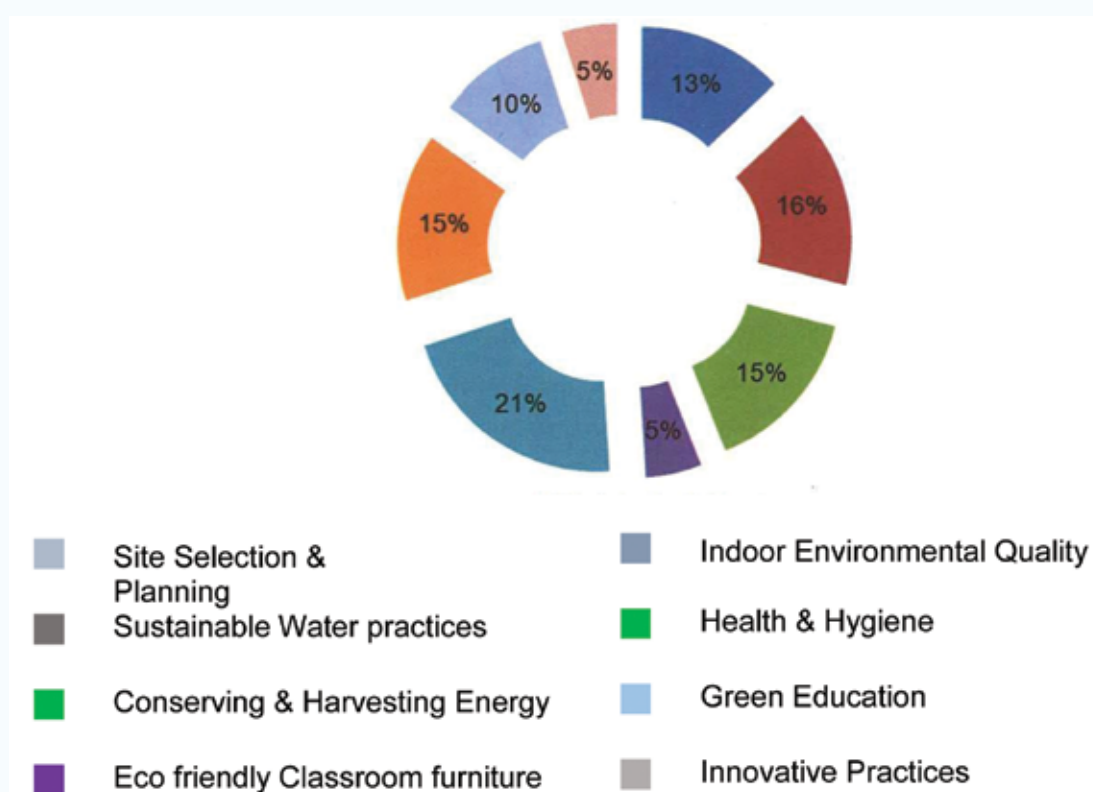
RESPONSIBILITY

Towards environment

Children learn to take responsibility for their own actions that concerns the environment.

Lucknow Public School – a leading chain of CBSE schools in Uttar Pradesh is imparting quality education to around 15,000 students. Keeping pace with the global trends and standards, the schools follow the curriculum, which shapes and nurtures students’ personality in holistic manner.

It is a matter of pride that the South City branch of the group has been awarded the first Platinum rated Green School award for an existing school by the Indian Green Building Council, Hyderabad. The various attributes of green schools are depicted in the following chart.



Green School has sensitized students towards environment, nature/resources, ethics, moral values and overall sustainable development. It has paved the path for other educational institutions/schools in Central India to endeavour along the lines of sustainability.

V. CONCLUSION

Based on the above discussions, it is important to note that promotion and development of energy-efficient building is the need of the hour. At present, the slight cost increment is a deterrent, but proper design could make it financially viable with a pay back of four to five years. Challenges in implementation of ECBC can be summarized as follows:

1. Costs involved in an ECBC-compliant building is higher, hence, financial justification to convince the building owner, sometimes becomes difficult.
2. Involvement of various agencies is a time-consuming exercise because of coordination matters, and hence, could delay implementation of building energy code in Government sector.

3. The knowledge and skills of professionals needs to be improved including knowledge of simulation software, and workforce in buildings should be trained to respond to the demands.
4. There are not many demonstrated case studies to compare the performance between buildings that are ECBC compliant and buildings that have the usual scenario.
5. Limited awareness on the availability, appropriate usage and cost difference of ECBC-compliant materials as against normal building materials.



5. APPROACH TO BUILDING ENERGY CODES' IMPLEMENTATION IN INDIA

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Abstract

Various works carried out by Centre for Advanced Research in Building Science and Energy (CARBSE) at CEPT University, Ahmedabad, has been discussed in this paper. The objective of this project was also to develop a framework for Third Party Assessor (TPA) model to facilitate ECBC compliance and enforcement. The proposed Third Party Assessor framework can resolve the issues of capacity and expertise to enforce ECBC at the local government level. However, coordinating with different government agencies and other relevant stakeholders to incorporate the TPA framework would be a challenging and time-consuming initiative. A tiered approach to ECBC compliance has been proposed wherein, Tier 1 includes those requirements of ECBC that are easy for market adoption, have a high energy savings potential, and are enforceable through the current building permit process, while tiers 2 and 3 include additional measures of ECBC that are more difficult to implement or enforce, given the current practices, and have a lower potential for energy conservation.

I. CONTEXT AND INTRODUCTION

As our fast interdependent global world enters the depth of the twenty-first century, we all focus on mitigation of climate change. One of the proven methods to address climate mitigation is to reduce energy consumption in buildings. The global emissions crisis gets intense every second we breathe. India, on its path of development, has experienced an economic growth in the range of 5–10 per cent in the last 15 years. This has led to a surge of new construction, and we expect to build 67 per cent of the total building stock of 2030 in the next 17 years. Being a country that needs space cooling during the most of the year, we rely on air-conditioning systems to maintain building thermal comfort. With the voluntary adoption of Energy Conservation Building Code (ECBC) in India, numerous energy-efficiency measures are being experimented and implemented in buildings in an endeavour to save energy. This paper talks about various work carried out by CARBSE at CEPT University, Ahmedabad.

A. About Developing a Tiered Approach for Building Energy Code Compliance

The 12th Five Year Plan of India expects an ECBC compliance rate of 65 per cent for new commercial buildings by 2017. This requires states to adopt ECBC and enforce it through the building and



development department of Urban Local Bodies (ULB). It will require building owners, developers, architects and engineers comply with ECBC.

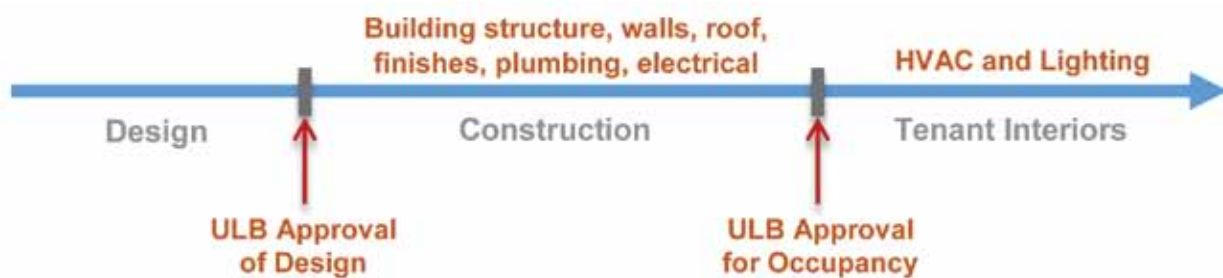


Figure 5.1: Tiered approach

Enforcement of all the requirements for ECBC is challenging because lighting and air-conditioning systems are often not installed in the building when ULBs provide construction and occupancy certificates. If the ULB is not able to enforce energy-efficient lighting and air-conditioning because they are installed by tenants who sign leases after the occupancy certificate is obtained, then there will be no burden of ECBC compliance on developers for lighting and air-conditioning systems.

In the Tiered Approach to ECBC compliance (Figure 5.1), Tier 1 includes those requirements of ECBC that are easy for market adoption, have a high energy-savings potential and are enforceable through the current building permit process. Tiers 2 and 3 include additional measures of ECBC that are more difficult to implement or enforce given the current practices, and have a lower potential for energy conservation.

Tiers 2 and 3 need not be enforced by the ULB for the construction and occupancy approval. This approach relies on BEE's expanded appliance labelling programme and Third Party Assessors for enforcing Tiers 2 and 3.

Tier 1 can lock in over 80 of the lifetime energy savings related to ECBC. Enforcing Tier 1 therefore, is a high priority and can be done more readily by the ULB. The savings, cost-effectiveness and enforceability are based on rigorous analysis done by CARBSE at CEPT University, and The Weidt Group, USA under funding from Shakti Sustainable Energy Foundation.

A building owner that attempts Tier 1 will be recognized for completing a set of requirements, as opposed to being penalized for not completing the difficult requirements in the higher tiers. The Tiered Approach reduces the burden on the ULBs to enforce requirements that are too technical in nature, and fall outside their normal purview. This builds success stories and provides a positive direction towards transforming the building industry.



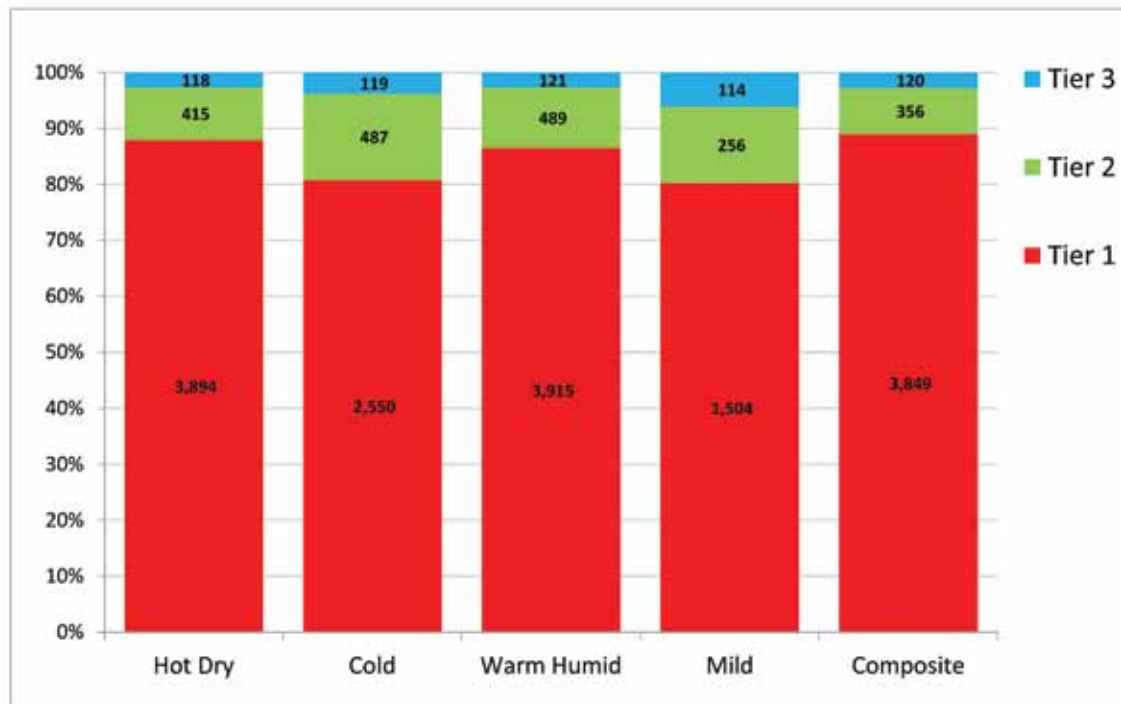


Figure 5.2: Lifetime Energy Savings based on typical useful life of building systems (numbers in the bars are energy savings in kWh per square meter of building).

The tiers described in Figure 5.2 are likely to result in high compliance rates for Tier 1 and will result in larger cumulative lifetime energy savings. Builders who have experience with Tier 1 may attempt Tiers 2 and 3 before these become mandatory, as a means of differentiating themselves in the market. Tiers 2 and 3 have low incremental costs and can be implemented any time during the long lifetime of a building. Builders or tenants can attempt these tiers later to differentiate their real estate.

The performance requirements for Tier 1 can be incorporated into the local building bye-laws more easily since they relate to the building structure, walls, roofs and windows which are usually in the purview of current building bye-laws.

II. ABOUT THE THIRD PARTY ASSESSOR MODEL FOR ECBC COMPLIANCE AND ENFORCEMENT

BEE, India, launched the Energy Conservation Building Code (ECBC) in 2007. As stated earlier, in order to achieve significant compliance and, subsequently, higher energy savings, the code must be adopted by the states and enforced by local governments. However, government and public sector agencies currently do not have the manpower or expertise to enforce ECBC. It is, therefore, crucial to build capacity and create a cadre of professionals outside the public sector. The objective of this project was to develop a framework for Third Party Assessor (TPA) model to facilitate ECBC compliance and enforcement. In order to develop this framework, various successful TPA models in India and worldwide were studied. Some of these TPA models were related to building energy codes or ratings systems, while others were from the non-building sector, but offered valuable insights towards developing a TPA model for ECBC implementation and enforcement in India. A large stakeholder engagement provided useful feedback for the development of the TPA's role and organizational framework. Some of the benefits of the TPA model are:

- 1) Increasingly popular mode of enforcement of building codes around the world
- 2) Allows easier scale up and down of capacity to handle growth
- 3) Market-driven model will ensure availability of TPAs across India
- 4) Adopted in China with substantial success; 80 per cent compliance reported
- 5) Offers a good resolution to challenges related to municipal level regulatory enforcement; used in Canada in similar context
- 6) Over 90 per cent of the US state of Pennsylvania's 2,562 municipalities have enforced the code locally, via employees or certified TPAs
- 7) Building Performance Rating systems with TPAs are used in Australia (NABERS) and USA (HERS)
- 8) Proposed cost of the TPA work for ECBC compliance could be less than INR

The proposed framework is based on issues of capacity, finance and administration of a TPA scheme and includes roles, scope of work, deliverables, eligibility, examinations and qualifications, quality assurance and funding and financing mechanisms. It defines the relationships between the project teams, TPAs, ULBs, SDAs and BEE, for ECBC compliance and enforcement. TPA framework includes roles for the following organizations and individuals (see Figure 5.3):

- 1) BEE: In-charge of the technical standards, administering the system with oversight and certifying the TPAs.
- 2) Project team: Consisting of the developer, owner, architect, engineers, contractor and the person responsible for ensuring that the project complies with the ECBC requirements.
- 3) ECBC Accredited Professionals (ECBC APs): Individuals either hired specially or part of the existing team, with relevant qualifications to provide assistance in developing ECBC compliant building design.
- 4) TPAs: Qualified individuals that check compliance of the building with ECBC requirements during design and construction. A TPA is required to be a building professional with an undergraduate degree and must possess relevant qualifications as notified by BEE. TPAs will be listed on BEE's website and permitted to provide compliance checking services across the country. They will be hired by project team but will not be paid by them directly.
- 5) State Designated Agencies (SDAs): Statutory bodies set up at the state level to implement the Energy Conservation Act 2001, which includes the ECBC. As nodal agencies at state level, they will coordinate and cooperate with BEE at the central level.
- 6) Quality Assurance (QA) Bodies: Organizations appointed by BEE to review TPAs' work for quality and consistency. A national level technical committee will help BEE select the QA bodies. QA bodies will be paid by the BEE through the central government funds which are specifically allocated for measuring and improving ECBC compliance rates.
- 7) Urban Local Bodies: Development authorities and municipal corporations responsible for providing construction and occupancy permits to buildings based on TPA's recommendation. The approval will be in two stages: construction permit and building occupancy certificate.



- 8) Financing Mechanism: A national bank and its selected state branches that collect and disburse payments to the TPAs. The SDA notifies the bank to release payments to the TPA for each milestone reached and deliverable completed.

The Operational Framework of TPA is as described. The project team selects a TPA for its project and the TPA is required to declare no conflict of interest for each project he/she reviews. Project team will follow all other processes to acquire building construction and occupancy permits as required by the concerned ULB. The TPA will only check for ECBC compliance and not any other aspects of the building code. Engaging a TPA on the project requires the project team to provide the TPA with a 'Letter of Credit' of the bank selected in that state. The TPA reviews each building project in two stages to determine ECBC compliance. The first stage is the design review and the second stage is the construction review.

During the design review stage, the TPA reviews the drawings, specifications and ECBC compliance forms to ensure that the Energy Conservation Measures (ECMs) are appropriately documented in the project design documents. During the construction review stage, the TPA reviews the ECBC compliance forms and inspects the building to ensure that the ECMs are incorporated in the construction of the building and the installation of its systems. If the design or construction does not meet the ECBC requirements, the TPA notifies the project team and requests for detailed documentation of non-complying ECMs. The TPA ensures that the EPI of the proposed building is reported consistently to BEE using the ECONirman Whole Building Performance tool or any other tool or methods approved by BEE time to time. If the proposed building complies with the ECBC, the TPA sends a 'Letter of Recommendation' along with the checklist to the ULB and the SDA.

The ULB uses the TPA's recommendation in its usual process of construction and occupancy approvals. The SDA compiles the records and authorizes the bank to release payments to the TPA for each milestone reached and deliverable completed.

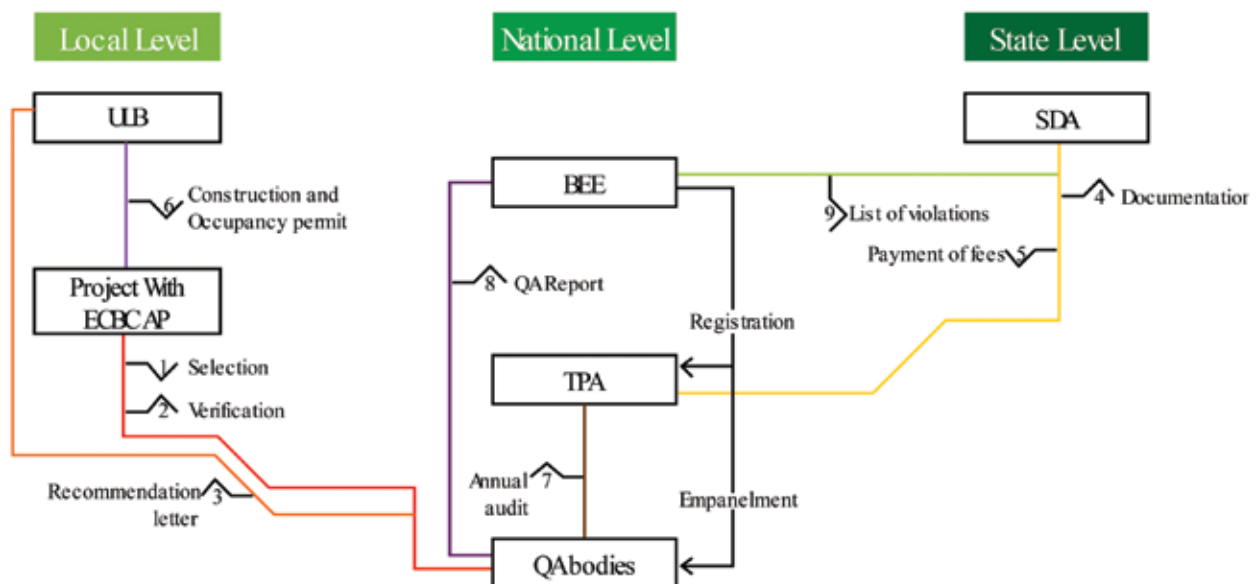


Figure 5.3: Operating model for TPA for ECBC compliance checks

In most states, officials were receptive of the proposed TPA framework. They expressed their preference to use experts to provide TPA services to overcome potential barriers related to capacity and skills.

ULB officials expressed a concern that TPAs, as individuals, are likely to be pressured and influenced into approving compliance. SDAs also stated that BEE would have to take the responsibility for overall quality assurance of the TPA work, and that the agency would prefer to not be directly involved in financial transactions for the TPA work.

III. RECOMMENDATIONS

1. BEE needs to appoint a Technical Committee to appoint QA bodies to oversee the operation of the TPA model, and select the first group of TPAs who can provide services across India while the rest of the TPA institutional infrastructure is set up.
2. BEE needs to appoint an examination agency that can develop and administer TPA examinations and conduct awareness and promotion campaigns over a long term.
3. BEE needs to develop a curriculum guide and a corresponding examination material for TPA training and examinations.
4. Template documents and checklists to be used by TPAs need to be developed based on the tiered approach.
5. There is a need to identify a financial institute and develop template 'Letter of Credit' payment system to be used by SDAs to work with state level branches.
6. BEE needs to appoint experts who can provide consultation to the SDAs for setting up the TPA model in states that are leading the ECBC implementation activity, such as Gujarat, Rajasthan, Odisha, Tamil Nadu, Maharashtra, etc.

The proposed Third Party Assessor framework can resolve the issues of capacity and expertise to enforce ECBC at the local government level. However, coordinating with different government agencies and other relevant stakeholders to incorporate the TPA framework would be a challenging and time consuming initiative. State level initiatives demonstrating effectiveness of the TPA framework may help overcome some of the aforementioned barriers.

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SECTION II

Policy, Regulation and Its Impacts
on Implementation—International
Experiences



6. AN OVERVIEW OF ENERGY-EFFICIENCY PROGRAMMES IN BUILDINGS SECTOR IN ASIA AND THE PACIFIC

- **Butchaiah Gadde**, *Regional Technical Advisor, UNDP Bangkok*

Abstract

Buildings sector account for over 40 percent of primary energy consumption. This paper provides an update on key areas for improvement of energy efficiency in buildings sector along with possible interventions tried and being tested in the region. Building energy codes are being implemented on voluntary basis in most countries of the region except in China and Republic of Korea where it is mandatory. The proven and tested energy efficiency and renewable energy measures are yet to be scaled up. There needs to be a focus on retrofitting of existing buildings towards energy conservation pathways.

Keywords: *Energy Efficiency, Buildings sector, Energy conservation, Building Energy Codes, GHG Emissions*

I. INTRODUCTION

There is an increased focus on energy efficiency in buildings sector as buildings account for more than 40 per cent of primary energy consumption. The share of energy consumption in commercial buildings is increasing because of emerging economies and increased built area of commercial building space in developing countries in the region. Currently, most of the energy consumption attributable to buildings is during their operational phase, rather than for construction or demolition.

This paper provides an update on some of the UNDP-GEF projects focusing on energy efficiency and energy generation in the buildings sector with reduced greenhouse gas (GHG) emissions. UNDP-GEF energy-efficiency projects in the buildings sector are being implemented in India, Malaysia, and Thailand in Asia and the Pacific.

II. IDENTIFIED KEY AREAS FOR IMPROVEMENT OF ENERGY EFFICIENCY IN BUILDINGS SECTOR

It was identified that consumer awareness about possible energy-efficiency measures and related benefits were one of the main barriers. Energy efficiency in residential buildings is better compared with commercial buildings. This is mainly because energy bills are paid by the users of the commercial building space and owners are reluctant to incur additional costs involved to implement energy-efficiency measures, as it will not pay off directly to the owner.



Some countries in the region are implementing Building Energy Codes on voluntary basis for both residential and commercial buildings except in China and the Republic of Korea where compliance with building energy codes is mandatory. Few countries have updated their building codes with energy conservation measures. Few countries, for example, India and Thailand are implementing voluntary certification, or labeling of energy efficient buildings. Overall, there is a less focus on retrofitting of existing residential buildings to ensure their compliance with building energy codes because of complexity involved in the retrofitting and related costs. Further, the practice of monitoring energy use and assessment of energy savings through energy audits in building sector is seldom.

The Energy Efficiency Improvements in Commercial Buildings project in India made an assessment on the additional costs involved to implement energy efficiency measures. It was identified that the costs involved are not significant and have a payback period of less than 10 years. However, the project is exploring the options of rebates, tariff discounts and tax incentives for energy-efficient equipment promotion linked with utilities. The Buildings Sector Energy Efficiency Project (BSEEP) project in Malaysia is coming up with an innovative approach of revolving fund mechanism led by private sector, perhaps an Energy Service Companies (ESCOs), for-profit initiative as it was identified that fiscal incentives are needed for investors. In the commercial buildings projects, it was identified that private sector participation is crucial for the success.

III. POSSIBLE INTERVENTIONS FOR ENERGY EFFICIENCY IN BUILDINGS SECTOR

Equipment related to heating, ventilation and air conditioning (HVAC) and lighting are the major energy consuming equipment in building space. All these interventions cannot be discussed in isolation of other. For example, the concept of natural lighting will enable internal heat gain in buildings. Therefore, an integrated approach has to be followed while addressing energy- efficiency measures.

With the improved policies, buildings are serving as sources of energy. In few countries, energy supply through renewable energy technologies is becoming prominent. With the changed policies of net-metering, many residential building owners are now implementing rooftop solar photovoltaic systems for electricity generation in India. Similarly, solar water heater systems are providing thermal energy needs in buildings.

There are effective policies in place to enable energy efficiency and renewable energy interventions. Policies such as (a) Energy Conservation Building Codes (ECBC), and (b) standards that establish minimum, mandatory energy-efficiency requirements for building components and equipment are seen as a first step towards transformation. Even the policies that sensitise utility companies through demand side management (DSM) are helpful to achieve energy conservation in buildings sector.

Reducing losses through improved insulated material is helping to conserve energy. Improved air sealing of doors, windows with proper ventilation is helping to improve air quality and safety of indoor occupants in China. Technologies for testing materials used in building envelope, its rating and labelling are yet to be matured in Asia and the Pacific.

Integrated implementation of energy efficiency and renewable energy measures in buildings are significantly contributing towards reducing energy consumption in building envelope. Reduced energy bill is leading to monetary savings for building owners. Thus, energy-efficient buildings are contributing towards reducing GHG emissions.



IV. CONCLUSION

The buildings energy code is being implemented on voluntary basis in most countries in the region except in China and Republic of Korea. There must be an institutional structure with clear mandate at the local level for verification and enforcement of building energy code, which is missing in most countries in the region. The Energy Efficiency Improvements in Commercial Buildings project in India is in the process of establishing local level institutions with a specific mandate to promote energy conservation building codes. This involves a lot of effort in terms of capacity building.

Policies for the promotion of energy efficiency shall have a longer time frame with defined targets. Having said this Energy Service Companies (ESCOs) mechanism for the promotion of building energy codes is not that successful although it was tried repeatedly in the region. There could be various reasons including non-compliance of performance based contracting.

There exists a combination of renewable energy and energy efficiency measures that were tested and proved to improve energy conservation in building sector. These initiatives are yet to be scaled up and replicated. No single financial mechanism can facilitate for the promotion of building energy code and its enforcement. In this regard, the experiences under BSEEP project in Malaysia will be helpful for the countries in the region.

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7. IMPROVING ENERGY EFFICIENCY IN RESIDENTIAL BUILDINGS IN THE REPUBLIC OF BELARUS (2012–2016)

- **Andrei Malochka**, UNDP-GEF Project's National Expert, Belarus

Abstract

This paper elaborates some of the key outcomes of the Belarusian project aimed at energy consumption in the residential buildings sector. The Project has become a sort of technical council and supporter for national building design communities while advising and teaching on energy efficiency policy, standards, engineering solutions and building a bridge between best EU practices and local experience. Three pilot residential buildings with total living area of 33.5 thousand m² were designed with annual specific energy consumption lower than 25 kWh/m² for HVAC system and lower than 40 kWh/m² for hot water supply system. This is unprecedented among residential building performance in Belarus.

BELARUS PROFILE:

In 2014 the main development indices of the Republic of Belarus were as follows:

- Population = 9.48 million
- GDP (in Purchasing Power Parity) = 166.8 billion US dollars
- GDP growth rate = 1.4 per cent

The energy sector in 2014 was characterized with the following indices:

- GDP energy intensity = 0.21 toe/1000 US dollars
- GDP energy intensity reduction rate = 2.1 per cent
- Total installed capacity = 9.94 GW
- Total primary energy supply = 30.5 Mtoe
- Total final electricity consumption = 37.5 TWh
- Total final heat consumption = 69.5 thousand Gcal
- Share of renewable energy in total consumption of boiler and furnace fuels = 8.2 per cent

The main indices for housing and construction sectors in 2014 were as follows:

- Total GHG emissions = 17.1 million tons of CO₂ equivalent
- Total final electricity consumption by residential sector = 6.4 TWh
- Total final heat consumption by residential sector = 23.5 thousand Gcal



- Total primary fuel consumption by residential sector = 0.85 toe per person
- Total living area of residential buildings = 248.7 million m²
- Living area of residential buildings built in 2014 = 5.2 million m²

The average temperature in winter -6 °C, in summer +18 °C.



The housing sector consumes more than 16 per cent of the total final electricity consumption and about 33 per cent of the total final thermal energy consumption. In 2014, residential buildings with total living area of 5.2 million m² were put in operation.

About the project:

Improving Energy Efficiency in Residential Buildings in the Republic of Belarus



Project website:
www.effbuild.by

The project is planned for a five-year implementation period and aims at reducing the energy consumption during the residential buildings construction and the following maintenance, as well as reducing the carbon emission that contributes to the climate change. Project focuses on developing and ensuring the effective implementation of new methods in residential buildings design, as well as construction standards and energy efficiency certification schemes.

The project is realized by the United Nations Development Programme with the financial support from the Global Environment Facility. The Department on Energy Efficiency under the State Committee on Standardization of the Republic of Belarus acts as the National Implementing Agency of the project. The project's main partners are the Ministry of Architecture and Construction of the Republic of Belarus, JSCo 'MAPID', RUE 'Hrodnagrazhdanproekt', Mahilou Regional Executive Committee.

The key project's objectives include:

- Assisting the legal and regulatory framework strengthening, as well as the legislation implementation mechanisms aimed at improving the energy efficiency in the residential building sector.
- Capacity building of the Belarusian specialists to effectively implement and apply the new energy-saving standards and construction norms.
- Demonstrate the energy and cost-saving potential of the new energy efficiency measures by implementing the three pilot construction projects.
- Establishing the monitoring and replication mechanisms to ensure the project's results reproduction in Belarus and worldwide.
- Improving the industry experts and the general public awareness of the energy efficiency issues in the residential sector.

The Project's progress was described in details in annual reports to GEF (PIR-2014 and PIR-2015) and to UNDP (APR-2013 and APR-2014), and in the MTE Report (the Project's mid-term evaluation took place in September-December 2014 with a final report submitted in January 2015). Taking into account recent developments in 2015, one can formulate the project's implementation status as follows:

OUTCOME 1: Strengthened legal and regulatory framework and mechanisms to enforce the legislation for improving the energy efficiency of the building sector with the focus on new residential buildings.

A detailed comparative analysis of existing gaps between the energy efficiency housing standards in Belarus and the European Union has been completed. This research provides a basis for a roadmap that includes a list of technical regulatory acts subject to further development and adoption. Many of these documents have been added to the Events Action Plans on the standardization and regulation in the field of energy efficiency and energy saving in the construction sector for 2014–2017. Our project together with RUE 'Stroytekhnorm' has initiated the development and has prepared the first variant of the 'Energy Efficiency for the Buildings' Technical regulations that is the most important legislative regulatory document in this field.



OUTCOME 2: Enhanced capacity of the Belarusian specialists to implement and effectively enforce new energy efficiency standards and norms with the initial focus on new residential buildings.

The project has become a sort of technical council and supporter for national building design communities while advising and teaching on energy efficiency policy, standards, engineering solutions and building a bridge between best EU practices and local experience. Owing to the project, there are already at least seven local design companies exercising new design approach, out of approximately 120 companies. To reach the target of 30 per cent companies, the project developed and disseminated about 100 technical reports with necessary guidelines on new energy performance provisions and design principles and other 15 reports with elaborate technical and design standards and conducted a training campaign of nine 2-day courses for more than 100 specialists and more than 20 companies attending the sessions. In order to facilitate trainings and enhance its quality, the project cooperates with one of the leading institutions in the field of advanced training in construction.

A successful energy audit of the 30 residential buildings has been completed using IPMVP protocol and 'eeMeasure' contemporary software application. We have prepared recommendations and updated the guidelines for improving the residential buildings energy audit practices. During the three training sessions organized by the project in September, October and December 2014 around 100 professionals improved their skills and knowledge in the field of contemporary energy audit methodologies for residential buildings. The project has analysed practices of designing residential buildings with minimal energy consumption and has proposed the latest solutions for the heating and hot water supply systems; developed a basic framework for energy-efficient residential houses certification; provided recommendations on the university curriculum content concerning the issues of energy-efficient residential buildings' design and maintenance. The outcomes of this analysis have become fruitful grounds for discussions at eight roundtable seminars and three international conferences organized by the project for the energy efficiency and construction sector professionals.

OUTCOME 3: Demonstrated energy and cost-saving potential of new energy-efficient measures in at least three new residential buildings in three Belarusian cities.

In the end of 2013, the project hired NIPTIS, the most advanced design company in Belarus, to develop design and detailed project report along with blue prints for three different pilot residential buildings of mass construction. Within the period from January 2014 through June 2015, the NIPTIS together with best national experts and institutions succeeded to incorporate most of the best technical solutions into pre-design simulations and design documentations. The design solutions, based on the best practices, also take into account local operational capacity and baseline designs of the buildings, which assure the building HVAC energy performance is less than 25 kWh/m² per year. The new design principles were a sort of unfamiliar development milestone for the State Construction Expertise. It took them up to eight months to examine the design documentations and release a positive assurance. Only in October 2015, the project and the developers/builders obtained all necessary permissions. The schedules of actual construction of the three pilot residential buildings are as follows (as per letters received from corresponding developers):



Pilot building	Commencement	Completion
Minsk	November, 2015	January, 2017
Hrodna	December, 2015	March, 2017
Mahiliou	February, 2016	February, 2017

OUTCOME 4: Documented, disseminated and institutionalized project results providing a basis for further replication.

The likelihood of achieving this outcome is high. Five international conferences on best practice in energy-efficiency improvement in residential buildings were organized and the audience represented more than 700 participants (in total) from eight countries. Other public outreach activities include 29 conferences/roundtables/seminars, 22 brochures, handbooks and manuals, more than 70 articles, more than 170 technical reports, three press-conferences, two exhibitions, about 90 releases and news. The website had 190 hits and 1700 downloads monthly. The partnership network included more than 25 media resources.

The project's particular contribution and value added to the policy framework:

The project justified and suggested a number of standards, i.e., the Technical Code 'Building Energy Efficiency', which is based on the energy-efficiency performance approach and Directive 2010/31/EU, and this suggestion resulted in inclusion of the said Code in Amendment No. 1 to the State Standardization Plan that was duly approved by the State Standardization Committee. The project also grounded few other standards, which were taken into account by the State Standardization Committee for further adjustments of the State Development Programme of Technical Regulation, Standardization and Conformity Assessment in the Field of Energy Saving for 2011–2015.

Three new courses, i.e., 'Design of Energy-Efficient Residential Buildings', 'Energy-Efficient Technologies in Architectural Engineering' and 'Energy-Efficient Construction Materials, Products and Production Engineering', were suggested by the project to three leading universities (Belarusian National Technical University, Belarusian State Technological University and Brest State Technical University) and prepared in draft along with related curriculum materials.

The Project's particular contribution and value added to the energy-efficiency developments in housing sector:

Three pilot residential buildings with total living area of 33.5 thousand m² were designed with annual specific energy consumption lower than 25 kWh/m² for HVAC system and lower than 40 kWh/m² for hot water supply system. No residential building in Belarus has shown such a performance yet. In addition to the technologies exercised in energy-efficient housing in 2014, the following new technologies were introduced in the design of the three pilot buildings:

1. ventilation with recovery of up to 80 per cent exhaust air heat that provides annual saving of 0.030 Gcal/m²;
2. heat recovery of household sewage and utilization of geothermal resources that provides annual saving of 0.04-0.05 Gcal/m²;



3. use of solar heating system that provides annual saving of 0.025-0.030 Gcal/m²;
4. use of solar PV-panels that provides annual saving of about 4 kWh/m²;
5. remote control and accounting of energy consumption.

Also several technologies were used taking account of:

1. shape, layout, orientation, etc.;
2. increase of tightness and thermal insulation of envelope;
3. ventilation with recovery of exhaust air heat;
4. individual control of heat consumption.

Owing to the applied technologies the following performances will be achieved:

1. fourfold reduction of thermal energy consumption if a new building is constructed according to the model suggested by the project;
2. saving up to 5000 tons of coal equivalent per building in the course of its lifetime.

8. IMPROVING ENERGY EFFICIENCY IN LOW-INCOME HOUSEHOLDS AND COMMUNITIES IN ROMANIA

- Raul Pop, UNDP GEF Energy Efficiency Task Leader, UNDP Romania

Abstract

Buildings in Romania are responsible for 36 per cent of final energy consumption and approximately 37 per cent of national CO₂eq emissions. The building sector is dominated by residential buildings—comprising 95.4 per cent of all buildings. The project has worked through four components, namely, improved EE policies, reduction of local fuel consumption, retrofit buildings and data and information availability for decision makers. As energy efficiency in buildings is rather cross-disciplinary public administration effort, determining and balancing the required inputs is challenging. Extensive multi-stakeholders consultations and harmonization efforts were deployed at the national and local levels.

I. INTRODUCTION/BACKGROUND

The buildings sector is a major consumer of energy and a major contributor of net greenhouse gas (GHG) emissions world-wide. The Intergovernmental Panel on Climate Change (IPCC) estimates that the buildings sector will be responsible for 11.1 to 14.3 billion tonnes of CO₂eq in 2030 out of a projected total of 40.4 billion tonnes. The IPCC also estimates that 29 per cent of these emissions can be reduced cost-effectively.

Within the transition economies of Europe, significant improvements are needed in the existing building stock to ensure the comfort and well-being of inhabitants and the sustainability of energy systems. Buildings account for 40 per cent of the total energy consumption in the EU. There are significant developments within the EU to address energy use in new buildings, but additional work must be done to address existing buildings and the needs of their occupants.

The project works to dismantle the barriers to the implementation of energy-efficiency measures among poorer households and in poorer communities in Romania, working to alleviate fuel poverty. The project acts at a national and local level to address energy-efficiency needs, develop appropriate policy measures, stimulate an ongoing market for locally produced, energy-efficient building materials, build capacity for implementation of energy-efficiency measures in poorer regions, implement real energy-efficiency works in order to improve the lives of 110,620 people in Romania and reduce energy-related GHG emissions by 666,800 tonnes of CO₂eq.

Buildings in Romania are responsible for 36 per cent of the final energy consumption and approximately 37 per cent national CO₂eq emissions. The building sector is dominated by residential buildings comprising 95.4 per cent of all buildings. Existing residential buildings are generally old (over half



of residential buildings were built before 1970). These buildings have poor thermal properties with average annual heating requirements between 137–220 kWh/m². However, various projects throughout Romania have shown that it is very possible to reduce these heating needs by at least 40–50 per cent. This is consistent with results in other countries as well as with large blocks of flats, which are mostly in need of significant repairs.

A. Project components and partners

There are four main components within the project:

1. Improved policies to support energy efficiency in low-income communities
2. Improved capacity at the local level to reduce fuel consumption in low-income communities
3. Retrofitted buildings (and potentially new EE buildings constructed) with reduced fuel consumption or using improved sustainable energy technologies in low-income communities
4. Data and information available for decision-makers for designing programmes to address fuel poverty

The project is funded by Global Environment Facility (GEF) and implemented through UNDP Romania, together with the Romanian Ministry of Regional Development and Public Administration, Ministry of Environment, Waters and Forests and six municipalities in Romania (Calafat, Craiova, Petrosani, Petrila, Vulcan and Calan).

B. Status of implementation

The implementation period runs from June 2011 to June 2016. The activities' status is almost completed, with some six months left for the implementation period.

Under Component 1 (Improved EE policies) several pieces of legislation were promoted, as to address vulnerable segments of the population as main beneficiaries of heating subsidies. As the Romanian energy efficiency legislation is continuously adapting to the EU Directives and EU Commission's specific requirements, the project team has constantly been a facilitator of public consultations amongst various national stakeholders and a promoter of the explicit fuel poverty alleviation measures. Several pieces of local legislation (at municipal level) were drafted as to address differentiated heating tariffs for under-privileged households.

On this component, the project is focusing on incorporating within the national legislation the main conclusions of the project-funded studies, including the definition of fuel poverty and the methodology for alleviating it, which allows low income households to get preferential treatment for energy-efficiency improvements. A national policy advisor contracted by the project is working on the adoption of at least two policy recommendations, regarding amendments of existing energy-efficiency legislation in buildings, national programmes and strategies, in order to increase investments in Energy Efficiency (EE) measures in buildings from the poorest areas. The support of the Ministry of Regional Development and Public Administration is crucial for the approval of these legislative amendments.



The project also works in cooperation with the leadership of EBRD, Ministry of Regional Development, including those from the Regional Operational Programme Team for promoting the development of the ESCO sector in Romania, building on the international expertise on ESCOs and fuel poverty. In this respect, the above-mentioned stakeholders have agreed to organize several further meetings as well as a major common event containing workshops with the relevant stakeholders on the ESCO market in Romania.

Concerning the local policy development, the project supported Vulcan Municipality in revising and adopting its local development strategy and integrating EE measures. The project also proposed EE measures to be validated and integrated into the local development strategies of Craiova Metropolitan Area in the next period, while the national policy advisor is working on other two local programmatic documents to be updated with EE measures.

Component 2 (Local capacity to reduce fuel consumption) was deployed via a consistent programme of energy efficiency trainings, targeting central and local public servants, engineers, architects, other specialists, in order to showcase energy efficiency measures and financing options (such as Energy Performance Contracts). In order to address low purchasing power in poor communities, we have identified and supported development of local, low cost energy-efficiency measures and technologies, as to allow communities to thermo-rehabilitate dwellings independently of expensive industrial off-the-shelf solutions. More than 50 local information points were developed, as to disseminate energy efficiency importance awareness, technical information and rehabilitation procedures.

The project is conducting a national level awareness campaign concerning the use of affordable, sustainable and locally available raw materials in 'do it yourself' projects for increasing the energy efficiency of individual houses.

Capacity at local level has already been improved, for the purpose of reduction of fuel poverty consumption in low/income communities: 800+ professionals and municipal officers have been trained through the project in relevant energy efficiency legislation and suitable energy efficiency and renewable energy technical solutions in different building types.

The project has established a partnership with two local sustainable EE building materials producers, and provided support for the accreditation process of both companies in order to obtain the necessary technical agreements for using these materials for the thermal insulation of public buildings.

The project organized a contest to promote energy efficiency at the local level. The contest concluded with three winners (Vulcan, Brad and Galicea Mare); all three municipalities have received the grant amounts for the installation of the heating units granted as prizes and, therefore, the central heating units have been installed.

Component 3 (Retrofitted buildings) helped rehabilitate 45 buildings of public utility (schools, kindergartens, hospitals and clinics, public markets) in partnership with corresponding municipalities. The measures deployed covered wall insulation, windows and doors replacement, high efficiency heating source installation, internal heating distribution systems.

The project supports the retrofitting of buildings, with reduced fuel consumption or using improved sustainable energy technologies in low-income communities; encourages and stimulates the use in rehabilitation works of locally available, environment-friendly (i.e., sustainable) building materials; takes



advantage of the economy of scale and encourages the replication of project results, e.g., supporting technical analysis of typical apartment block designs; provides subsidies for selected buildings in the pilot regions/municipalities which would otherwise have not been reached by the financing programmes developed at the national level (e.g., very poor households).

So far the project has financed the installation of 12 central heating units in select social buildings and measures of thermal rehabilitation for seven buildings in the pilot localities within the scope of the project's fruitful partnership with local authorities.

As we speak, and throughout its time period (by the end of June 2016), the project deploys thermal retrofits (to up to 34 social buildings and multi-apartment blocks in Dolj and Hunedoara Counties) and conducting a technical analysis of 50 types of buildings, which will represent a significant portion of the building stock of apartment blocks in Romania. The 50 types of blocks technical documentation will be completed this year and by the end of project will be pursued for financing through the National Rehabilitation Programme and the Regional Operational Programme of the Ministry of Regional Development. These deliverables are of crucial importance for the achievement of the outputs under Outcome 3 and for the reduction of energy-related direct greenhouse gas emissions by 666,800 tons of CO₂eq in terms of direct and indirect CO₂ emission savings.

Under Component 4 (Data and information available for decision makers), the project has developed the National Buildings Registry, an online platform aimed at enlisting, monitoring and statistical analysis of the existing buildings stock, in order to elaborate priorities in energy efficiency investments. The platform's beneficiaries (buildings administrators, central authorities, local authorities, various building stocks holders) will be able to monitor the status of energy efficiency measures deployments within the buildings of interest, existing and ongoing EE certifications, capture utilities consumptions and carbon footprint; moreover, options of further rehabilitation measures can be comparatively modelled and evaluated, so as to prioritize investments based on forecasted returns in terms of energy savings and GHG emissions.

Information necessary for decision-makers in the buildings sector include the size and composition of the building stock, prioritization of building retrofitting or rehabilitation for energy performance improvement and the fuel consumption/costs in various types of buildings. While most cities/towns/villages are well aware of their building stock, they are not aware of the costs of fuel to heat these buildings and measures that should/could be taken to improve the building performance.

The Buildings Registry, just launched by the project, is a unique, inter-institutional and synthetic data bank that can and will be used in order to prioritize public investments aimed at increasing energy efficiency in buildings (handled by the Ministry of Regional Development), reducing of the carbon footprint (pursued by the Ministry of Environment and Climate Change) and better allocation of heating subsidies (by the Ministry of Labor and Social Protection) based on the actual dwelling conditions.

C. Issues, concerns, challenges faced

As energy efficiency in buildings is rather cross-disciplinary public administration effort and determining and balancing the required inputs is challenging. There are policies in the area of energy pricing and energy independence (especially in the Eastern Europe, caught between natural gas-dependent countries and Russia), public budgeting for energy efficiency improvements as required by



the population needs and the EU Directives, social protection policies such as heating subsidies and environmental concerns so as to significantly reduce GHG emissions.

Every single one of the mentioned public policies is administered by at least one different public decision-making institution. Rarely those institutions run in sync, and their ability to manage integrated energy-efficiency programmes is limited. The overall strategic, nationwide decision-making ability is also severely affected by frequent top-level political changes, in terms of both individuals and policy priorities.

In terms of deploying significant energy efficiency in building measures, the budgetary burden is significant; it is in direct relationship to the low-quality building stock and therefore, discontinuously and insufficiently made available. Thus, the thermal rehabilitation of the building inventory advances very slowly and rather sparsely. There are no thermal rehabilitation programmes covering the poorest population. Moreover, the slow and imperceptible return on investment makes self-funded thermal rehabilitation projects rather unappealing.

There are no functional financing mechanisms in place, alternative to the public subsidies and, therefore, the thermal rehabilitation progress is tributary to the national budgetary allocation which in turn, depends on the priority order of the moments' decision makers.

D. Particular challenges and strategies to overcome such challenges

Besides the inherent operational challenges to implement such cross-geographical and multiple institutional partners, with their own procurement procedures, timeframes and approval routes, the project has had to overcome the fact that energy efficiency in buildings is a highly cross-sectorial effort. Moreover, funding flows related to increasing thermal comfort and decreasing carbon footprint do not work in a synergetic way yet and each budget holder works on his own agenda and priorities.

Extensive multi-stakeholders consultations and harmonization efforts were deployed at the national and local levels. Those consultations were conducted in several settings:

- facilitation of bilateral cooperation between line ministries and state agencies dealing with specific energy-efficiency issues,
- setting up of an inter-organizational working group at the national level to harmonize EE public policies towards heating subsidies and national GHG emissions' reduction.



9. NAMIBIA ENERGY EFFICIENCY PROGRAMME IN BUILDINGS

- Kudakwashe Ndhlukula, Consultant/RE expert

Abstract

Set against a background of rising electricity consumption in Namibia and power deficit in South Africa—the country's main supplier—the NEEP programme has endeavoured towards energy efficiency in buildings. Local authorities, including the regional electricity distributors (REDs) are the largest single electricity consumers with the domestic/residential sector accounting for over 60 per cent of that portion. Key outcomes include establishment of the Green Building Council of Namibia (GBCNA), five standards pending for approval from NSI, energy audits of private and public buildings, training and certification of energy auditors.

I. BACKGROUND

The Namibia Energy Efficiency Programme in Buildings (NEEP) is a project awarded to Namibia for funding by the Global Environment Facility (GEF) under the Global Framework for Promoting Low Carbon Buildings. The primary focus of the Framework is on two thematic approaches: a) Promotion and increased uptake of high quality building codes and standards – by introducing and enforcing mandatory energy efficient building codes; and b) Developing and promoting energy-efficient building technologies, building materials and construction practices by piloting integrated building design. The three-year project was implemented by the Ministry of Mines and Energy and the Renewable Energy and Energy Efficiency Institute (REEEI) at the Polytechnic of Namibia between 2010 and 2013. The implementers were supported by UNDP.

NEEP is set against a background of rising electricity consumption in Namibia and power deficit in South Africa, the country's main supplier (see Figure 9.1).

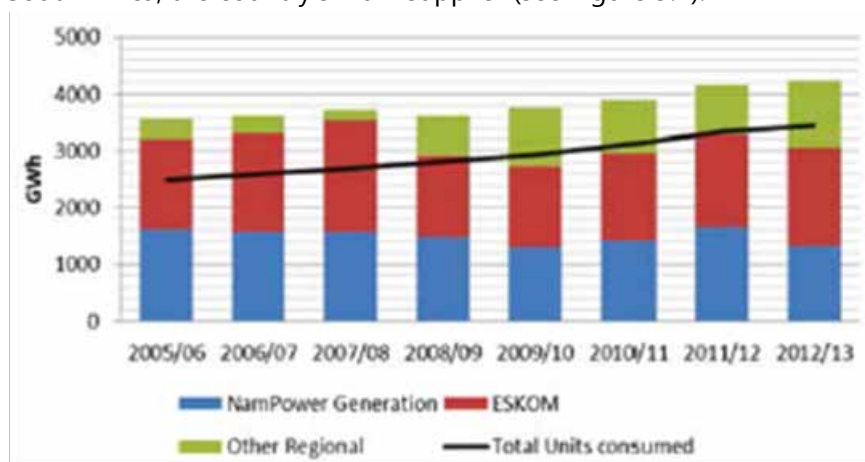


Figure 9.1: NamPower units into system; Import source and local supply

Source: Electricity Control Board

In Namibia, subsequent threat to the country's economic growth and vulnerability to developments in South Africa, contrasts with the limited application of energy-efficient measures and technologies. Local authorities, including the regional electricity distributors (REDs), are the largest single electricity consumers with the domestic/residential sector, accounting for over 60 per cent of that portion (see Figure 9.2).

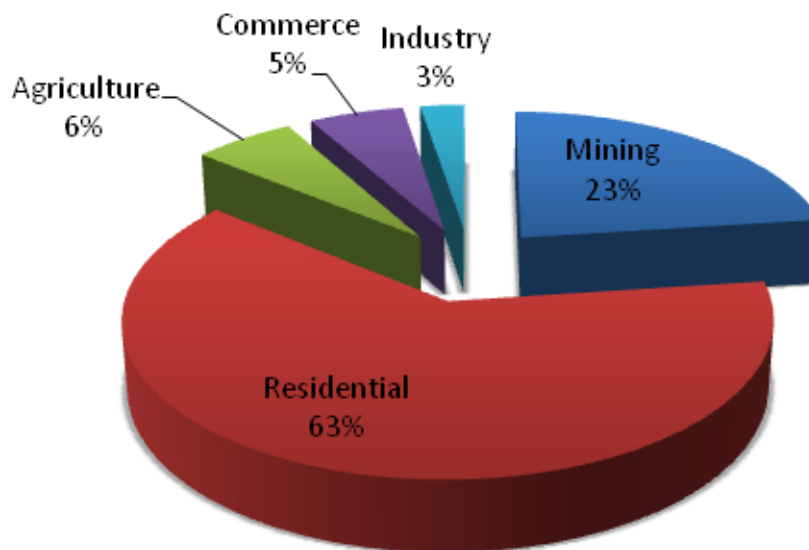


Figure 9.2: Sector-wise electricity demand

Source: REEEI (derived from NamPower 2005 statistics)

Buildings often present a cost-effective GHG emission reduction option. Before the project implementation, the dominant Namibia mindset was that of lack of awareness regarding energy efficiency in general, as well as the cost advantages of energy-efficient technologies and equipment.

A. Project objective

The project was aimed at reducing Namibia's energy-related GHG emissions through the promotion of nation-wide adoption of energy-efficient technologies and practices in the commercial and residential buildings such as government office buildings, hospitals, hotels, schools and possibly a sample of residential buildings.

The following activities were identified to achieve the objective of NEEP.

- *First, the development of improved regulations (standards and labelling of building appliances) and adoption of building codes for energy savings. This would lead to an improved policy framework for energy efficiency in buildings, including an updated list of recommended appliances and materials to be used in the building sector subject to tax and duty reductions.*
- *Second, the provision of auditing and energy marketing services would stimulate the demand and supply of EE services and technology, particularly through the introduction of mandatory audits in public and commercial buildings.*
- *Third, the strengthening of institutional capacity and awareness on EE in buildings that would further contribute to the adoption of EE technologies and best practices.*

KEY OUTPUTS

A number of key outputs were identified along with their results are as summarized below.



Some of the interesting results from Baseline Study of EE in Buildings (see Figure 9.3) indicate that in the buildings surveyed in Namibia only supermarkets are performing badly against the SANS 204 (Energy Efficiency in Buildings) standard of South Africa (see Figure 9.3). SANS 204, which is being reviewed, assumes that buildings comply with regulations and standards in terms of artificial illumination, comfort conditions and typical occupancy levels.

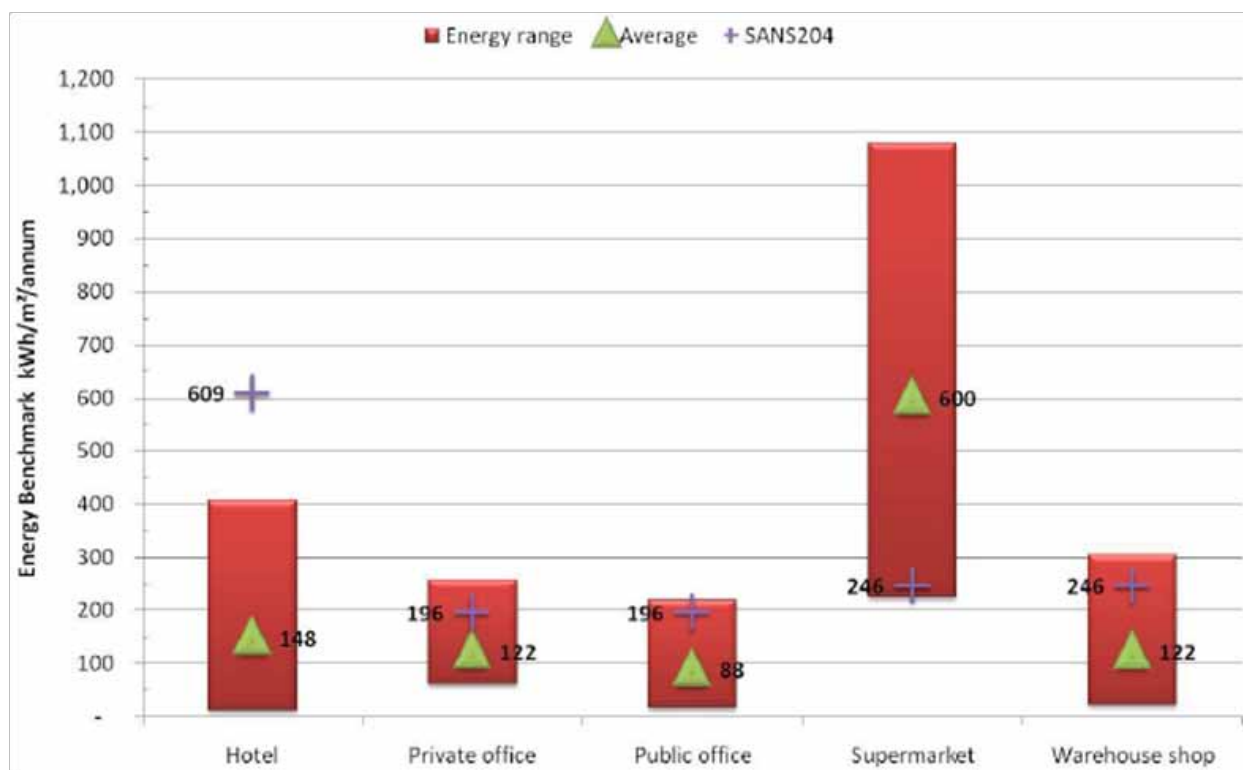


Figure 9.3: Comparison of energy benchmark results with SANS 204

Source: Baseline Study on Energy Efficiency in Buildings for the Namibia Energy Efficiency Programme

The level of awareness of EE in buildings is generally high in hotels than most buildings (see Figure 9.4).



Figure 9.4: Four Star Green Star SA FNB Freedom Plaza building in Windhoek

Source: Green Building Council South Africa

KEY RESULTS AND CONCLUSION

1. NEEP has met most of its outcomes save for the obligatory building codes whose adoption was hindered by institutional inadequacies.

2. The level of awareness on energy efficiency and capacity building at both individual and institutional levels was raised through a number of supporting activities such as training of energy auditors and establishment of Green Building Council Namibia. However, skills in building physics are still very limited.
3. Stakeholder engagement was achieved at very high level, with the Ministry of Mines and Energy and other private players adopting energy efficiency practices in their own energy efficient buildings.
4. Building performance standards are critical in ensuring energy efficiency in buildings. Energy-efficiency standards, including those dealing with performance, are currently being adopted by the Namibian Standards Institute (NSI).
5. Accompanying support policy tools are important for the adoption of energy-efficiency practices and technologies in buildings.

10. BUILDING SECTOR

ENERGY-EFFICIENCY PROJECTS'

BEST PRACTICES TRANSFER FROM

SOUTHEAST EUROPE INTO THE

MALAYSIAN CONTEXT

- *Miroslav Lesjak, BSEEP Energy Efficiency Financing Consultant*

Abstract

This paper identifies best practices and successes from the Croatian building EE project and how they were transferred into the Malaysian context, namely, Energy Management Information System, financing and incentive mechanism ideas. Difference in approaches of overcoming barriers, implementation experience and lessons learnt are covered in this paper.

I. CROATIAN ENERGY EFFICIENCY PROJECT (2006–2013)

The UNDP-GEF project 'Removing Barriers to Energy Efficiency in Croatia' was implemented during 2006–13. The project was the result of an initiative of the Ministry of Economy with assistance from UNDP and financing through Global Environment Facility (GEF) grant. The main project objectives were removal of key barriers for implementation of feasible procedures and technologies for improvement of energy efficiency (EE) in the residential and service sectors in Croatia. This also included promotion of new technologies and improvements of energy efficiency. One of the specific project goals was implementation of systematic energy management within the buildings of Croatian public sector, in order to reduce unnecessary consumption of energy and water, and to encourage the use of EE products and systems.

The project evolved in two national components: the 'Systematic Energy Management in Cities and Counties in Croatia' (SEM Project) for the local and regional level; and the Croatian Government Programme 'House in Order' (HiO Programme) for the central government. Funding of the first five project years was secured by GEF, and this funding was primarily used to start the activities, scale them up, thus making the ground for mobilization of national funding resources primarily provided by Croatian Environmental Protection and Energy Efficiency Fund (EPEEF), that extended the project duration to eight years in total. The total invested amount until the project end in 2013, was 21.7 million USD, out of which the EPEEF had allocated a total of almost 15.8 million USD, with initial GEF funding of 4.4 million USD, UNDP contribution of 0.8 million USD and contribution from other donors to a tune 0.98 million USD.



A. Project Implementation Methodology

One of the biggest results of EE Project in Croatia was development and implementation of a Systematic Energy Management methodology (SEM methodology) that was put in practice in the Croatian public sector (see Figure 10.1). The SEM methodology includes local level capacity building through establishment and education of energy-efficiency teams (EE teams) and energy-efficiency offices (EE offices), establishment of the register of buildings, as well as introduction of regular energy and water consumption monitoring and continuous data monitoring and analysis through Energy Management Information System (EMIS).

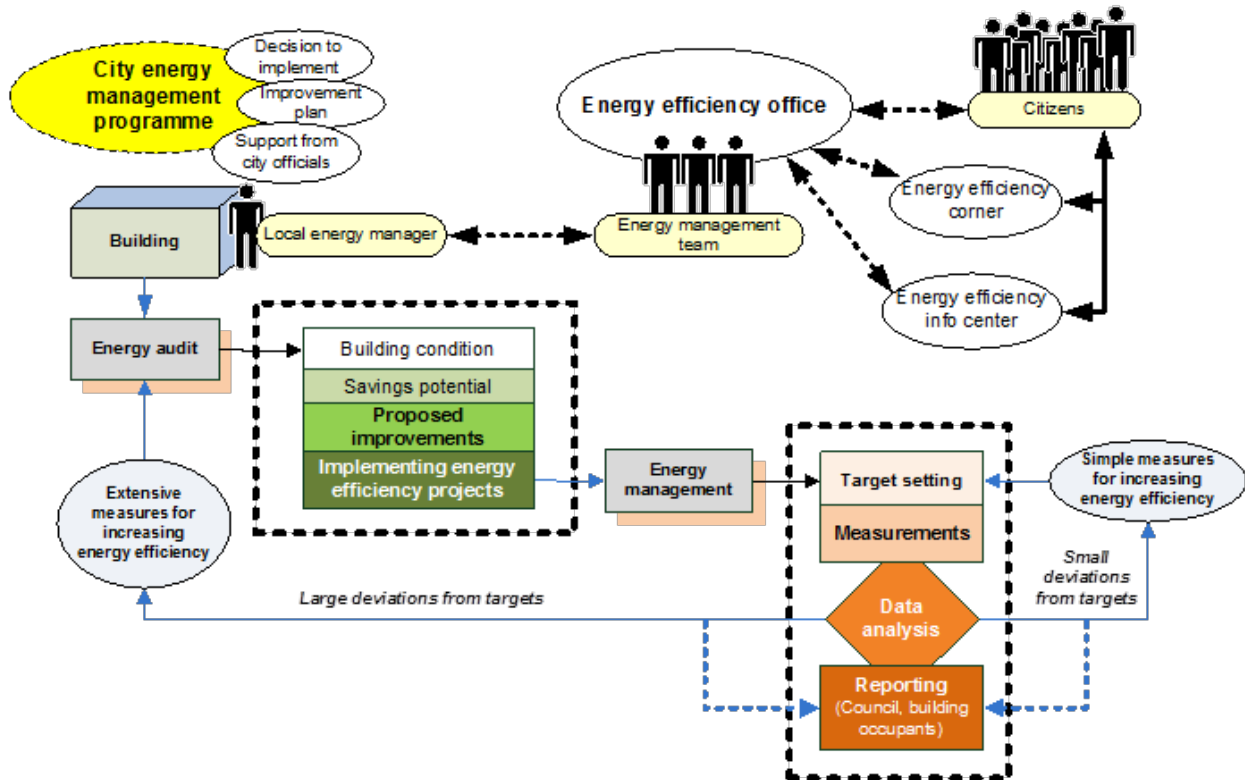


Figure 10.1: Methodology of Systematic Energy Management—SEM

B. Strengthening the Capacity

Key project targets included development of necessary human capacities and exchange and transfer of knowledge and practical experience to the local level as well as between end-users. The established EE teams received high quality training through various workshops, manuals and other technical literature that were developed. Technical assistance has been continuously provided to different ministries and other public institutions, and the most important was the technical assistance to Ministry of Economy in the development of existing and new strategic documents and legal frameworks, including development of:

- Energy Efficiency master plan for 2008–2016,
- Energy strategy of Republic of Croatia,

- First National Energy Efficiency action plan (2008-2010),
- Second National Energy Efficiency action plan (up to 2013),
- Law on Efficient End Use of Energy and several others sub-laws and technical documents

On the communication and outreach plan, more than 29,000 people have received education or training through various workshops covering different aspects of energy efficiency and energy management.

C. Energy Management Information System—The Tool

Key project target was development and establishment of Energy Management Information System (EMIS), a web-based application that is used as a main tool for continuous collection, storage, analysis and interpretation of energy consumption data in buildings (see Figure 10.2). This is an innovative application that significantly facilitates monitoring, analysis and comparison of energy consumption data. EMIS was fully developed during the implementation of EE Project as a result of the needs that UNDP experts encountered in the field. The easy data access and analysis significantly simplifies preparation of energy consumption reports and local energy-efficiency improvement plans as well as easy monitoring and verification of achieved energy savings upon EE project implementation. EMIS contains all the static technical parameters on the building and the dynamic information on amounts and costs of energy consumed. Under the Law on efficient end-use of energy the public sector institutions in Croatia have the obligation to enter the data on energy and water consumption of public buildings in EMIS.

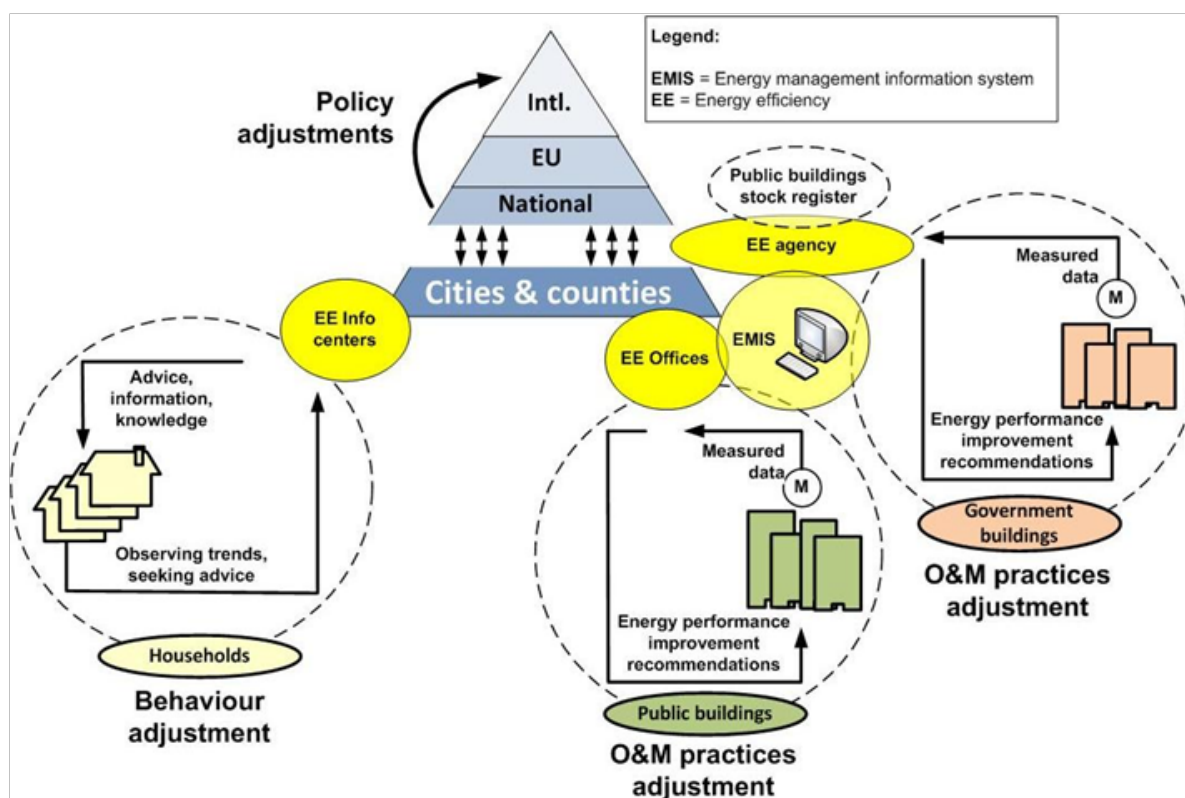


Figure 10.2: Establishment of organizational structure that will enable effective EE policy implementation and verification of results

By the end of the project in 2013, the following main results of EMIS implementation have been achieved:

- EMIS is active in 20 ministries, 20 Counties, 114 cities, 24 municipalities and 25 other state administration bodies.
- EMIS has more than 1,490 active accounts
- Almost 8,500 public buildings are included in EMIS (more than 85 per cent of the buildings are used by public sector in Croatia).
- EMIS contains 1.1 million energy and water invoices and 4.6 million direct meter readings out of which majority is from 46 installed energy consumption remote reading systems that cover more than 330 metering points.
- EMIS provides an easy access to simple graphical and tabular display and a listing of the energy and water consumption data for any user with internet access and user account.

D. Sustainability of project results

One of the key concerns during the implementation of EE project was how to ensure the sustainability of the activities after project is finished. To ensure sustainability on the local and regional level the focus was put on the establishment and education of independent EE teams and local experts that would continue with the implementation of activities. To facilitate this, from the project beginning a lot of effort was invested in improvements of existing legal framework, and these efforts resulted in the adoption of law on end-use energy efficiency that introduced the obligation of energy management for the public sector. In 2013 Transfer agreement between UNDP, Ministry of Construction and Physical Planning (MoC), Environmental Protection and Energy Efficiency Fund (EPEEF) and Agency for Transactions and Mediation in Immovable Properties (APN), defined the roles and obligations of national institutions in continuation of EE project activities, notably, the transfer of management, administration and further development of Energy Management Information System (EMIS), and coordination of systematic energy management at the national level to the APN. The transfer of the organization and implementation of informative educational activities onto the national institutions and thereafter to EPEEF.

E. Lessons learned and Outcome of Croatian Energy Efficiency Project

Out of the number of factors that influenced successful implementation of EE project, the key ones that were present from the beginning up until the project are:

- **Accepting the Change:** Improving energy efficiency (EE) is a process of change, because it requires changing attitudes to energy use, and the focus is on building capacity for change and making proactive EE attitudes a part of daily routines.
- **Managing the Complexity:** Complex stakeholder interrelationship and environment with lots of variables and shifting goals and targets forced the focus on the process itself rather than on the specific tasks.



- Emergence of Solutions: Pre-planned activities and outputs cannot be rigidly maintained and adaptive management is a must.
- Development of People and Competencies: Key barriers to any change process or for achieving development is lack of skills and knowledge that are necessary for effective work, therefore, awareness raising, capacity building and developing of people competencies were the prime tasks of EE project.
- Monetary Savings: Upon completion of the Croatia EE project, analysis on energy consumption from more than 1,500 public sector buildings has shown that cumulative savings of all buildings that were included in EE Project and EMIS for 2011, 2012 and 2013, amount to 26.8 million USD, or on average 6.4 per cent of building energy consumption. The energy savings produced by the project implementation exceed the total project investment with GEF contribution to a factor of 4 due to national project co-financing.

II. TRANSFER OF BEST PRACTICES TO MALAYSIA

The Building Sector Energy Efficiency Project (BSEEP) has the objective to reduce the annual growth rate of GHG emissions from the Malaysia building sector. The project is financed by the GEF and implemented by UNDP and the Malaysian Public Works Department (JKR).

Though BSEEP’s operational framework resembles the one from Croatia’s EE project, the approaches are quite different. As Malaysia is a developing country, showing high potential of increase in the commercial building stock, BSEEP primarily targets its efforts on improving building EE at the design stage, and secondarily in the implementation of energy conservation projects in the existing buildings so as to attain sustainable building sector energy consumption scenarios (see Figure 10.3).

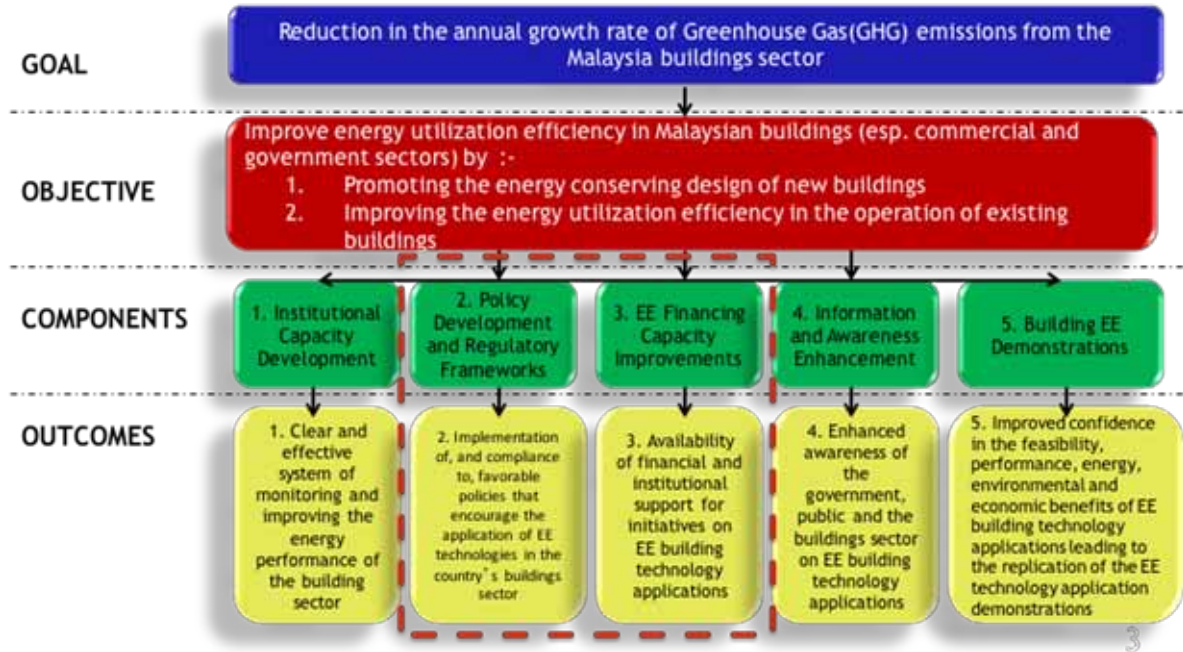


Figure 10.3: BSEEP objectives and operational framework

A. Current situation in Malaysia

Contrary to Croatia’s case, where legislation was the first target of the project, EE in Malaysia still shows undeveloped regulatory foundation combined with lack of or inadequate enforcement of the existing policies. Energy subsidies lower the energy prices and hamper the business case for EE, at the same time conveying a message to the public that wasteful energy usage is acceptable.

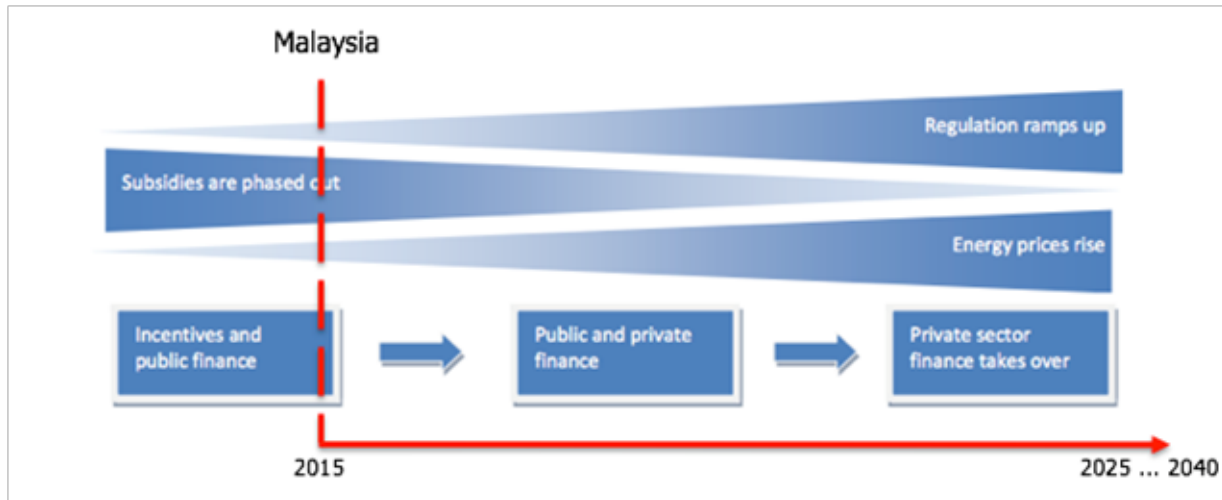


Figure 10.4: Qualitative assessment of the current Malaysian EE policy and economic instruments status

Access to financing for EE projects is still not prevalent due to high perceived risks and undeveloped capacity of the banking sector, with private finance waiting for signals from policy makers. This analysis of the Malaysian situation created a need for the synergetic approach between policy and economic instruments in addressing the identified barriers (see Figure 10.5). The three main areas are:

- Building energy efficiency codes to be mandatory based on MS1525
- Appliance efficiency codes (minimum energy performance standards, MEPS)
- Building energy intensity (BEI) disclosure

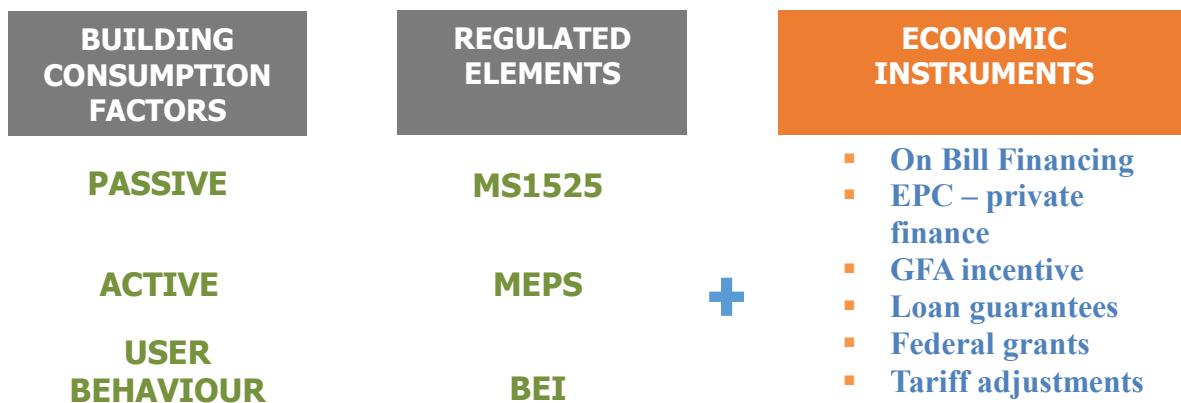


Figure 10.5: Synchronizing Building Sector Policy and Economic Instruments

B. EMIS transfer to Malaysia

To address the BEI disclosure at a national level, prioritize on policy and deployment of economic instruments. To measure and verify their impacts in Malaysia, implementation of centralized national building energy-efficiency database became an imperative. Even though several unconnected databases with different scope exist in Malaysia, none of them has sufficient traction and stakeholder support to take the role of a national building energy consumption database. In collaboration with Energy Commission (EC) of Malaysia, BSEEP has started the transfer of EMIS software and expertise developed under UNDP Croatia EE project to Malaysia. In the technology transfer, due diligence process and different software options were reviewed. 'The usual suspects' targeting business enterprise needs for energy management significantly differ from EC's regulatory requirements. More over software price tags vary significantly depending on complexity and functionality and can range from \$50,000 to over \$5 million. Transfer of EMIS to Malaysia offers three main advantages:

- the tendered costs in the range from USD 250,000 to about USD 500,000 including software development, data migration and training costs, as well as licensing, support and maintenance costs for a subsequent three-year period.
- Our experience is that annual support and maintenance costs for bespoke software systems such as the one proposed can run to 20 per cent of the system development costs.
- EMIS transfer and customization would be just a fraction of that price, mainly for customization and technical assistance services from UNDP Croatia.

On the development timeline, if EC decides to develop software from scratch (functional specification, procurement, development, testing, rollout), they are looking into at least two years' period till operation, nonetheless with very optimistic assumption. Transfer and eventual customization of EMIS can be done within a few months assuring BSEEP's contribution to meet the national targets.

Technical assistance package ensures that together with the software transfer of knowledge is also done, mitigating the learning curve from ST and promoting knowledge and know-how transfer between similar UNDP projects.

BSEEP's activities target involvement of key Malaysian stakeholder in order to implement EMIS in Malaysia and build local capacity for usage of this powerful and proven tool.

C. Implementation of EE economic instruments

Main source of public EE financing in Croatia is the Environmental Protection and Energy Efficiency Fund (EPEEF), a polluters pay facility envisioned to incentivize take-up of EE in wide variety of sectors, from transport to building, household, commercial sector and industry EE and Renewable energy (RE) projects. In regard to current Energy Efficiency Action plan for Croatia, and in line with international experience on EE financing, the conclusion is that public funds itself cannot drive EE in the building sector towards creating a critical mass on the market. At the end of the day, EE has to be a viable business case in order to leverage private funding while risks are covered with public grants. This lesson learned was implemented in Malaysia and the focus of the work in the economic instrument project component focused on the commercially operated project-base financing schemes. Described pathway offers a smoother transition for the building EE sector with market driven and sustainable



schemes that are harmonized with energy-efficiency policy development and tightening of the energy requirements for the building sector.

- Introduction of on-bill financing for commercial building retrofits and household electrical appliances as a part of utility driven demand side management.
- Dedicated credit line for EPC contracts that target holistic building energy retrofits with project financing.
- Malaysian energy-efficiency fund, profit-driven 300–600 million RM financing vehicle for Energy Performance Contract (EPC) that targets commercial and public sector EE retrofits.
- Developed incentive schemes target both new and existing buildings, building energy performance disclosure and energy auditing, together with the take-up and strengthening of MEPS.
- GFA scheme—no cost-economic instrument that builds a market and creates capacity in delivery of green buildings, aids the transition and uptake of building EE standards by allowing additional gross floor area beyond the limit of normal planning controls. Scheme is implemented at the local government level.
- Incentivizing energy audits connected with building energy performance reporting, and related to the goal of creating local energy auditing technical and human resource capacity, in order to aid take-up of the project based on commercial financing.
- Soft loan mechanism connected to the commercially operated on-bill financing scheme, specifically used for strengthening and expansion of the MEPS standards.

D. Conclusions and Way Forward

The same reasoning on the key factors that influenced successful implementation of Croatia's EE Project can be transferred into the Malaysian context:

- **Accepting the Change:** Improving EE is a process of change, because it requires changing attitudes to energy use, the focus to be on building capacity for change and making proactive EE attitudes as a part of daily routine. This connects with the subsidized energy price in Malaysia that hinders a push for the required attitude change. Portion of energy subsidies have to be directed into demand side management programmes with strong outreach and marketing component targeting general public and commercial sector, in order to soothe the transition process to a non-subsidized electrical energy market.
- **Managing the Complexity:** Complex stakeholder interrelationship and environment with lots of variables, shifting goals and targets forces the focus on the process itself. In the Malaysian case, fragmented policy and the lack of institutional champion adds to this complexity, having to target key messages to a wide range of stakeholders.
- **Emergence of Solutions:** Pre-planned activities and outputs cannot be rigidly maintained and adaptive management is a must. This also connects with the lack of flexibility of the project implementation framework and operational procedures from the implementing partners that have to act as a support for the project goals in respect to adaptive management.
- **Strengthen Capacities of People and their Competencies:** Key barriers to any change process or



for achieving development is lack of skills and knowledge that are necessary for effective work, therefore, awareness raising, capacity building and developing of people competences were the prime tasks of EE project. Key issue that has to be tackled in Malaysia is identifying and preparing key stakeholders for activities transfer, before the BSEEP project tenure finishes. Success of the project will be measured in continuation of the activities of all five components.

- Knowledge Dissemination: On the UNDP programme management side focus should be on facilitation of best practices and success stories dissemination, due to similar and repetitive nature of issues connected to EE in the building sector, regardless of the geographic position.



11. BUILDING SECTOR ENERGY EFFICIENCY IN MALAYSIA—SCENARIO OF POLICIES, LEGISLATION AND ENABLERS TO INCREASE THE ADOPTION OF ELECTRICAL ENERGY EFFICIENCY IN THE MALAYSIAN BUILDING SECTOR

- **Kevin Hor**, National Project Manager, BSEEP, Malaysia

Abstract

Malaysia committed itself to voluntary emissions intensity reduction of 40 per cent by the year 2020 in comparison to 2005 level. Electricity consumption from the building sector has grown steadily between 1990 and 2012, predicting a building sector electricity consumption of 94,000 MWh by 2020. KeTTHA, the policy-making ministry published a ten-year energy efficiency action plan for Malaysia in 2013. This action plan outlines a range of policy measures expected to result in a 6 per cent reduction in electricity consumption. Mired in flaws, absence of long-term goals, fragmented government efforts and weak legal instruments, the action plan remains stagnant and the building sector is unsure of its contribution to the commitments made. The paper illustrates the barriers to energy efficiency and the role of BSEEP in identifying new and innovative methods to leverage private financing into energy efficiency and in showcasing several demonstration models with quantifiable impacts.

I. BUILDING SECTOR ENERGY EFFICIENCY PROJECT (BSEEP)

The Project has a goal to reduce the annual growth rate of GHG emissions from the Malaysia buildings sector. The project objective is the improvement of the energy utilization efficiency in Malaysian buildings, particularly those in the commercial and government sectors, by promoting energy conserving design of new buildings and by improving energy utilization efficiency in the operation of existing buildings. The project has five main components:

- Component 1 – Institutional Capacity Development
- Component 2 – Policy Development and Regulatory Frameworks
- Component 3 – Energy Efficiency Financing Capacity Improvements
- Component 4 – Information and Awareness Enhancement
- Component 5 – Demonstration buildings



The project started in year 2011 with a target date of completion in December 2015. There are many stakeholders and to name a few: Energy Commission, UNIDO, JKR, and other agencies. The project is on track to complete the necessary activities detailed in the project document though it kicked off a bit late in 2013.

II. WHY ENERGY EFFICIENCY MATTERS TO THE MALAYSIAN BUILDING SECTOR

Malaysia in 2009, at the 15th Conference of Parties meeting committed to voluntary emissions intensity reduction of 40 per cent in terms of emissions intensity of GDP (gross domestic product) by the year 2020 compared to the 2005 levels. Buildings contribute to around 60 per cent of the total Malaysian electricity consumption and 15 per cent of total energy consumption. As buildings are significant CO₂ emitters in Malaysia, the building sector should contribute its fair share of the abatement goal made in 2009 (see figs 11.1–11.3).

Sum of Building electricity intensity, Wh/GDP (... Sum of Building electricity intensity target, Wh/GDP ...

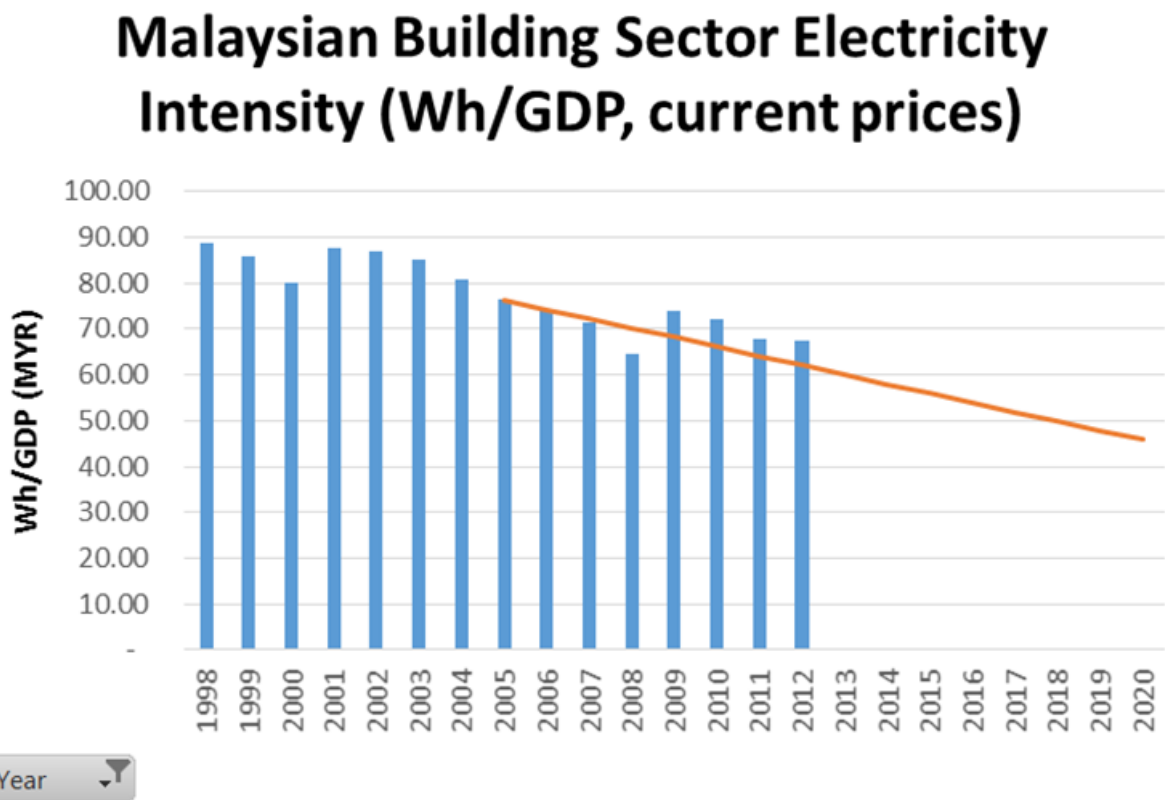


Figure 11.1: Building Sector Electricity Intensity (Wh/GDP, current prices)

Malaysian Building Sector Electricity Intensity (Wh/GDP, constant prices)

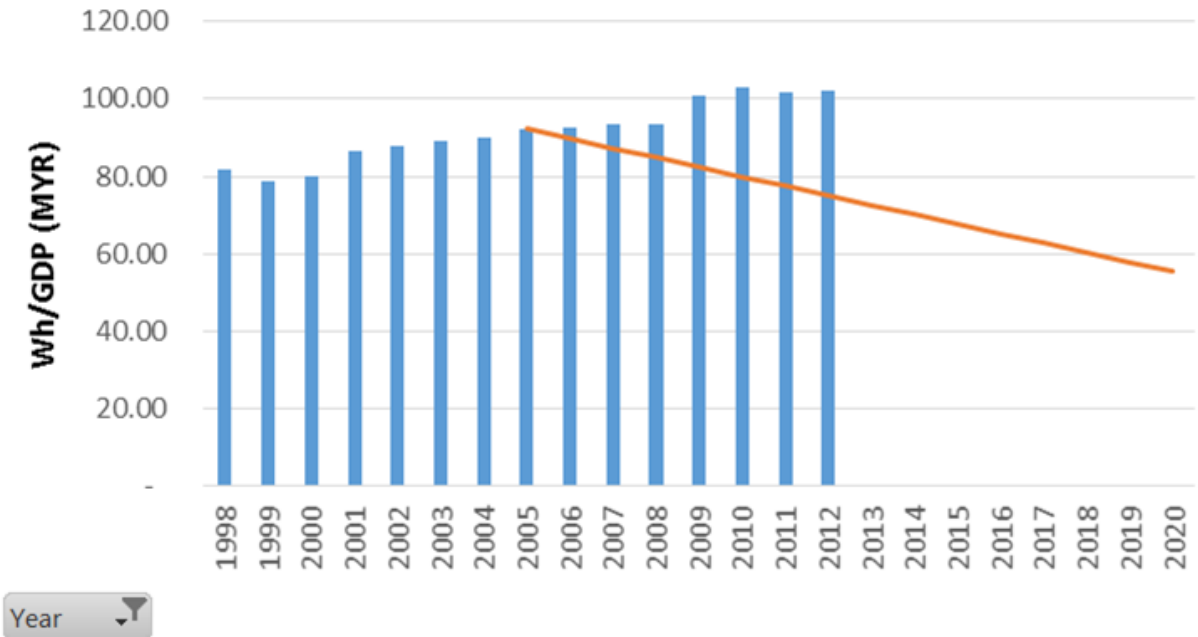


Figure 11.2: Building Sector Electricity Intensity (Wh/GDP, constant prices, 2010 base)

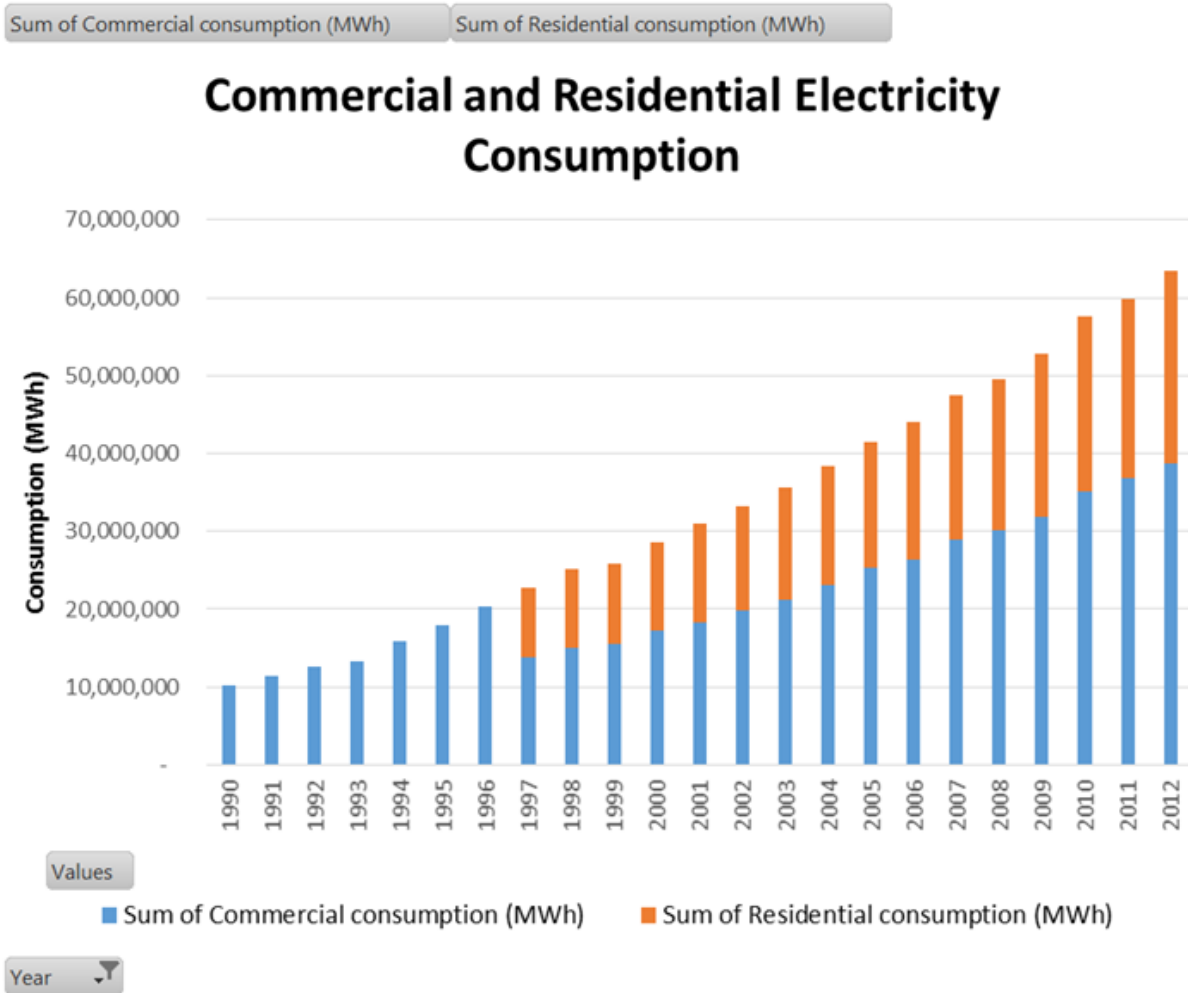


Figure 11.3: Commercial and Residential Electricity Consumption, 1990 to 2012. (Based on EC data from the Malaysia Energy Information Hub)

Source: <http://meih.st.gov.my/statistics>

It is important to note that electricity consumption from the building sector has grown steadily. The trend line of electricity consumption has been highly predictable (with a R2 correlation of 0.99). Trend line of building sector electricity consumption, 1990–2012 shows that if this trend was continued till 2020, the building sector electricity consumption would be 94,000 MWh in 2020 (see Figure 11.4).



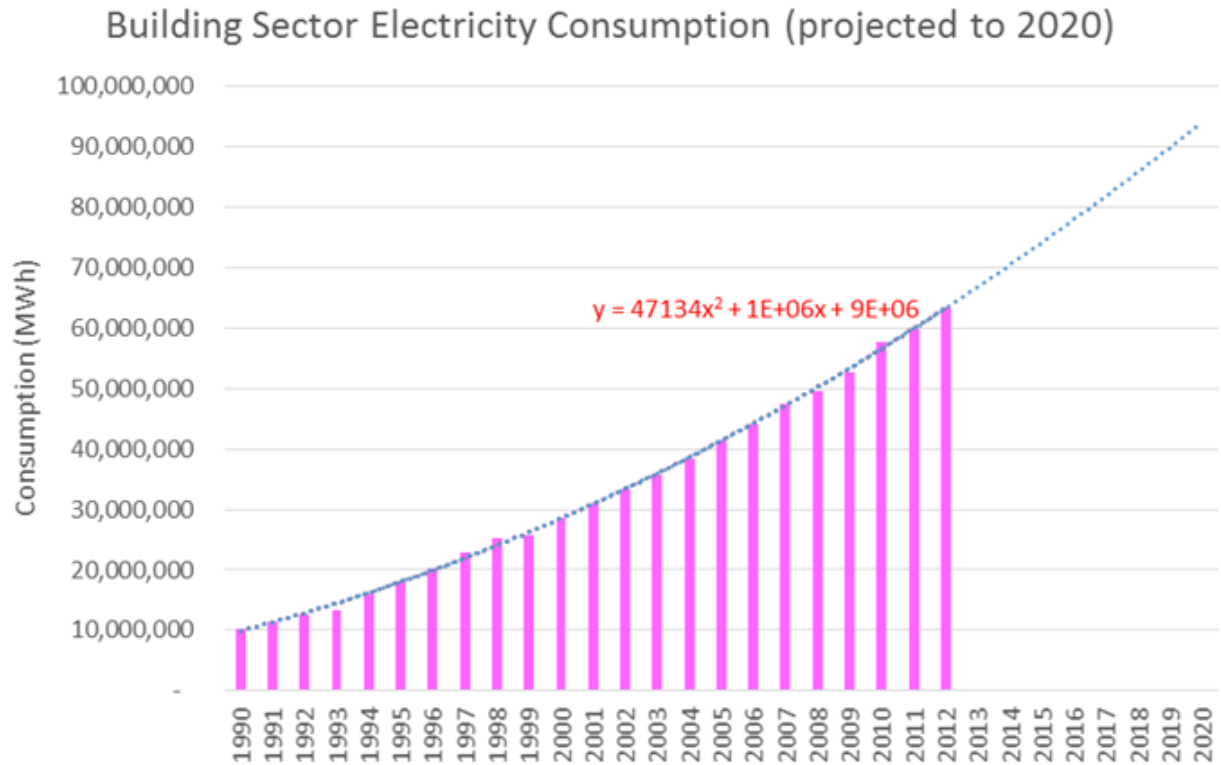


Figure 11.4: Trend line of building sector electricity consumption projected forward to 2020.

Subsequent to the voluntary commitments, very few initiatives have been implemented by the government to improve building energy efficiency. With the exception of private sector driven initiatives such as Green Building Index and GreenRE, there have not been any notable initiatives that have contributed to building energy efficiency significantly.

III. BARRIERS TO ENERGY EFFICIENCY

A. Weak regulatory and institutional framework

How efficient a building is in its energy consumption depends on its design and operational use. No single entity exists in Malaysia which is able to amalgamate all policies and regulations to meet these two criteria. Ministry of Energy, Green Technology and Water, Malaysia (KeTTHA) is the policy-making ministry in charge of formulating bold and forward thinking policies to drive energy efficiency. The implementation of such policies is subsequently left to its agencies such as Malaysia Green Technology Corporation and the Energy Commission who are limited to the purviews of the acts and regulations assigned to each agency. Fragmentation is evident in the current institutional set up with gaps in enforcement of Malaysia’s only regulation on energy efficiency entitled ‘Efficient Management of Electrical Energy Regulations 2008’.

At the same time, the Ministry of Housing and Local Government is the ministry which has the mandate to regulate building energy design as per the Uniform Building By-Law. Unfortunately, due to the

federal and state divides in Malaysia, federal Uniform Building By Laws which incorporate energy-efficient elements is not automatically mandatorily enforced in the 13 states and three federal territories in Malaysia without first being gazetted in state by-laws. To make matters worse, although state laws have the energy-efficient elements gazette, local councils have not enforced such requirements in the building plan submission process or has conducted site inspections to verify such compliance. As on date, only building envelope and energy management systems are mandatory requirements in the by-law. The three-tier governance has proven to be a barrier in building sufficient capacity to enforce within the local councils. The cascading of information and knowhow to enforce has hindered additional efforts to incorporate more of Malaysian Standard 1525 into the Uniform Building By-Law.

B. Lack of a Master Plan or Action Plan

KeTTHA in January 2013 published a ten-year energy-efficiency action plan for Malaysia. This action plan outlines a range of policy measures expected to result in a reduction in electricity consumption of around 60,000 GWh over the ten-year period (compared with BAU), or around 6 per cent.

The KeTTHA plan comprised five strategic actions and five key initiatives. It identifies barriers to energy efficiency, and puts forward ways of overcoming these barriers by providing a coherent framework. It was intended to be a tool for driving energy efficiency. A key principle of the KeTTHA ten-year energy efficiency action plan is one of voluntary participation. This is based on the premise that energy consumers will behave rationally when exposed to information that shows the advantages of energy efficiency. This premise may not be true.

With the exception of the premium end of the property market, where green ratings add substantially to the asset value, there is little evidence that consumers will voluntarily make significant cuts to their energy consumption without either regulation or substantial incentives that can bring forward the value of energy savings to the point of purchase.

The numbers presented in the action plan provide little background information so as to how they have been derived (for example, the savings from each sector), which makes it difficult to understand or query any assumptions that have been made. For example, there is little or no reference to studies for the public. It also lacks the long-term energy efficiency goals as in developed countries.

KeTTHA action plan focused on rating and labelling of appliances, minimum energy performance standards, energy audits and energy management in buildings and industries, targeted rebate and support programmes and energy-efficient building design. While it was intended to be holistic, the action plan was mired with flaws and received critical feedback from industry players who desired long-term goals, a component which was severely lacking in the action plan. Although the draft was released for public comments in January 2013, the plan still remains a draft.

At the same time, the Economic Planning Unit (EPU), with the assistance of the Switch Asia programme, has developed a Sustainable Consumption and Production (SCP) Blueprint to coordinate the goals of economic growth, environmental protection and social inclusiveness into an integrated development concept for input into the 11th Malaysian plan. One of the key sectors in this plan is Sustainable Buildings.



C. No long-term goals

Without any master plan, long-term energy goals and fragmented efforts within the government, the market is left wondering if the building sector is able to contribute to meeting the voluntary commitments made in 2009. It is also worthwhile noting that the Government of Malaysia is also not in possession of building energy database where credible data analysis can be carried out to ascertain the impacts of different policy measures. This is ironic given that the Efficiency Management of Electrical Energy Regulations 2008 allows the government to collect building energy data. While it is targeted at large users, presently, there are no hindrances to allow the Energy Commission to amend the regulation and mandate smaller energy users to report their energy use as well.

D. Priority of energy efficiency in the fuel mix

The 11th Malaysia plan and Malaysia's fuel diversification strategy does not recognize the important contribution of energy efficiency towards improving energy security of Malaysia. Under the New Energy Policy 2010 that was to be implemented within the 10th Malaysia Plan period of 2011–2015, energy efficiency was included as one of the five pillars which then became the basis for three programmes in the 10th MP:

- Sustainability Achieved via Energy Efficiency (SAVE) programme – RM 40 million
- Establishment of an EE Testing Laboratory in SIRIM – RM 45 million
- Drafting of a National Energy Efficiency Master Plan (NEEMP) and Act.

While work was supposed to have been carried out on the national energy efficiency master plan under the 10th Malaysia plan, that commitment was not realized and has become a demand side management study in the 11th Malaysia plan. It might be argued that the rationalization of energy prices towards the true cost was one such measure to prioritize energy efficiency; however, such argument is difficult to justify considering that Malaysia embarked on increasing energy prices closer to market prices as part of its subsidy rationalization plans.

E. Fragmented legal instruments

While there is some legal provision for energy efficiency, it is distributed across a number of different legal instruments such as the Electricity Supply Act (ESA), Efficient Management of Electrical Energy Regulations (EMEER) 2008 and the Sustainable Energy Development Act (SEDA) 2012. This jurisdictional overlap creates poorly defined boundaries on the scope and authority of the various enforcing agencies for driving building energy efficiency improvements. The legal provisions are weak and inadequate leading to an absence of firmly differentiated policy actions for transitioning to energy efficiency, one of which being a mandate for building energy-efficiency improvements.

F. Access to Finance

Malaysia has one of the most highly developed residential, commercial and government buildings sector in Southeast Asia, accounting for 54 per cent of Malaysia's electricity use and contributing to a sizeable market for energy efficiency. The government has put in place various initiatives including



tax and financial incentives (such as subsidized loan rates through the Green Technology Financing Scheme), capacity building, equipment labelling and standards.

While these incentives have garnered interest in the sector, they have only removed the initial barriers. By themselves, these incentives provide a limited solution to the problems of financing energy-efficient projects (EEP) because end-user Hosts and Energy Service Companies (ESCO) still do not have access to efficient debt and equity project financing. In addition, grants should not be considered a long-term 'sustainable' solution for promoting EEPs and a more market-based solution should be pursued.

Going forward, the next logical step is to create a financing mechanism that encourages commercially viable private investment in and lending to EEPs. Commercial, market-based financing mechanisms have been well documented as the best way for creating a sustainable long-term energy-efficiency market, by reports from the UNEP and the World Bank.

However, the following barriers exist for commercially viable lending and investing in EEPs in Malaysia, and they will need to be addressed before widespread implementation of energy efficiency can follow.

G. Lack of Commercial Interest from FIs

The lack of commercial interest by FIs in EEPs is due to a variety of reasons not unique to Malaysia. The success of energy-efficiency initiatives in North America and Europe reflects the maturity of these markets, but in Malaysia there is a lack of commercially-funded EEPs which could serve as reference points (i.e., case studies) for banks and other types of FIs to appreciate their attractiveness for debt providers. With limited examples within Southeast Asia, FIs have not had exposure to the ESCO business model and the energy performance contracting mechanism. With a lack of experience and low level of awareness, it is difficult for FIs to identify and evaluate profitable and viable energy efficiency projects. Without an ability to see beyond the perceived risks and appreciate the business opportunities and returns offered, FIs, therefore, tend to avoid lending to EEPs.

FIs in Malaysia for the most part are 'collateral lenders', especially when making credit decisions for the SME market and smaller scale transactions. Although EEPs involve the purchase of new assets, it is difficult for FIs to accept savings, which is the real value in EEPs, as collateral for a loan. They have yet to gain sufficient experience and confidence through energy-efficiency financing transactions to support project-based loan products that match the needs of Hosts and the ESCO industry.

In addition, the Malaysia energy-efficiency market is still in its early stages resulting in the typical investment size of EEPs being relatively small (often between RM 300,000 to RM 15 million). However, the complexity of the credit decision process by FIs (cash flow versus collateral) creates high transaction costs. In addition, the legal documentation associated with small 'non-standard' loans is relatively high. This disproportionate transaction cost impacts project returns and financial viability, which in turn discourages FIs from lending to EEPs or ESCOs.

One often proposed solution is to bundle EEPs to hopefully reduce transaction costs. However, this solution does not solve all the issues presented above, and therefore, presents some limitations.



H. Context of the problem in Malaysia

The arguments in the preceding sections illustrate the barriers to energy efficiency as well as explain why energy efficiency is important to the Malaysian building sector. It is evident that there is a lack of regulatory frameworks and long-term policy or master plans. Neighboring counterparts like Singapore is already at their third green building master plan but Malaysia has yet to complete the first master plan. What is more worrying is the apparent unwillingness to enact comprehensive laws to drive the adoption of energy efficiency. This dilemma is further complicated by the distorted electricity tariffs in Malaysia which hide the real cost of the fossil fuels that generate electricity.

Without a clear stand from the government on Malaysia's position on energy efficiency, the market will be slow to react and Malaysia will continue to trail in the per capita consumption of energy. The effect of this is a very slow uptake of energy-efficient building design or energy management practices which means that the carbon lock-in of most of the new buildings and future buildings is high. Seeing that leadership cannot be relied upon by the government, new innovative methods to leverage private financing to drive greater voluntary participation is likely the best option for Malaysia.

IV. BSEEP STRATEGIC APPROACH

BSEEP has identified suitable non-mandatory market-driven policy and financing schemes capable of increasing energy-efficiency adoption within the Malaysian building sector. BSEEP has projected itself as a business case for energy efficiency, thereby as a logical endeavour for capital expenditure, and has presented innovative schemes to tip decision makers into making investments in energy efficiency. The following are schemes that have been developed by BSEEP:

- Development of new Malaysian Standard Code of Practice for Energy Efficiency in Residential Buildings
- Development of an On-bill financing scheme for chillers and household appliances
- Development of an energy management information system to promote building energy disclosure.
- Development of a dedicated credit line with a local government owned bank for energy service companies.
- Development of a gross floor area incentive for local councils to increase local council revenue, energy efficiency compliance
- Development of an energy efficiency fund scheme.

V. Quantifiable impacts achieved by BSEEP

- BSEEP is currently facilitating the delivery of the first energy performance contract within the public sector at a hospital in Putrajaya Malaysia. BSEEP provides the commercial, business plan, legal and finance raising capacity to stakeholders involved in the performance contracts.
- BSEEP will be demonstrating the creation of a novel Energy Efficiency Fund where the fund will be private sector lead for profit initiative. A letter of support has been obtained from the economic planning unit and a fund manager is being identified at the point of drafting this document.



- BSEEP in collaboration with the economic planning unit has been engaged with the relevant stakeholders to explore the possibility of creating an on-bill financing scheme with the Tenaga Nasional Berhad, the largest utility company in Malaysia.
- Gross floor area incentives are being implemented by selected local councils in Malaysia. This is currently limited to affluent local councils as developments are concentrated in these more affluent local councils.
- BSEEP is also trying to import the energy management information system developed by UNDP Croatia to be used by the Energy Commission in Malaysia as part of the enforcement of Efficient Management of Electrical Energy Regulations.
- BSEEP is currently engaging with the University of Rosenheim in Germany to transfer research, development and training certification schemes post the introduction of BSEEP of Association of Energy Engineer's certificate courses on energy audit and measurement and verification. These training schemes will be hosted by the Public Works Department at their centre of excellence.
- BSEEP has also released the BETA version of the updated building energy intensity prediction tool. This tool is set to replace the earlier tool and it will be used by the building industry as part of building rating tools. To complement the use of this tool BSEEP has published two books on active and passive design.

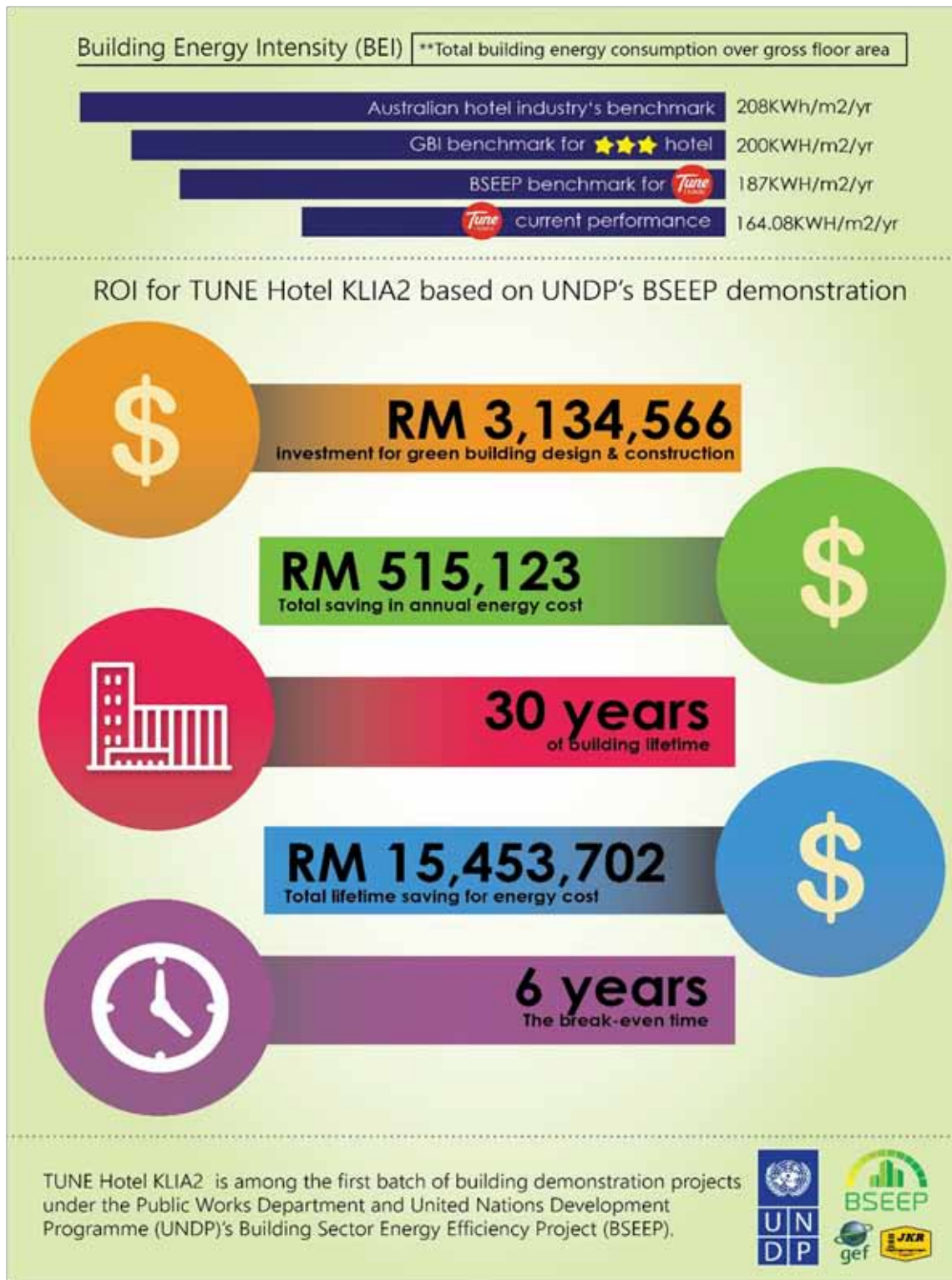
IV. LESSONS LEARNT

Realizing policy and regulatory change in Malaysia is an arduous process due to the fragmented institutional framework in Malaysia. There has not been a central coordinating agency for energy-efficiency-related matters. The involvement of the Attorney General Chambers is imperative for the development of any proposed policy or regulations since approval and buy in from the Attorney Generals Chambers is required prior to acceptance by the government. Capacity building is often forgotten for the attorneys. Increased capacity of attorneys increases the success rate of any proposed policy or regulation due to the technical nature of energy efficiency.



Case study of BSEEP demonstration project

Tune Hotel (new private hotel)



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1. 2012 data for commercial and residential consumption as a percentage of total. Based on data from the Malaysia Energy Information Hub; <http://meih.st.gov.my/statistics>, accessed on 27 March 2014.
2. 'Public Finance Mechanism to Increase Investment in Energy Efficiency', BASE(Basel Agency for Sustainable Energy) for UNEP SEFI, 2006.
3. Energy Efficiency Portfolio Review and Practitioners' Handbook, World Bank GEF, 2004.



12. UNDP-GEF 'BUILDING ENERGY EFFICIENCY IN THE NORTH-WEST OF RUSSIA'

- Vitaly Bekker, National Project Manager, UNDP Russia

Abstract

With an objective to demonstrate local solutions and strengthen capacities in energy efficiency of new and existing buildings, this project has undertaken key interventions to consolidate the various fragmented outputs on energy management. This initiative focuses on wider application of its achievements in the form of new construction pilots in Parfino and Porkhov, public sector demo-sites in Pskov, Arkhangelsk and Vologda region, Russia.

I. PROJECT DETAILS

Key partners: Russian Energy Agency (NIM Partner), Ministry of construction and communal housing, Administrations of the North-West provinces and municipalities, technical universities and professional organizations (design and architectural bureaus, energy management companies), private sector (construction companies/investors).

Total budget GEF/co-finance: USD 5.84 million / USD 27.5 million

Original duration: November 2010-November 2017 with Project Office in Russia, Moscow/St. Petersburg.

II. PROJECT OBJECTIVE/OUTCOMES

The project objective is to build local capacities for and demonstrate local solutions to improved energy efficiency in new and existing buildings in the north-west of Russia: Pskov, Vologda and Arkhangelsk Oblasts.

Outcome 1: Enabling environment and strengthened enforcement capacities for improved energy efficiency at the provincial and local levels. The project helps to create incentives for energy efficient investments and the reduction of end-use energy consumption. The project looks at national and provincial legal and regulatory framework for enforcement and monitoring of energy-efficiency construction norms and for effective implementation of regional energy efficiency programmes. In Pskov Oblast, the project develops institutional and management model for energy-efficient municipalities (energy management system).

Outcome 2: Capacity building and know-how. The project will establish a means of disseminating new technologies in design and maintenance of energy-efficient buildings and housing networks. This component will also target current practicing architects, engineers, planners, and other target



groups. In particular, the project will: (a) develop recommendations and programmes for professional education and training on energy efficiency in construction and building maintenance; (b) integrate energy-efficiency units into the curricula of provincial universities and technical schools; and (c) establish an inter-regional network of vocational training centres.

Outcome 3: Demonstration of local energy-efficient solutions and management models. The project will support three pilot initiatives in order to demonstrate energy-saving potential of proposed technical and management solutions and provide models for replication. The project will cooperate with financial institutions active in North-West Russia to leverage additional financing for each of the demonstration initiatives in order to ensure that they are of a scalable size.

III. KEY ACTIVITIES OF THE PROJECT IN 2015

Municipal energy-efficiency management system integration, creation of energy managers and software for Pskov Oblast region are the key activities of the project. The project joined a study tour to Croatia to the UNDP-GEF EE project to look at the municipal energy management experience there. Various fragmented outputs on energy management achieved by the Russian project so far has been consolidated and are being presented at the provincial level through a comprehensive approach. Energy managers are hired at the provincial level. Energy consumption monitoring software will be integrated into the national energy-efficiency monitoring system run by the Russian Energy Agency.

1. Regulatory and legal work taken up to the federal level with the leadership of the Ministry of construction. A list of regulatory and methodological documents to be developed with the project endorsed by the Ministry.
2. Demonstration project with the new construction (residential building) is to be launched in Parfino municipality (Veliky Novgorod Oblat); co-financing and cooperation agreements to be signed with the Municipality. Project design is on the way. The Parfino pilot will be financed/implemented in 2015. The second pilot site has been identified.
3. A series of demonstration projects on energy-efficient capital repairs has been identified with the Arkhangelsk Oblast administration for implementation in 2015. Technical feasibility study is underway to establish detailed specification for the project technical assistance. Similar work will start with the Pskov oblast on the coming month.

IV. KEY ACTIVITIES PLANNED IN 2016

Key activities in 2016 will be focused on:

1. Wider replication of achieved project results, with support of key federal and regional authorities.
2. Finalization and monitoring EE results on new construction pilots in Parfino and Porkhov.
3. Start-up of demo capital repair public sector demo-sites in Pskov, Arkhangelsk and Vologda regions.
4. Implementation of Croatian EMIS software and dissemination in Pilot region, with the support of regional energy management teams (in Pskov and Vologda).



13. PROMOTING ENERGY EFFICIENCY IN COMMERCIAL BUILDINGS IN THAILAND (PEECB)

- *Jirayut Charoenchatchai*, Assistant Project Manager, PEECB—Thailand

Abstract

The PCEEB project has worked towards intensifying the pillar components of energy efficiency (EE) identified as policy framework, awareness enhancement on building EE technologies and practices and technology application and demonstration. The Commercial Building Energy Efficiency Centre (CBEEC), as an information source of energy-efficiency-related issues, available for all stakeholders has been successfully developed under this project. Awareness enhancement measures include simulation models, demonstration buildings, Specific Energy Consumption index (SEC), promotional newsletters, guidebooks, etc. Alongside, 12 sites have participated in the project and are currently in the process of conducting feasibility study and preparation of baseline energy consumption.

I. INTRODUCTION

Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy in cooperation with UNDP are promoting the energy efficiency programme for commercial building in Thailand to reduce the growth rate of GHG emission from the Thai commercial building sector. The project, namely, 'Promotion Energy Efficiency in Commercial Buildings, PEECB' has been initiated with funding supported by GEF, Government of Thailand and related private sector.

Promoting Energy Efficiency in Commercial Building, PEECB Project consists of three major components:

- Component 1 : Awareness Enhancement on Building EE Technologies and Practices
- Component 2 : Energy Efficiency Building Policy Framework
- Component 3 : Energy Efficiency Building Technology Applications Demonstrations

Two consultants have been engaged to implement the project. Bright Management Consulting Co. Ltd. (BMC) has been contracted by DEDE in April 2013 as the project consultant on component 1, partly of component 2 and 3 and project management. Engineering Solution Provider Co. Ltd. (ENSOP) has been contracted by DEDE on April 2013 as the main consultant on component s2 and 3.



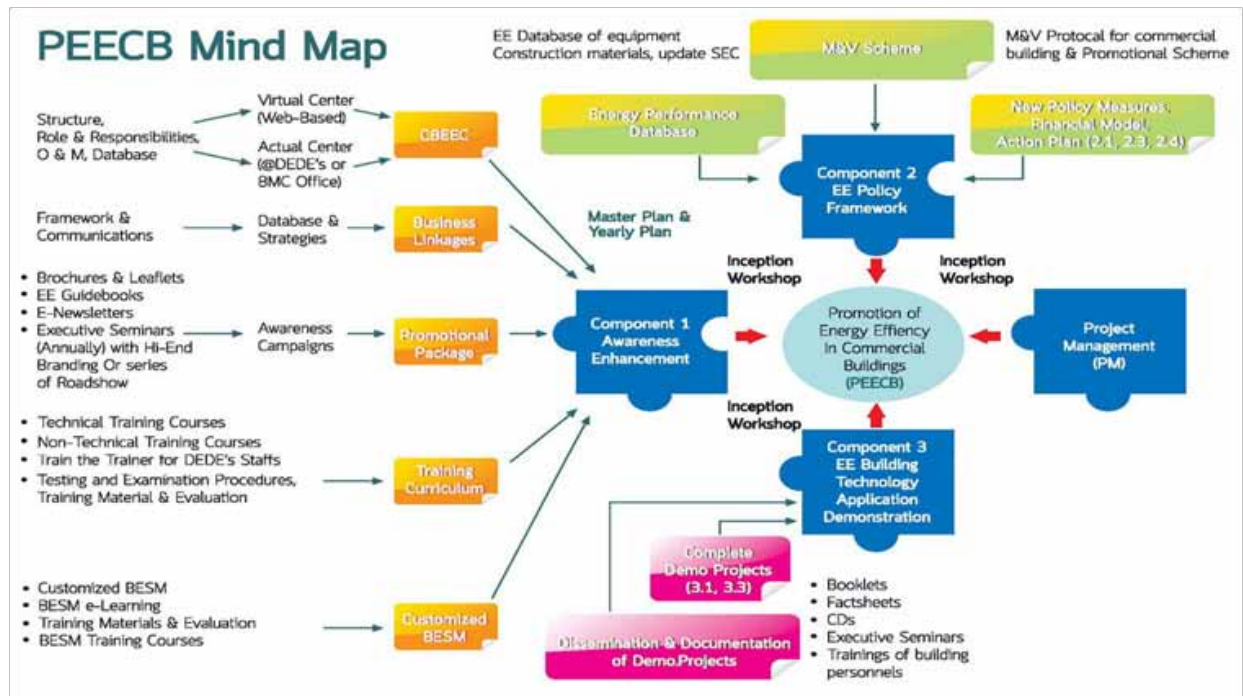


Figure 13.1: PEECB Mind Map

The project comprises a broad range of activities. Project management and other required activities to support the implementation of the three components are also important for the success of the project. Thus, in order to understand the overall methodologies and approaches that BMC propose for this project, the mapping of all project major activities, deliverables and specific proposed activities has been prepared as 'PEECB Mind Map' (see Figure 13.1)

A. Project Objectives

1. To raise awareness on energy efficiency in commercial buildings in Thailand including the establishment of Commercial Buildings Energy Efficiency Information Centre, the development of training programme and related activities and the development of Energy Simulation Software for Commercial Buildings in Thailand
2. To study and prepare policy frameworks, short- and long-term action plan to promote energy efficiency in commercial buildings including evaluation and revision of related policy on energy efficiency in commercial buildings
3. To demonstrate the application of energy-efficiency technologies in commercial buildings and disseminate the successful results to other buildings

B. Project Status

The master plan (4 years) including resource plan and budgetary plan has been developed and was approved in the first project boarding (PB) meeting. The master plan defines the project into four

phases—Preparation phase, Development phase, Realization and Dissemination phase and Conclusion phase (details as stated below).

Phase	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017
1.Preparation	Q2 Mar	Q4 Dec			
2.Development		Q1 Jan	Q4 Dec		
3.Realization and Dissemination			Q1 Jan	Q4 Nov	
4.Conclusion				Q4 Dec	Q1 Mar

Currently, the overall percentage of actual project progress as of Jun 2015 is at 58.19 per cent. The summary of completed works of each task is as follows:

C. Project Management (PM)

Summary of completed works

Project management has been continuously executed by BMC through close coordination and cooperation with all concerned stakeholders, such as UNDP, DEDE, ENSOP, other government and private sectors involved the project. This is to ensure the achievement of the project components to run smoothly under the specified time frame. Several management activities mostly went through meetings and consultation which were regularly organized. The activities include:

1. Setting up Project Board (PB)

The project board of the PEECB project has been formulated to supervise and monitor the project to ensure cooperative and effective implementation of the project. The structure of PB consists of representative from key agencies, namely,

- a. Department of Alternative Energy Development and Efficiency – DEDE
- b. United Nations Development Programme – UNDP
- c. Office of Natural Resources and Environmental Policy and Planning – ONEP
- d. Energy Policy and Planning Office, Ministry of Energy – EPPO
- e. Department of Public Works and Town & Country Planning – DPT
- f. Pollution Control Department – PCD, Ministry of Natural Resources and Environment
- g. The Revenue Department – RD
- h. Department of City Planning , Bangkok Metropolitan Administrator- BMA-CPD
- i. Thailand Greenhouse Gas Management Organization (Public Organization) – TGO
- j. Thai Green Building Institute - TGBI

2. Organize project meeting

Project meetings are organized continuously with PB, DEDE, UNDP, ENSOP and relevant project team to clarify task details, follow up on the project development of each component.

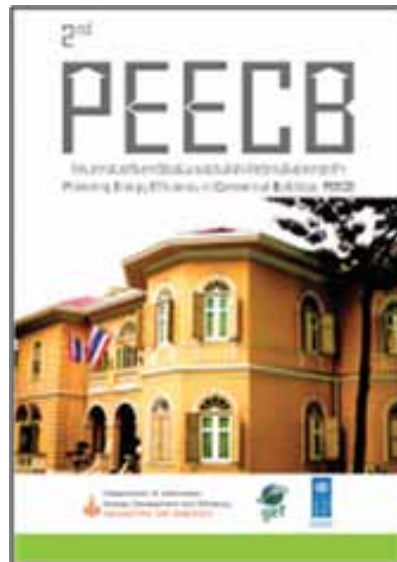
D. Component-1: Awareness Enhancement on Building EE Technologies and Practices

Summary of completed works:

- Conduct situation analysis, initial design concept of the development of CBEEC
 - The CBEEC has been set up to be an information source of energy-efficiency-related issues available for all stakeholders concerned such as developers, owners/end users, engineers, architects, professional institutions, producers/technology suppliers. At this stage, PEECB website has been developed comprising six categories of information and developed as PEECB Website through the banner link from DEDE website which are:
 1. Specific Energy Consumption Index (SEC)
 2. Simulation Models
 3. Building Technologies/Suppliers
 4. Demonstration Buildings
 5. Training Courses
 6. Knowledge/Statistics
- Design-effective promotional scheme: Two newsletters were launched and distributed to the project board and the general public. It was also uploaded in the PEECB's website in June 2015



1st Edition Newsletter



2nd Edition Newsletter

- EE guide book is under preparation based on the content of training courses, results from the project component 2 & 3 on SEC, M&V and demonstration sites

The development or modification concept of Building Energy Simulation Model (BESM) has been prepared according to the comments from the users and also from DEDE officers. The newly created BESM has been proposed to avoid complexity from modification of existing software. The concept of new BESM will address type of buildings with higher energy efficiency than existing Building Energy Code (BEC). Graphic user interface will also be selected where applicable to make the new BESM more user-friendly than the existing BEC software.

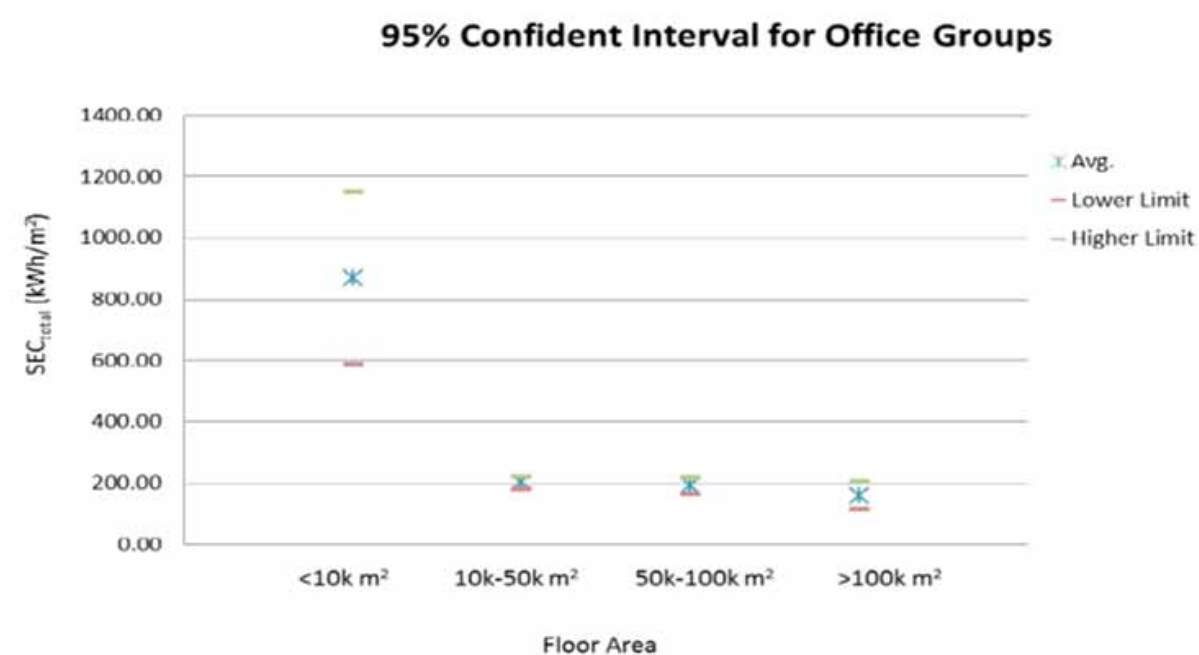
- Studying and identifying the overall training courses for EE technologies and practices
 - There are 11 technical training modules and two non-technical training modules being proposed to be developed under PEECB projects
 - Four major aspects covering 13 technical modules: Basic Knowledge (B), Operation and Maintenance (O&M), Design Practice (D) and Energy Audit Practice (E)

E. Component-2: Energy Efficiency Building Policy Framework

Summary of completed works:

- Nine types of commercial buildings under PEECB have been confined to Energy Conservation Promotion Act (ENCON Act) B.E.2535 (office building, hotel, hospital, department store, educational institute, condominium, theatre, conventional centre, entertainment complex) Building. > 1 MW
- Review and recommend the modification of EE policy to be in three programmes: EE procurement (Leadership program), Building Energy Disclosure Programme, Stepped BEC programme.
 - EE procurement : Developing the project proposal
 - Building Disclosure : DEDE has started for the pilot programme
 - Stepped BEC : Apply Green Bank concept for the buildings
- Review and Assess DEDE's buildings Energy Labelling and Green Building Scheme
 - The option suggested: First, 2 labels using BEC as asset rating and operational rating. Second, using both BEC as asset rating and operational rating together to one level
- Preview structure and software database of energy performance database for building construction materials and electrical equipment.
 - Identify and validate data compilation and database in the BEC software
- Review Specific Energy Consumption Index (SEC) from other countries and existing SEC in Thailand.
 - The energy data survey in office buildings was completed based on energy management report submitting to DEDE by designated buildings and the required information made from the site survey as well as other information source such as Thailand Standard Industrial Certification.
 - There are in total 594 office buildings reported to DEDE in 2013.





- Review existing M&V scheme for completed projects in Thailand. The DRAFT M&V is currently testing at all demonstration sites. The results of the testing will also be discussed in the Focus Group Meeting.

F. Component-3: Energy Efficiency Building Technology Applications Demonstrations

Summary of completed works:

- Currently, there are 12 sites participated in the project as following list;
 - Saint Gabriel's College – school
 - Provincial Electricity Authority, PEA – office building
 - Double A (Double A Business Park; DAP) – office building
 - Energy Complex (EnCO) - office building
 - Kasikorn Bank (K-Bank) – office building
 - CP. Tower 2 – office building
 - Centara Grand at Central World
 - Chaweng Garden Beach Resort, SAMUI Island
 - Grand Mercure Bangkok Fortune Hotel
 - Samrong General Hospital
 - Aik Chol Hospital 1



12. Aik Chol Hospital 2

- These 12 EE buildings were in progress of feasibility study and energy consumption baseline preparation to come out with the best recommendations of technologies being applied for their energy efficiency improvement.

References

1. Two most popular simulation models can be assessed from the following:

- BEC V1.0.5 <http://www.2e-building.com/detail.php?id=14>
- VisualDOE4.0 : <http://www.archenergy.com/product/visualdoe>
- eQUEST 3.64, August 2010 <http://www.doe2.com/equest/>
- TRNSYS 17.1, June 2012 <http://www.trnsys.com/>
- Tas9.2.1.5 <http://www.edsl.net>
- EnergyPlus Version 8.1.0 , April 2005 www.energyplus.gov
- Ener-Win VersionEC , June 2005 members.cox.net/enerwin



SECTION III

Benchmarking, Technical, QA,
Measurements, Verification, Compliance,
Funding Issues



14. BENCHMARKING OF COMMERCIAL BUILDINGS IN INDIA

- *Shabnam Bassi, UNDP-GEF-BEE Project*

Abstract

The buildings sector in India offers a huge potential for electricity savings by use of efficient appliances and implementing other energy-efficiency features in the building design and systems. As per a World Bank Study, electricity savings of 75,356 GWh can be achieved in 2021 by using efficient household appliances. ECBC is currently voluntary, but it is proposed to make the ECBC mandatory for all new buildings that have a connected load of 100 kW or higher or a contract demand of 120 kVA or higher. This paper outlines the objectives along with key findings and recommendations of the benchmarking project, which is a UNDP-GEF intervention to address the barriers and assist the government to implement and operationalize the ECBC through a comprehensive and integrated approach. The total electricity consumption for a commercial building is a critical piece of information needed for benchmarking the building's energy performance, as electricity is the main source of energy for buildings. EPI will only focus on electricity consumption. The need for a central system wherein all utilities could feed in the relevant information is highlighted and so also the huge market potential for EE products, equipment and technologies that are lying untapped.

I. ENERGY SCENARIO IN INDIA

Energy is one of the major inputs required for the economic development of a developing country like ours. The annual energy consumption of India is more than 420.6 Mtoe. India faces an overall energy shortage of 9.8 per cent and a peak shortage of 16.6 per cent. About 64.7 per cent of the power generation in India is through thermal power plants; 24.7 per cent through hydropower, 2.9 per cent through nuclear and 7.7 per cent through renewable energy. India is dependent majorly on fossil fuels and imports part of its coal, and almost all of its natural gas and oil demand. India has coal reserves that shall last for around 114 years, while the natural gas and oil reserves shall last only for 36 and 20 years, respectively, considering our country's current rate of energy consumption. This poses a serious concern for energy security of India. Since fuel resources are scarce and heavy imports of fuel greatly affect the Indian economy with an additional burden of environmental degradation, it is rational to undertake efforts to consume energy more efficiently than the current practices.

The domestic sector is one of the major energy consumers in India. Commercial establishments are expected to grow rapidly in the near future, which includes offices, IT parks, hotels, shopping malls and hospitality industry. This implies that massive investment in energy sector is required to deliver a sustained 8 per cent GDP growth rate. Owing to the ever-increasing energy demands, it is imperative to work on the demand side of the projects by achieving energy efficiency in buildings. Energy efficiency is viewed as a resource option, just like coal, oil or natural gas. It provides an additional economic value by preserving the resource base and reducing pollution. Every unit of energy consumption saved through energy-efficient practices is equivalent to generating two units of energy at the power



generation plant. In addition, it would also prevent pollution caused on account of the production of energy.

The electricity consumption increased from 411,887 GWh during the year 2005–06 to 882,592 GWh during the year 2013–14, showing a Compounded Annual Growth Rate (CAGR) of 8.84 per cent. Out of the total consumption of electricity in 2013–14, the industry sector accounted for the largest share (43.83 per cent), followed by domestic (22.46 per cent), agriculture (18.03 per cent) and commercial sectors (8.72 per cent) (see Figure 14.1).

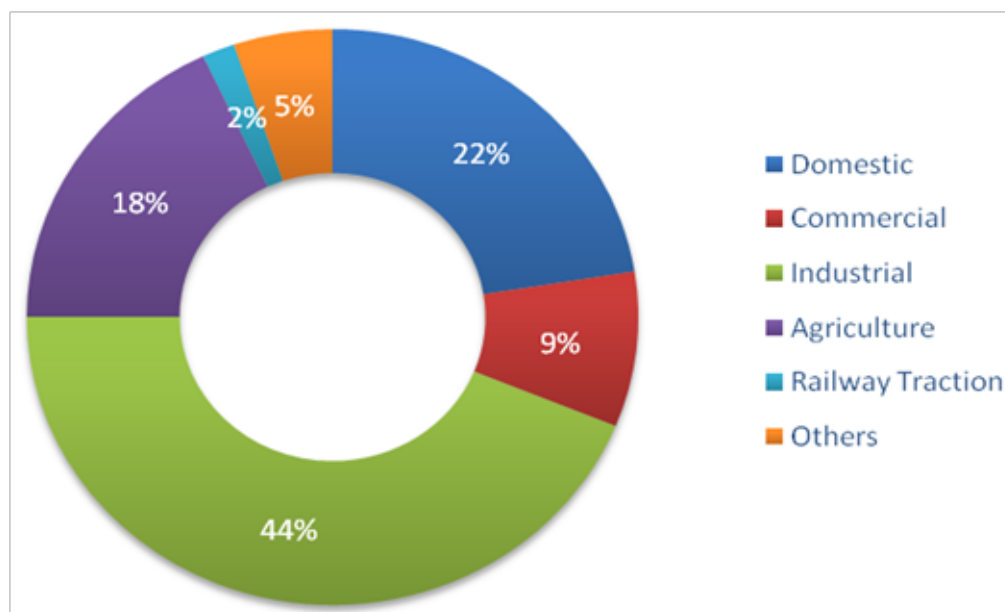


Figure 14.1: Total consumption of electricity in 2013–14

II. BUILDING SECTOR

An estimation of the existing buildings stock has been done by using secondary data reported by various agencies. It has been estimated that the area of building stock in India in the year 2011 is 11,627 million m². As per a report of the Royal Institution of Chartered Surveyors (RICS), 4127 million m² of real estate space (which includes residential, retail, offices, hotels, healthcare and education sectors) is expected to be built between 2012 and 2020 which is on an average construction of 460 million m² of real estate space per year. This real estate demand will be led by the residential sector buildings. This fast-paced growth of the Indian building stock is likely to result in an enormous demand for energy in the near future. Buildings sector in India offers a huge potential for electricity savings by use of efficient appliances and implementing other energy efficiency features in the building design and systems. As per a World Bank Study, electricity savings of 75,356 GWh can be achieved in 2021 by using efficient household appliances. It is estimated that approximately 40,000 MW of power generation capacity can be avoided in 2021 by building energy efficiency.

III. BUILDING ENERGY CODES

Building Codes has proven to be source of long lasting energy savings in new construction where they have been implemented with care. Building Codes have been acknowledged as an important tool of

the government for energy efficiency and climate change policies. First developed as a response to the oil crisis in the 1970s, Building Codes have progressively been adopted in most developed countries. These codes are regularly updated to meet the challenges of the dynamics of the construction sector. Building Codes benefits both the individual building owners and the society. Benefits to property owners include reduced energy costs and improved comfort (both thermal and visual). The benefits to society include reduced capital investments in energy supply infrastructure, reduced environmental impacts, improved electricity reliability and more efficient use of resources.

A. Energy Conservation Building code (ECBC)

To promote energy efficiency technologies and measures in new commercial buildings under its statutory authority, the Bureau of Energy Efficiency (BEE) under the Ministry of Power (MoP) launched the Energy Conservation Building Code (ECBC) in 2007. The purpose of this code is to provide minimum requirements for the energy-efficient design and construction of buildings. The process of development of ECBC involved extensive data collection and analysis regarding building types, building materials and equipment. Further, the code takes in to consideration the climatic condition. There are five distinct climatic zones in India and the ECBC takes in to account these climatic zones in case of Building envelop design. ECBC is currently voluntary, but it is proposed to make the ECBC mandatory for all new building that have a connected load of 100 kW or higher or a contract demand of 120 kVA or higher. The ECBC is currently voluntary still in the early stages of implementing the new building energy code. The expected addition of commercial building floor area in India is growing at about 8 per cent per year and hence, achieving energy efficiency in this sector is important.

IV. DATA COLLECTION CHALLENGES

Lack of statistical data of the Indian building sector like stock of existing buildings, upcoming buildings, energy consumption of buildings, etc., is not only a deterrent in adequate and effective policy making but also a hindrance in monitoring progress of schemes and evaluation of their impact. There is an urgent need to improve the existing system for collection and management of the building sector-related data. A few of these are listed below:

A. Building stock

There are several data gaps in the existing system of collection and management of data related to the Indian building sector. Different real estate and management companies, research institutes and organizations bring out reports/articles with estimation of existing building stock or estimated area added to the existing building stock every year. There is a wide variation in the numbers estimated in these reports and there is no way to cross-check the accuracy of these numbers as all the estimations are based on secondary data and different methodologies are used for arriving at these numbers

B. Energy consumption

In case of energy consumption by buildings, data on consumption of electricity (from utilities) is available for overall domestic and commercial sector. However, there is no data on the consumption of electricity generated from captive power plants. Data on segregation of fuel consumption for different end uses like space cooling/ heating, lighting, other electrical appliances, etc. is not available for both domestic and commercial sector



C. Energy efficient building materials and equipment

There is no common database of the various energy efficient electrical appliances and building materials available in the market. Data on production of star-labelled products covered under the BEE Star Rating programme is available with BEE.

IV. UNDP-GEF-BEE project on Energy Efficiency in commercial buildings

UNDP-GEF's intervention aims to address the barriers and assist the government to implement and operationalize the ECBC through a comprehensive and integrated approach that will focus on (a) Strengthening of institutional capacities at various levels to implement ECBC and other energy efficiency programmes for commercial buildings; (b) Developing technical expertise and awareness raising of key partners; (c) Compliance with ECBC demonstrated in eight model buildings (with a total floor area of 1.47 million m²) in five climatic zones; (d) Formulating fiscal and regulatory incentives for investors and (e) Monitoring evaluation; knowledge sharing and learning.

The UNDP-GEF project has been designed to facilitate the implementation of ECBC across the country. The project's intervention aims to address the barriers and assist the government to implement and operationalize the ECBC through a comprehensive and integrated approach. Energy benchmarking is a process of creating a whole building energy consumption profile of a group of buildings characterized by their primary use, construction, physical, geographic and operating characteristics.

Under the project, a study on collection of data for upcoming and existing commercial buildings throughout India was conducted for finding measures those are required for wide-scale implementation of ECBC in built environment to achieve the target of 75 per cent of all new starts of commercial buildings are ECBC compliant by the end of the 12th Five Year Plan period, Administration and Enforcement of ECBC Implementation through notification of commercial buildings as designated consumers and all new commercial buildings being ECBC complaint. As per amendment of the Energy Conservation Act 2001 in the year 2010, buildings having connected load of 100 kW and above or contract demand of 120 kVA and above have been targeted for this study.

Keeping this background in mind the objective of the benchmarking study is outlined as below:

- Develop an institutional mechanism for the collection and analysis of data on the commercial building sector on a periodic basis at the state level and it's reporting to BEE;
- Prepare a baseline of existing commercial buildings. This baseline will capture data state-wise/ building category-wise and end-use-wise, including the assessment of energy consumption based on the building type, hours of use, and climatic zones of the buildings and conditioned area. Data analysis also needs to be done on the basis of Energy Performance Index (EPI). The effort is expected to provide benchmarking indices (e.g., kWh/m²/year, kWh/m²/hour, kWh/bed/year, kWh/room/year, etc.) that can be used by policy makers, building designers, Energy Service Companies (ESCOs), energy auditors, energy analysts and researchers to get a better understanding of energy use in this sector. The statistical analysis can help to identify parameters that strongly influence energy use in buildings;

- For the purpose of data collection and its analysis, commercial building categories have been covered with an appropriate sample size in the various climatic zones to obtain confidence level of at least 85 per cent
- Projection of the annual addition of new construction growth in this sector in the current Five-Year Plan and estimate the energy savings potential that could be delivered through mandatory implementation of ECBC

With the building energy benchmarking, we are able to compare buildings performances against similar building types and proactively improve buildings energy efficiency. This study will be focusing on electricity consumption of commercial buildings. After benchmarking of commercial buildings we can compare the EPI and analysis over the years on year basis. The EPI data also show the impact of various climatic zones on energy consumption pattern. The online tool has been created to capture and analyse building information and energy consumption data which will form the basis for energy consumption monitoring.

In order to conclude, a study has been conducted using the collected data across all the climatic zones and across office, hotel, hospital, BPO and shopping mall categories of commercial buildings on random sampling basis. A total 1,160 commercial buildings data was collected from all climatic zones. Energy performance indices are used around the world to evaluate and monitor energy performance for buildings during design, construction, renovation and operation. The EPI range of different types of office building is given below:

EPI benchmark for office building

Particulars	Less than 50% AC	More than 50% AC
	EPI (kWh/m ² /year)	
Warm & Humid	101	182
Composite	86	179
Hot & Dry	90	173
Moderate	94	179

EPI benchmark for shopping mall

Particulars	EPI (kWh/m ² /year)
Warm & Humid	428
Composite	327
Hot & Dry	273
Moderate	257

EPI benchmark for BPO

Particulars	EPI (kWh/m ² /year)
Warm & Humid	452
Composite	437
Hot & Dry	-
Moderate	433

EPI benchmark for Hotels

Particulars	Up to 3 star	Above 3 star
	EPI (kWh/m ² /year)	
Warm & Humid	215	333
Composite	201	290
Hot & Dry	167	250
Moderate	107	313

EPI benchmark for Hospitals

Particulars	EPI (kWh/m ² /year)
Warm & Humid	275
Composite	264
Hot & Dry	261
Moderate	247

EPI benchmark for Institutes

Particulars	EPI (kWh/m ² /year)
Warm & Humid	150
Composite	117
Hot & Dry	106
Moderate	129

V. KEY FINDINGS AND LIMITATIONS OF THE SURVEY

- The total electricity consumption for a commercial building is a critical piece of information needed for benchmarking the building's energy performance, as electricity is the main source of energy for buildings. EPI will only focus on electricity consumption.
- Office buildings with higher EPI were generally larger buildings with 24-hour daily operations and large data centres. However, this does not suggest that buildings with longer operating hours or large data centres are energy inefficient. Further studies will be required to establish the correlation between various factors and energy efficiency of a building.
- It was observed that shopping malls with higher EPI were smaller-sized buildings with long operating hours and using split-unit air-conditioning or air cooled centralized chiller systems. However, this does not result in an energy-inefficient building.
- It was observed that hotels with higher EPI are older, smaller-sized hotels using split air-conditioning systems. However, this observation does not imply using split-unit air-conditioning systems is energy inefficient for smaller sized hotels, as other factors such as user behaviour and climate conditions can also contribute to high energy usage.

The limitations of data collection for building are as follows:

- Operation of buildings in India are dynamic in nature;
- Lack of information provided by building owners to the surveyor;
- Building owner's unfamiliarity with the information required by surveyor;
- Building owners' oversight leads to data entry error in the questionnaire submission;
- Building owner's reluctance in sharing information.

A. Recommendations for improvement in the existing data collection and management system

i. System for compilation of data on building stock through local authorities

In India, property owners are liable to pay property tax to municipal authorities on an annual basis. The amount of tax is estimated based on the value of the property. All local municipal authorities in India collect property tax and have information (including area of the property and type of buildings) on the properties within their municipal limits. Some authorities already have a computerized system to maintain their municipal property tax records. A centralized national system should be set up by the Ministry of Statistics and Programme Implementation to regularly collate and update taxed property records from all municipalities in India. This information should include the type of building and the total built-up area of the building.

After a project is complete, it is mandatory for a builder or property owner to get a Building Completion Certificate from the Local Authority to get supply of basic amenities. After getting the Building Completion Certificate, the building owner has to apply to respective departments along with the completion certificate, to get water, electricity connection and other basic amenities. In the aforementioned centralized system, in addition to information related to taxed property, local authorities should also be able to feed in information on the Building Completion Certificate issued by them on a regular basis. This information should include the type of building and the total built-up area of the building for which local authorities have issued the Building Completion Certificate.

ii. System for compilation of data on electricity (from utilities) consumption by building stock through electricity utilities

- A central system wherein all utilities can feed in information on the electricity connections issued by them on a regular basis, should be set up by the Ministry of Statistics and Programme Implementation.
- This information should include the type of building and the total connected load of the building. In addition to this, information on the electricity consumed by all buildings to which the power is supplied should be fed in this system.
- Each connection number could be assigned a code depending on the building typology, and data on electricity consumed by each connection number should be fed in the system.



- iii. Market for energy-efficient products, in the last few years, has seen a noticeable improvement in terms of availability of products. Rising demand for insulation materials, high performance glass, heat reflective paints, energy-efficient masonry units, etc., and increasing number of manufacturers and suppliers of these materials. However, there is still a huge market potential for energy-efficient products, equipment and technologies in India.
- One of the key factors hindering the growth of building energy efficiency in India is the general apprehension of the building industry that green buildings do not make business sense. For the last few years, energy efficiency in buildings has regularly been described as the 'low hanging fruit' at various platforms and forums by Indian policy makers and other stakeholders of the building industry.
 - However, energy efficiency has not yet become an integral part of the building sector. These initial studies of the building sector is not only going to help the policy makers and the developers in adopting efficient practices for designing commercial buildings in India but also help them to align themselves to the future requirements of the industry.

REFERENCE

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15. BUILD GREEN

- Anshula Kumar, Project Officer, GRIHA Council, TERI

Abstract

Green building aims to fundamentally change the built environment by creating energy-conscious, healthy, and productive buildings that reduce or minimize the significant impacts of buildings on urban life and global environments. The various myths and misconceptions around a green building have to be often countered with statistics showing the benefits accrued over the long term period. The lack of incentives, absence of hassle-free and faster regulatory approvals and funding are also among the major constraints.

I. INTRODUCTION

The tremendous growth in economic activity across the globe is placing pressure on natural and environmental resources. There is increasing evidence that human activities are causing an irreversible damage to the global environment, which will have an adverse impact on the quality of life of future generations. The rising concern for the environment in response to global warming is driving thinkers to seek sustainable solutions.

The real estate industry is a significant contributor to the global warming due to extensive emissions of greenhouse gases (GHGs) from the energy use in buildings. In some countries, the built environment accounts for about 40 per cent of the energy used.

Therefore, there is an imperative for the industry to develop sustainable building technologies and green buildings.

Building green means being more efficient in the use of valuable resources such as energy, water, materials and land than conventional building. A green building depletes the natural resources to a minimum during its construction and operational phase. The aim of a green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources when in use, and maximize the reuse, recycling, and utilization of renewable resource.

Green building aims to fundamentally change the built environment by creating energy-conscious, healthy, and productive buildings that reduce or minimize the significant impacts of buildings on urban life and global environments.

In the Indian context, a building is 'green' when:

- It is designed using an integrated approach
- It provides its users with an 'optimal' level of comfort and uses minimum resources, sourced locally
- It consumes minimum energy and water
- It generates optimum waste, processed locally



II. GRIHA TOOL BY TERI

With an overall objective to reduce resource consumption, GHG emissions and enhance the use of renewable and recycled resources by the building sector, GRIHA is a rating tool clubbing various initiatives, essential for effective implementation and mainstreaming of sustainable habitats in India.

GRIHA is an evaluation tool to help design, build, operate, and maintain a resource-efficient-built environment. It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'.

It has a few variants, like SVAGRIHA and GRIHA LD (for large developments), which makes GRIHA applicable to all buildings, irrespective of their areas.

SVAGRIHA is a rating system for small homes, offices and commercial buildings with built-up area of less than 2500 m². On the other hand, GRIHA LD is a rating system for planning large green developments like green campuses, townships and special economic zones.

III. GREEN BUILDING- MYTHS AND CHALLENGES

There are various myths regarding the green building implementation. One example is the myth that sustainability costs more, which ignores recent research as well as the reality that for any society to thrive and prosper, it must seek to create a healthy balance between its environmental, social, and economic dimensions as sustainability is not just about building green but building a healthy community and sustaining a quality of life.

Although green building has made tremendous strides in the past few years, there remain many who still are unconvinced of its benefits due to numerous myths and misconceptions floating around the main stream construction.

- Green buildings often lack the aesthetic quality of conventional buildings
- Green building products are often difficult to find
- Green building products do not work as well as the traditional ones
- Building green is too difficult and complicated
- It is difficult or not possible to convert existing conventional buildings into energy efficient buildings

In reality, it is proven that all these myths are the misconceptions of the people, all it needs is better implementation and education of people about the concepts and contexts of building green.

Second, a major constraint being faced by the real estate industry is the lack of incentives. These are absolutely necessary to motivate the real estate developers to construct green buildings. For developers, the incentives include high 'Floor Area Ratio' (FAR), tax incentives, hassle-free and faster regulatory approvals and funding.

GRIHA has worked with government construction departments such as Central Public Works Department (CPWD) and has revised their standards and specifications to adhere to GRIHA requirements, with particular emphasis on Energy Conservation Building Code (ECBC).

Here are a few green building strategies, used to bring down energy consumption.

A. Indira Paryavaran Bhavan: Built up area: 31,400 m²



Figure 15. 1: Indira Paryavaran Bhawan

This is a Net Zero Building. This means that this is a building with zero net energy consumption where the total amount of energy used in the premises on an annual basis is more or less equal to the amount of renewable energy created on the site.

'Total energy savings of about 40 per cent has been achieved by adoption of energy efficient 'chilled beam' system of air conditioning. This is an innovative air conditioning system, where air conditioning is done by convection currents rather than air flow through diffusers and chilled water is circulated right up to the diffuser points unlike the conventional systems,' said an official statement.

Effective ventilation has been achieved by orientating the building in an east-west direction, separating different blocks with connecting corridors and having a large central court yard. The design is such that 75 per cent of natural daylight is utilized to reduce energy consumption. With an installed capacity of 930 kW peak solar power, the building has the largest roof top solar system among multi-storied buildings in India.

Green materials were used like fly ash bricks, regional building materials, materials with high recycled content, high reflectance terrace tiles and rock wool insulation of outer walls.

Reduction in water consumption has been achieved by use of low discharge water fixtures, recycling of waste water through sewage treatment plant, use of plants with low water demand in landscaping, use of geothermal cooling for HVAC system, rain water harvesting and use of curing compounds during construction.

67.3 per cent reduction in energy consumption as compared to GRIHA benchmarks has been achieved. This is a five-star GRIHA-rated building.

B. IOCL DO Office Building, Indore: Built up area: 870 m²



Figure 15.2: IOCL DO Office Building, Indore

This building makes use of passive architectural design. Incorporation of passive architectural techniques in a building design helps to minimize the load on conventional systems such as heating, cooling, ventilation and lighting.

The building is designed in a way that it reduces direct heat gain, while maximizing daylight penetration. Over 82 per cent of the total area falls under the day lit zone. A 2 kWp solar photovoltaic panels have been installed to meet the energy requirements.

Building envelope has been optimized through selection of appropriate wall and roof construction to increase the thermal efficiency.

Over 71 per cent of the total open area on site is soft paved and shaded. Turf pavers have been used that allows vegetation growth and penetration of water.

This is a five-star SVAGRIHA-rated project.

IV. CONCLUSION

The growth and development of human settlements has a large impact on our natural environment. The manufacturing, design, construction and operation of the buildings in which we live and work are responsible for the consumption of many of our natural resources.

Creating and maintaining built spaces will always have some impact on our natural environment, but changes in the way these spaces are designed and built will allow for a softer 'ecological footprint' which meets human needs while minimizing pollution and impacts on land, water and other natural resources. The sooner these changes become widely demanded, the greater the potential for sustainable outcomes around the world.

SECTION IV

Perspectives and Case Studies from
Stakeholders—Architects, Consultants,
Builders



16. ENERGY-EFFICIENT BUILDING DESIGN: A CASE-STUDY OF ARANYA BHAWAN, JAIPUR

- *Saswati Chetia, Prashant Bhanware, Kira Cusack, Pierre Jaboyedoff and Sameer Maithel, Project Management and Technical Unit, Indo-Swiss Building Energy Efficiency Project (BEEP)*

Abstract

The energy consumed by a building is not an isolated aspect but a function of various factors, like climate, architectural design, building envelope (walls, roof, windows, solar shading) and building usage and occupancy, equipment and lighting, heating, ventilation and air-conditioning (HVAC) systems. This study elaborates some energy-efficient strategies proposed for Aranya Bhawan, Jaipur. In hot and composite climates, incorporation of simple energy-efficiency measures, such as insulation of roof and walls, use of double glazed windows and efficient air-conditioning system, has the potential to reduce the energy consumption significantly. In case of Aranya Bhawan, a reduction of 32 per cent in the annual electricity consumption is estimated through the adoption of these measures. The study also highlighted the fact that the increase in the capital cost of the building due to integration of energy-efficiency measures was only 2 per cent over the pre-charrette cost estimation and the simple payback period of energy-efficiency measures estimated for three years.

I. INDO-SWISS BUILDING ENERGY EFFICIENCY PROJECT (BEEP)

The Indo-Swiss Building Energy Efficiency Project or BEEP, as it is known, aims at promoting energy-efficient design in new buildings. BEEP is a bilateral cooperation project between the Ministry of Power, Government of India, and the Federal Department of Foreign Affairs (FDFA) of the Swiss Confederation. The Bureau of Energy Efficiency's (BEE) is the implementing agency on behalf of MoP while the Swiss Agency for Development and Cooperation (SDC) is the agency in charge on behalf of the FDFA.

The project has four components.

- Component 1: aims at promoting integrated design among India's builders and developers, as a tool for energy-efficient building design.
- Component 2: focuses on reinforcing India's laboratory-testing capacities for building insulation materials.
- Component 3: supports best practices in the design of energy-efficient residential and public buildings.
- Component 4: comprises training and capacity building as well as knowledge dissemination.



II. INTEGRATED DESIGN CHARRETTE

The energy consumed by a building is not an isolated aspect but a function of various factors, like:

- Climate
- Architectural design
- Building envelope (walls, roof, windows, solar shading)
- Building usage and occupancy
- Equipment and lighting
- Heating, ventilation and air-conditioning (HVAC) systems

These are all variables that affect the energy consumed in building operation. Design of a high energy performance building thus requires a careful consideration of all the above-mentioned aspects and an integrated design process involving both the architect and engineering design teams along with the clients. The earlier this process is started in the design phase, the more effective are the results. Since its inception in 2012, BEEP has promoted the integrated design process among builders, developers and the broader building community, by conducting integrated design charrettes. The charrettes are conducted for new building projects with the objective of tapping the largest energy-saving potential at minimal cost.

The concept of integrated design charrette is shown in Figure 16.1. As shown, ideally the integrated design charrette is organized during the concept design or schematic design phase. Integrated design charrette consists of a four-day interactive workshop which brings together the entire building project design team (client, architect, HVAC engineer, structural engineer, green/energy consultant) with BEEP team of Swiss and Indian experts. The inputs provided by the expert team allow the building project team to address the design of the project in a holistic manner while integrating energy efficiency as a primary goal. As the charrettes are organized in the early design phase, they allow tapping of high energy saving potential at low or no additional cost.

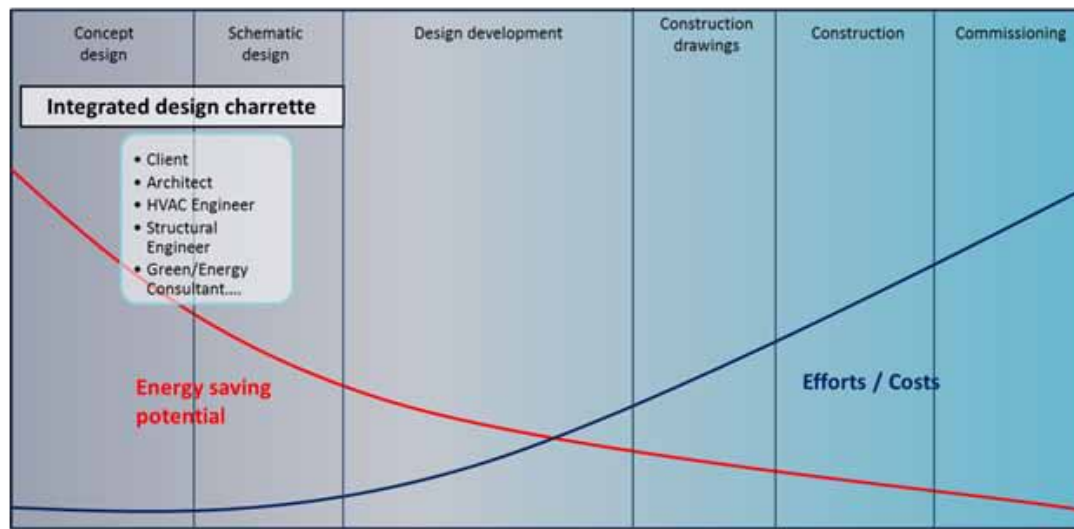


Figure 16.1: Early intervention in the building design process allows tapping the largest energy saving potential with minimum cost increase

BEEP has carried out 15 integrated design charrettes for large commercial building projects such as, offices, IT parks, educational buildings, hospitals as well as residential townships, covering a built-up area of approximately 1.2 million m². Energy savings in the range of 25 to 40 per cent are usually achieved due to energy-efficient building design developed during charrettes.

A. Introduction to the Aranya Bhawan, Jaipur

Aranya Bhawan (Figure 16.2), the new office building of the Rajasthan Forest Department in Jaipur, was one of the first projects selected for the BEEP Integrated Design Charrette. The project was submitted by Rajasthan State Road Development and Construction Corporation Ltd. (RSRDC), which was the executing agency for the project.

The charrette for Aranya Bhawan was held in December, 2012. The project has site area is 18,620 m² with a building footprint of 2,400 m². The five-storey building has one basement for parking and is envisaged for 250 office users. It consists of offices, an auditorium, and a few guest rooms.



Figure 16.2: The recently completed building of Aranya Bhawan, Jaipur

The total built-up area is 14,000 m². The building was planned to be fully air-conditioned except for the corridors, staircases and toilets.

As shown in typical office plan of the building (Figure 16.3), there are three distinct blocks in the building which are connected by corridors and two staircase blocks. The longer sides of these blocks face north-east and south-west. In the initial design the south-east and the north-west facades had 2 metre-wide verandas for shading as well as for aesthetical purposes. The two staircase blocks are covered from the top. The original elevation of the building i.e. the elevation before the charrette is shown in Figure 16.4.

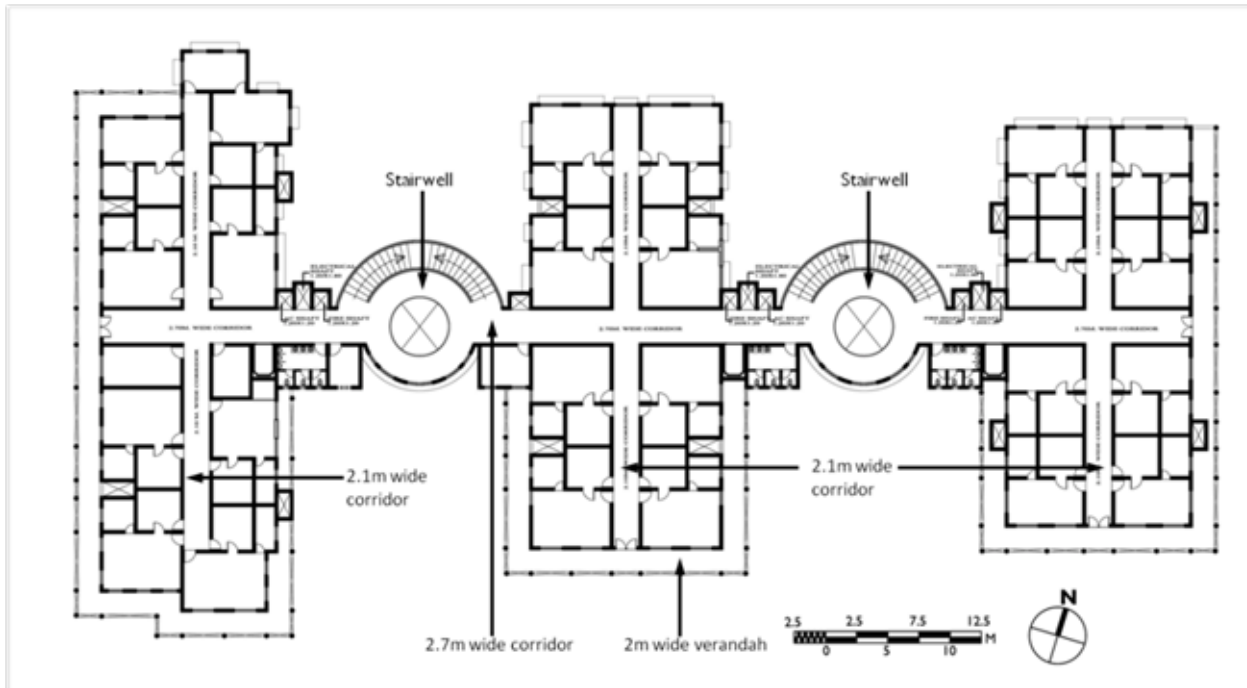


Figure 16.3 Typical office floor plan of Aranya Bhawan



Figure 16.4 The elevation of the building prior to the charrette

B. Energy Efficiency Strategies Proposed for Aranya Bhawan

Jaipur, the capital of the desert state of Rajasthan, falls in the composite climate zone as per the Energy Conservation Building Code (ECBC). Its climate is characterized by extreme temperatures—hot summers with maximum temperatures of around 45 °C and cold winters with minimum temperatures of around 10 °C. The average humidity here remains between 40 and 60 per cent. Summers are relatively dry, but humidity increases to 80 per cent in monsoon (July and August). Summer months also see the occurrence of dust-laden high-speed winds. The simulation of energy use in the building at the beginning of the charrette showed that most of the energy in the building will be used for cooling the building. This is due to the predominant hot season in Jaipur. Hence, the focus during the charrette was to reduce the heat gain into the building and improve efficiency of the air-conditioning systems

C. Measures to reduce heat gain from the envelope

The building envelope measures that were proposed to reduce heat gain from the roof, walls and window glazing are given in Table 16.1.

Table 16.1: Building Envelope Measures

	Base case (prior to charrette)	Proposed case (during the charrette)
Wall	230 mm thick brick wall; U value: 2.0 W/m ² .K	Cavity wall with insulation (50 mm extruded polystyrene used); U value: 0.44 W/m ² .K
Roof	150 mm thick RCC slab; U value: 3.2 W/m ² .K	150 mm thick RCC slab with insulation (75 mm polyurethane foam used) ¹ U value: 0.41 W/m ² .K
Window	Single glazing; U-value: 5.8 W/m ² .K; Solar Heat Gain Coefficient (SHGC): 0.8; Visual Light Transmittance (VLT): > 85%	Double glazed unit; U-value: 1.8 W/m ² .K; Solar Heat Gain Coefficient (SHGC): 0.24; Visual Light Transmittance (VLT): 40%

Figure 16.5 shows cavity wall insulation, while Figure 16.6 shows the photographs of the double glazed windows installed at Aranya Bhawan.

The pre-charrette design was estimated to have an Energy Performance Index (EPI) of 78 kWh/m²/year. With the above passive measures the EPI is estimated to be reduced by about 20%.



Figure 16.5: Cavity wall insulation



Figure 16.6: Double Glazed Windows

D. Measures to increase efficiency of the Heating, Ventilation and Air-conditioning (HVAC) system

A centralized high-efficiency water-cooled chiller system was recommended for air-conditioning the building, replacing the air-cooled Variable Refrigerant Volume (VRV) system originally proposed. This system was considered due to the following reasons:

- High efficiency water-cooled chiller has much better performance as compared to air cooled VRV system. A water-cooled chiller with Coefficient of Performance (CoP) of 5.8 has been used in the building. An air-cooled VRV system generally has a CoP of 2.75.
- VRV systems are suitable for buildings with varying cooling loads. However, as a day-use office building, the cooling loads will not vary significantly through the use-period in Aranya Bhawan.

There was another important concern about the availability of water for the centralized cooling system proposed. As a result, a waste water treatment system (Figure 16.7) has been installed to treat waste water from the building for reuse in the centralized HVAC system. The peak daily requirement is estimated to be about 9000 litres/day.



Figure 16.7: Cooling towers for the centralized high-efficiency water-cooled chiller system (right) with the waste water treatment system (left)

The implemented envelope and HVAC measures are estimated to reduce the Energy Performance Index (EPI) of the building by 32 per cent (Figure 16.8).

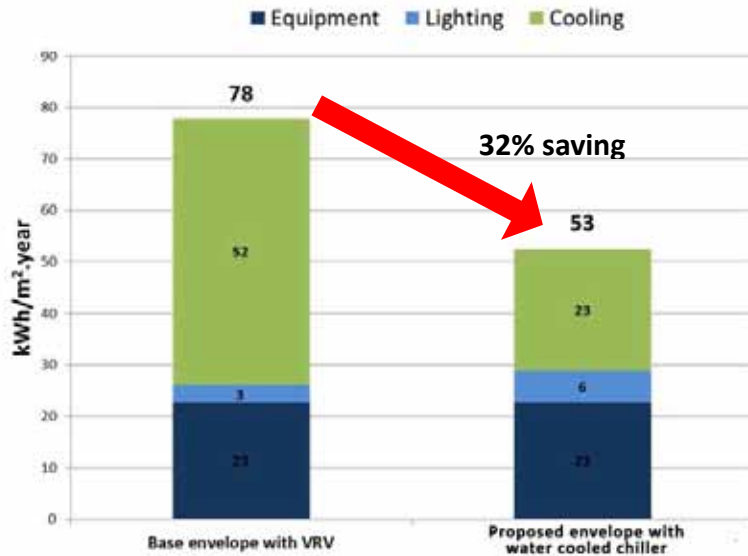


Figure 16.8: Estimated reduction in Energy Performance Index (EPI) due to the envelope and HVAC measures

E. Integration of solar energy

Jaipur receives high-intensity solar radiation which provides a good potential for solar energy utilization. Both types of solar technologies, solar photovoltaic for electricity generation and solar water heater were recommended during the charrette. While the charrette suggested a solar PV system of 120 kWp capacity, utilizing half the available roof area; a solar PV system of 45 kWp (grid connected without battery) is now under implementation in the building which is expected to generate 55,000 kWh of electricity per year.

F. Passive downdraft evaporative cooling (PDEC) for the stairwell and corridors

Passive downdraft evaporative cooling (PDEC), which cools hot, dry ambient air by spraying controlled volumes of microscopic water droplets, was proposed in the two stairwells to cool non-air-conditioned areas such as corridors.

It was estimated that it could lead result in 10–12 °C lower temperatures in the stairwell and corridors than the outside (see Figure 16.9). This feature is currently being analysed in detail for its design and execution in the building.

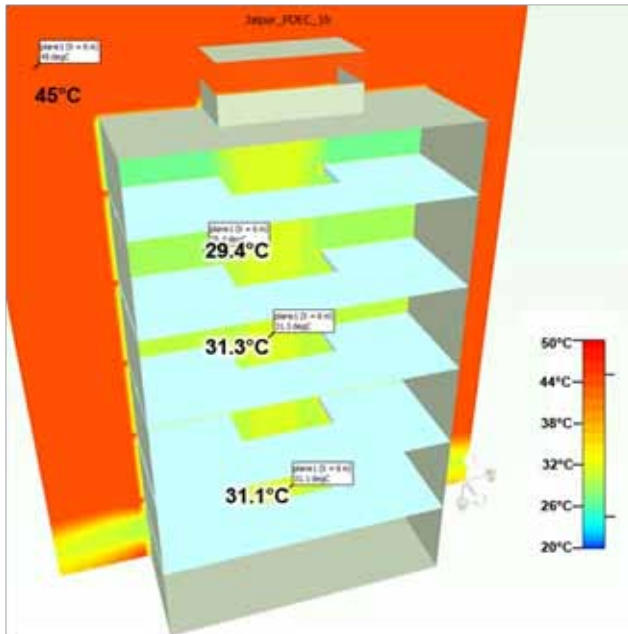


Figure 16.9: Building simulation model showing outdoor and indoor temperature difference due to PDEC

III. Cost Implications of Incorporating Energy Efficiency Design Features

The effect on the capital cost of the project due to suggested energy efficiency measures (excluding the cost of solar PV system) during the design charrette is shown in Figure 16.10. It can be seen that while there is increase in cost due to the recommended material specifications (wall insulation, roof insulation and double glazed windows) and the waste water system, this cost increase is offset to a certain extent due to the reduction in the size and cost of the air conditioning system. Overall, a cost increase of INR 5.7 million or 2 per cent over the pre-charrette capital cost of the project is estimated. The energy-efficiency measures are estimated to result in savings of 240,000 kWh of electricity per year. The electricity tariff for large non-domestic consumers in Rajasthan is INR 7.85/kWh.. Thus the annual savings in the electricity cost is estimated at INR 1.9 million/year, which gives a simple payback period of three years for the energy-efficiency measures.

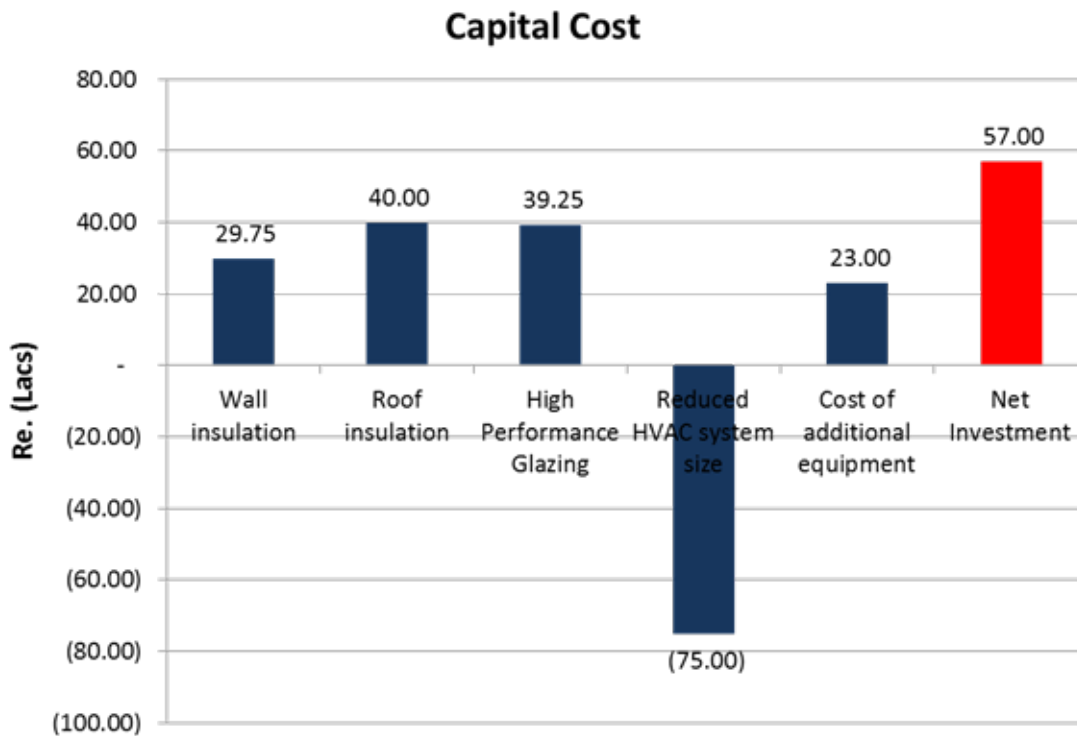


Figure 16.10: Effect on Capital Cost due to Energy-Efficiency Measure

CONCLUSIONS

The case study of Aranya Bhawan project shows that:

- An approach based on conducting an integrated design charrette during the early design phase is an effective approach to develop energy-efficient design of buildings.
- In hot and composite climates, incorporation of simple energy-efficiency measures, such as, insulation of roof and walls, use of double glazed windows and efficient air-conditioning system, has the potential to reduce the energy consumption significantly. In case of Aranya Bhawan, a reduction of 32 per cent in the annual electricity consumption is estimated through the adoption of these measures.
- Significant improvements in the energy performance of new buildings is possible at low increment in capital cost and investments in building energy efficiency measures can have attractive simple pay-back period. In case of Aranya Bhawan, the increase in the capital cost of the building due to integration of energy-efficiency measures was only 2 per cent over the pre-charrette cost estimation and the simple payback period of energy-efficiency measures was estimated at three years.

The Aranya Bhawan building was inaugurated in March 2015 and the building has been fully occupied now. In an effort to educate the users and visitors of the building about the energy-efficiency measures a poster exhibition has been installed at the reception area of the building. BEEP has also initiated the monitoring of energy performance of the building for one year to validate the energy-efficient design.

Acknowledgements

The authors would like to thank the team from Rajasthan State Road Development and Construction Corporation Ltd. (RSRDC) led by Mr Akshya Kumar Jain and the officials of the Rajasthan Forest Department for their proactive participation in the charrette process and in the implementation of the energy-efficiency measures.



17. ENERGY AND MOTIVATION THROUGH MATERIALS

- Isaac Emmanuel, India Insulation Forum (IIF)

Abstract

Innovative and customized solutions for sustainable, environmentally friendly and cost-effective construction can only be realized if the conflicting priorities of sustainability, cost-effectiveness and design can be reconciled. Covestro inaugurated its first emissions-neutral office building in Asia as part of its group-wide sustainability programme in January 2011. It draws 100 per cent of its electricity from a photovoltaic plant. India Insulation Forum (IIF) was created as a platform to introduce and promote the practice of insulation in buildings and thereby make them energy efficient. Its formal launch took place in August 2013 with a seminar participated by key stakeholders like IGBC, TERI, raw material suppliers, applicators and BEE. Key interventions are Stakeholder Awareness Campaign, website to familiarize users with regard to materials, testing, and standards. An Applicator Capacity Building Programme with the goal of offering certified courses to be deployed at various ITIs and other technical training institutes across the country.

I. INTRODUCTION

Conscientious architects who create pioneering building strategies, project developers who manage construction projects, and property developers and users of office buildings, industrial halls, supermarkets and hypermarkets have one thing in common—they need innovative building solutions and services that improve the energy efficiency and environmental impact of their buildings in the long term, and thus also play a part in boosting the profitability of the companies concerned. The legitimate need to make informed decisions about a diverse range of technologies and how their use will impact the environment, society and the bottom line—in terms of investment and lifecycle costs is increasing significantly globally.

Innovative and customized solutions for sustainable, environmentally friendly and cost-effective construction can only be realized if the conflicting priorities of sustainability, cost-effectiveness and design can be reconciled.

The first steps towards sustainable construction as an all-in solution was a novel idea in the construction industry when Covestro, formerly Bayer Material Science, as a high-tech materials supplier, set a benchmark by recognizing the need for a large interdisciplinary network of partners to be involved in the planning process at an early stage to ensure that requirements regarding the design and cost-effectiveness of sustainable construction projects are met in the most efficient way. The consequence of each decision is cumulative, impacting both immediate investment outlays and long-term energy saving potential.

The result is innovative buildings which were made possible by the EcoCommercial Building Programme (ECB), a worldwide network of experts for sustainable building under the leadership of Covestro. The

essence of the programme is a holistic approach combining the various disciplines and coordinating products and solutions to find the best solution with respect to ecology and costs for a specific building. No more was it to be First Costs. Rather, the more realistic and correct Project Life Cycle Cost came into the calculations.

II. ENERGY EFFICIENCY – INTERESTING FROM AN ECONOMIC POINT OF VIEW

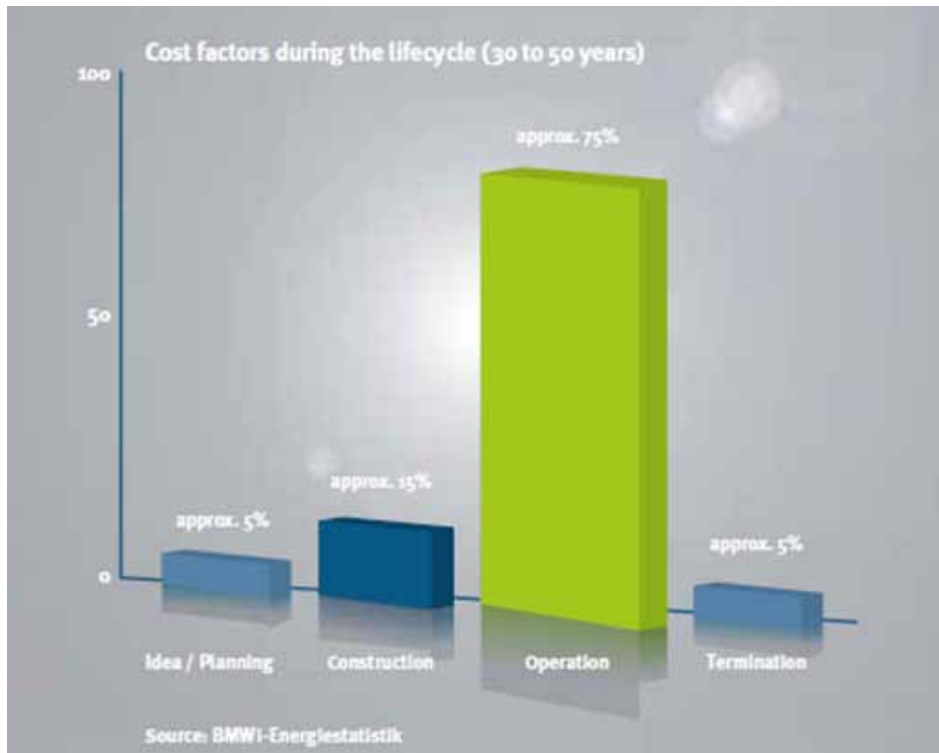
On a global basis, buildings account for 40 per cent of energy consumption and 30 per cent of greenhouse gas (GHG) emissions. This underscores the importance of energy efficiency in the context of buildings and economics. While planning and construction costs typically account for less than 20 per cent of the building's lifecycle (30–50 years) costs, the operation costs add up to more than 75 per cent, of which 30 per cent is energy costs.

Examples of the EcoCommercial Building programme, such as a children's day care centre near Cologne, Germany, show that a smart combination of currently available technologies permits savings of 90 per cent of primary energy consumption compared to, conventional standards. In many cases the additional required investments range from 5 per cent to a maximum of 15 per cent with amortization times of less than 10 years.

Bayer Admin. Bldg., Diegem, Belgium	ECB Conference Centre Pittsburgh, USA	Office Building Greater Noida, India	Day-care center Monheim, Germany
			
Total energy demand: ca 30 kWh/m ² a	Zero-Emission Building	Zero-Emission Building	Zero-Emission Building
<ul style="list-style-type: none"> • Opening May 2009 • 250 office workplaces, conference rooms, kitchen & restaurant • Low-energy building with renewable energies • CO₂ emissions reduction by 300 t/p.a. • Durable LED-lighting • Rain water utilization 	<ul style="list-style-type: none"> • Educational and R&D resource • Located on the BMS campus as a showcase of BMS technologies • Zero-emission building • Energy supply by renewable energy PV • Awards in categories of "Engineering" and "Lighting" 	<ul style="list-style-type: none"> • 40 office workplaces, 3 meeting & conference rooms, 1 lounge & display area • Total space: 940 m² on two floors • High energy efficiency • Total energy demand: ca 30 kWh/m² a • Energy supply by renewable energy PV • Global applicability proven • Opening January 2011 	<ul style="list-style-type: none"> • For 60 children, seminar & office room • 1.000 m² of total space • High energy efficiency • Total energy demand: ca 11 kWh/m² a • Energy supply by renewable energies • "EnOB": Award of German "ministry of the national economy and technology"

A. Early-phase planning is essential

Building design and geometry, window-to-facade ratio, and window and roof orientation are key factors in planning. Further saving potentials can be realized through building envelope technologies, such as insulation, sealants and state-of-the-art mechanical systems. Advanced building technology also contributes significantly when optimizing the energy demand of a building. Renewable energy sources are considered to supply this optimized demand, and when it is supplied entirely with renewable energies, even zero emission buildings are possible.



Such an understanding of collaboration, use of innovative materials and a mindset for life cycle costs provides the basis for next generation of construction.

This is something which has become a reality in our own country as we can see at the Aranya Bhavan in Jaipur, Rajasthan. With just a 3 per cent cost increase, a highly commendable EPI has been achieved. But we must come back to the ECB at Greater NOIDA, which was inaugurated in January 2011 and has reported four years in a row Net Positive!

Covestro operates emissions-neutral office building as net positive for consecutive four years of its operation in India with the vision of net zero through integrated building concepts and sustainable technologies

Covestro inaugurated its first emissions-neutral office building in Asia as part of its Group-wide sustainability programme on 21 January 2011. It draws 100 percent of its electricity from a photovoltaic plant, needs approximately 70 percent less power than comparable buildings in the region.

Following over a year of net positive operational energy performance, the 930 m² office building outside New Delhi achieved LEED Platinum status in May 2012 with an impressive 64 out of 69 possible points, officially making it the highest-rated LEED new construction project in the world.

Special care was taken while designing the building especially for the tropical monsoon climate using diverse Covestro technologies throughout. Extensive simulations in the rigorous planning phases were implemented to make India's first net-zero vision possible.

Renewable energy sources like a photovoltaic array on the roof power the building, which is designed to function for up to eight hours off-power without any impact on the infrastructure. High performance

technologies such as Covestro polyurethane insulating materials, combined with extensive daylighting, LED illumination, and photovoltaic shades (using Covestro Polycarbonate material) bolster the structure's ultra-conservative energy consumption profile.

Other environmentally conscious elements include rain water harvesting and grey water systems as well as low-VOC protective coatings, paints and flooring materials from Covestro (Figure 17.1).



When we say we seek to 'evolve building', we are demonstrating a commitment to changing the built environment with practical, sustainable solutions. We are impacting the future of our planet with logical, integrated steps toward vast building improvement, while employing performance metrics to ensure the correctness of our course. Whether new or retrofit, there always exists an untapped potential for smarter design, construction, and long-term waste and energy savings.

The project is a perfect example to showcase that the approaches such as combining efficient insulation with renewable energies can help to dramatically reduce a building's energy consumption and therefore its CO₂ emissions.

Scope of Insulation : Roof Insulation Material – 75 mm Thick PIR Insulation
 Exterior Wall Insulation (Type 1) - 80 mm Thick PIR Insulation
 Exterior Wall Insulation (Type 2) -150 mm Thick PIR insulation

Highlights: Annual net-zero energy – first of its kind in India; clean renewable energy production; local solutions and expertise used (Figure 17.2).

- Rigid **polyurethane** foam for high- and low-temperature insulation
- Lightweight, stable and transparent **polycarbonate** sheets
- Components for durable, efficient photovoltaic
- Flame retardant polycarbonate blends for smart energy metering and cabling
- Materials for low- and zero-VOC paints, **coatings and adhesives**
- Polycarbonate for energy-saving LED and other interior lighting solutions
- A concept for zero-emission buildings

This now set the stage for the next giant step – the genesis of the India Insulation Forum (IIF). Having established its commitment to the sustainability in the industry, the task of consolidation of the industry voice was taken up along with, first, the Indian Polyurethane Association, and next through the entire industry body brought together at the IIF under the aegis of the BEE.

To quote Dr. Ajay Mathur in his foreword to the Training Manual which was a landmark release in 2015.

'The Government of India is on a mission to provide 24X7 power to all by 2019. This means that not only does it have to increase the generation capacity, but also reduce the demand for electricity. Buildings are one of the largest consumers of electricity and hence incorporating energy efficiency features in the design would help in reducing the energy consumption together with improving thermal comfort.'

'The building envelope plays a very critical role in the performance of energy efficient buildings as the major heat gain take place through the roof and walls. Insulation is therefore a key element in achieving the building energy performance parameters as prescribed in building codes. Although the building codes are at the early stages of implementation, BEE is working closely with the urban development departments of the state governments for its wide-scale adoption. It is equally important to sensitize building design professionals and practitioners on the importance of appropriate building insulation usage.'

'It is heartening to see that the India Insulation Forum (IIF) is working towards creating a skilled workforce for enabling proper application of insulating material. This is equally essential in enhancing the confidence of building developers and the construction industry to the benefits of insulation usage for energy efficient building design. These guidelines developed by the IIF for insulation material applicators will help in adopting standard operating procedures for insulation application in buildings....'

'I congratulate the India Insulation Forum in their endeavor, and acknowledge the technical support extended under the Indo-Swiss BEEP and the UNDP-GEF projects in developing this manual. I urge the building construction fraternity to make use of these guidelines to arrive at energy efficient building solutions and create a large pool of thermally comfortable buildings.'

Anyone building or renovating a property today should be aiming to minimize energy requirements. After all, cooling and lighting costs need to remain affordable. Effective energy-saving practices must therefore always start with the energy required for cooling.

Several ways lead to energy savings, the main ones being installing efficient solar protection; add thermal insulation to the building envelope and modernizing the cooling system. If only modernization of the cooling system is done, in any way, you end up with an oversized system that works hard to compensate for cooling losses through the building envelope. Subsequently, insulating the building leads then to reduce the heat load and the mismatch is expensive!

The first step to be taken by a designer/architect/engineer should be to lower heat gains by installing efficient solar protection together with thermal insulation. Only then should you plan how to efficiently cover the remaining cooling energy requirements, for example, with renewable energies.

Effective insulation lowers cooling bills and is therefore, an important step toward no longer being affected by rising energy prices. Insulation reduces the amount of energy required and keeps cool in rooms. Interior wall surfaces, ceilings and floors stay in the conditioned temperature and thus prevent the moisture that can allow microbes or mold to flourish.



If your building is insulated, it will achieve a better energy certificate rating. In addition to actively helping to protect the climate, insulation pays a key role in significantly reduce the global CO₂ emissions. If you are planning to renovate, bear in mind that solar protection and insulation are the first and most important step to energy efficiency!

What will energy cost in the future? In the recent past, rising energy costs have put increasing pressure on owner-occupiers and tenants alike (Figure 17.3). Many are wondering what the future will bring. No one can accurately predict how energy prices will develop in the short term because they depend on the economic situation and a number of other factors.

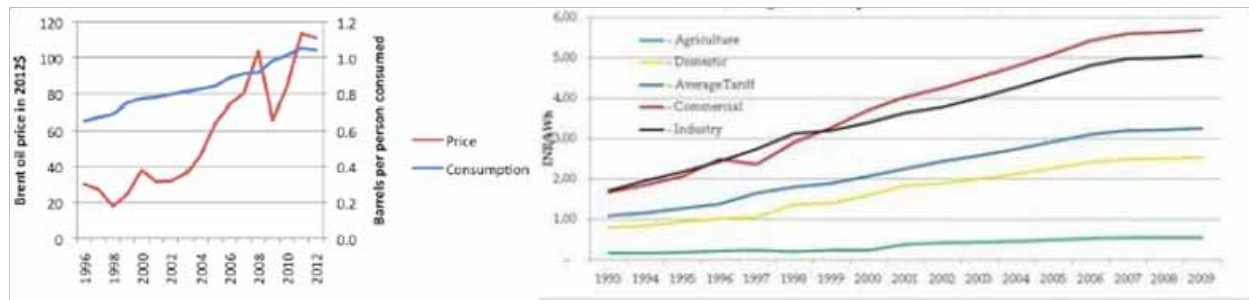


Figure 17.3: Oil Prices and Consumption in India

Source: <http://THEENERGYCOLLECTIVE.COM/> AND <http://WWW.THEALTERNATIVE.IN/>

Prices are falling now but we do not know for how long! We are however certain that in a future today's buildings live, the energy cost will grow with the depletion of fossil sources. So, the time is ripe to grab the opportunity and invest in making your home/office energy-efficient by installing insulation. India is seeing an aggressive growth which would translate into higher demand of energy and rapid price increases can be expected in the future.

But crucial to the success of actually benefiting in the multiple ways listed above is the process and skill of technical insulation. This IIF Manual is the first professional attempt by industry experts and government policy implementers who are concerned of the danger of the country losing out on the benefits through poor installation and preparing for the liabilities therefrom, the case as it is beset by its less popular usage. Knowledge shared is half the problem solved.

IIF was created as a platform to introduce and promote the practice of insulation in buildings and thereby make them energy efficient. Its formal launch took place in Aug 2013 with a seminar participated by key stakeholders like IGBC, TERI, raw material suppliers, applicators and of course, BEE.

A core committee of members from companies such as Lloyd Insulation, Isofoam, Covestro (formerly Bayer Material Science), Supreme Petrochem & Owens Corning and IPUA was formed. Simultaneously, the IIF initiative was keeping in alignment with the Indo-Swiss BEEP project. Three working groups were formed to cover the specific topics of the project and the following roadmap is being implemented:

1. Stakeholder Awareness Campaign, beginning with Delhi in September 2014 to cover Tier I and II cities (Raipur, Bangalore, Chennai, Vijayawada) in a phased manner. The mantra is on insulation and ECBC.

In order to help the users, a website to familiarize users with regard to materials, testing, and standards, has been set up.

2. An Applicator Capacity Building Programme with the goal of offering certified courses will be formulated and deployed at various ITIs and other technical training institutes across the country.
3. Testing of insulation materials protocol, along with the Indo-Swiss BEEP.

This includes collaboration with Institutes and testing houses like CEPT University's CARBSE, Nirma University, Spectro, Isolloyd and Shriram Testing House and also creation of an Advisory Board for IIF with the aim of gaining inputs from industry veterans and regulatory authorities.

We consider it as a privilege that IIF can work with BEE to help bring about the implementation of the ECBC initiative into normative building and construction.



18. MARKET ASSESSMENT OF ENERGY-EFFICIENT BUILDING MATERIALS

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Abstract

The paper analyses the market preparedness for energy-efficient building materials before ECBC enters into mandatory regime. The study followed a three-step approach: identification of building material, development of key performance indicators (KPIs), and availability of building materials with an objective to assess and identify the sales of energy-efficient building materials in India. Major building materials, covered as part of this study were wall material, insulation (wall and roof), fenestration and cool roofs/reflective paints. Stakeholder consultations were undertaken with a number of stakeholders for each building material to arrive at the market data. Based on the above data points, key performance indicators were finalized for different building materials.

I. INTRODUCTION

A. Background

India, the seventh largest country in the world, is a leading economy and home to over one billion people living in various climatic zones. The country's economy has been growing at a fast pace ever since the process of economic reforms started in 1991. Construction plays a very important role in its economy, contributing on an average 6.5 per cent of the GDP. Commercial and residential sectors continue to be a major market for the construction industry. The construction sector poses a major challenge to the environment. Globally, buildings are responsible for at least 40 per cent of energy use. An estimated 42 per cent of the global water consumption and 50 per cent of the global consumption of raw materials is consumed by buildings when taking into account the manufacture, construction, and operational period of buildings. In addition, building activities contribute an estimated 50 per cent of the world's air pollution, 42 per cent of its greenhouse gases (GHGs), 50 per cent of all water pollution, 48 per cent of all solid wastes and 50 per cent of all chlorofluorocarbons (CFCs) to the environment.

India too faces the environmental challenges of the construction sector. The gross built-up area added to commercial and residential spaces was about 40.8 million m² in 2004–05, which is about 1 per cent of the annual average constructed floor area around the world and the trends show a sustained growth of 10 per cent over the coming years. It is observed that in 2020 almost 500 million people will be living in urban India. Cities have a central role to play in the reduction of CO₂ emissions and the fight against climate change. Cities can mitigate climate change by reducing energy consumption in the construction, maintenance and refurbishment of buildings. Building sector contribution to overall electricity consumption has grown from 15 per cent in 1970–71 to 34 per cent in 2010–11, and therefore, offers cost-effective opportunity for savings.

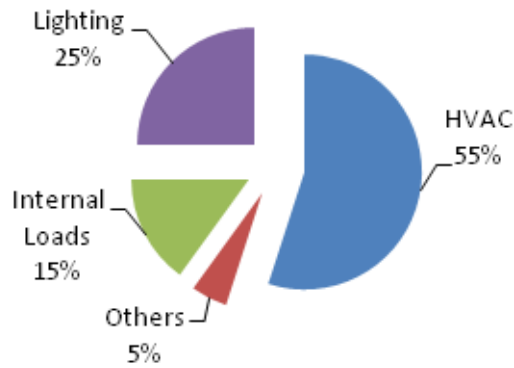


Figure 18.1: Electricity Consumption Pattern in Commercial Buildings

Focusing on the ‘Indian Commercial Building Sector’, (which includes offices and public buildings; see Figure 18.1), it has started to receive the attention of policy makers for the last five to six years. The building construction industry at present contributes about 10 per cent of GDP, and is expanding rapidly at over 9 per cent per year spurred largely by the strong growth in the services sector. Electricity consumption in the commercial sector in India at present accounts for about 8 per cent of the total electricity supplied by the utilities and has been growing annually at about 11–12 per cent, much faster than the average 5–6 per cent electricity growth in the economy. It is also anticipated that by 2030, the total amount of electrical energy consumed by commercial buildings will be equal to what entire India is consuming today.

Energy consumption would continue to rise unless suitable actions to improve energy efficiency are taken up immediately. It is fortunate to read in one of the studies by the World Bank that states the commercial building stocks (existing-2011 and to be constructed by 2021) holds significant potential in electricity savings (see Figure 18.2).

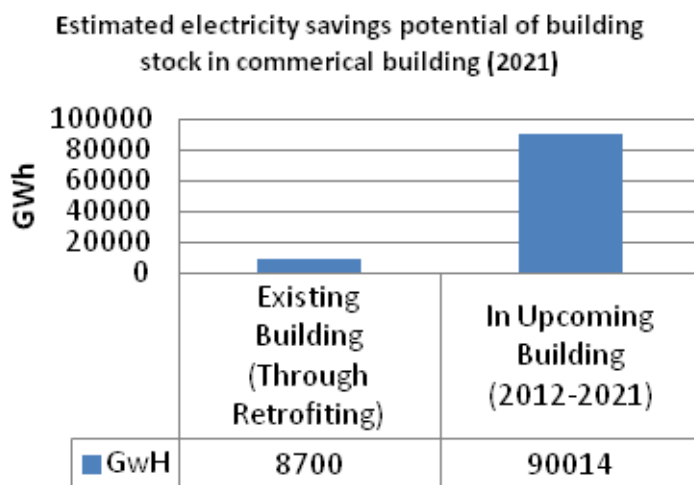


Figure 18.2: Estimated Electricity Savings Potential of Building Stock in Commercial Building (2021)

B. Government’s initiative

In a major motivation to institutionalize energy efficiency in the country, the Government of India had enacted the ‘Energy Conservation Act’ in 2001. Under the EC Act 2001, the Government of India

established Bureau of Energy Efficiency (BEE) in March 2002, a statutory authority under the Ministry of Power (MoP) to enact and enforce energy efficiency policies through various regulatory and promotional measures. BEE developed energy-efficiency action plan which focused on various thrust areas, one of the key areas being design of Energy Conservation Building Code (ECBC).

C. Energy conservation building code

ECBC has been developed as a voluntary code for all new commercial building, having a connected load of 100 kW or greater, or a contract demand of 120 kVA or greater. ECBC provided minimum performance standards for the following components:

- Building envelope (walls, roofs, windows)
- Lighting (indoor and outdoor)
- Heating ventilation and air-conditioning (HVAC) system
- Solar hot water heating
- Electrical systems

It could be made mandatory after capacity building and its implementation experience. Though the ECBC has been developed by BEE, its enforcement lies with the state governments and urban local bodies through notification within their states as per their regional requirements (see Table 18.1).

Table 18.1: Status of ECBC notification in states

Status	Name of states/ Union territories
States where ECBC has been notified	Rajasthan, Odisha, Uttrakhand, Andhra Pradesh, Telangana, Punjab, Karnataka & UT of Puducherry
States which have amended ECBC for their States	Uttar Pradesh, Kerala, Gujarat, Tamil Nadu, Haryana, Chhattisgarh, Maharashtra, West Bengal, Himachal Pradesh, Bihar and Madhya Pradesh
States which are targeted to notify ECBC by the end of the 12th Plan Period	All states

II. BUILDING MATERIALS: STATUS

A. Global performance

Understanding the need of the hour, 'Energy Efficient Building Materials', the 'International Energy Agency' (IEA) had conducted a study in 2013 and realized that countries across the globe (as studied) have realized the importance of energy-efficient building materials and have started various policy push in their respective countries for ensuring the availability of such materials. The study clearly indicates that only one-third of the listed countries (study conducted by IEA) have established markets/



matured market for the building materials. Analysis also shows that the market of energy efficient building materials in countries like India, Brazil, China, Mexico, Middle East, Russia and South Africa lies at the initial stage.

B. Status in India

Referring to the study performed by IEA, it seems that in India, none among the listed energy-efficient building materials have matured markets. Considering energy efficiency, it's a state of irony that though India is experiencing tremendous expansion in building construction industry, the market for majority of energy-efficient building materials are yet to mature. The inflow of new material has increased in the last decade but the characterization of newly developed building material still remains unfamiliar to a local developer/contractor.

C. Initiative rationale

Building energy efficiency has become a very important issue to meet the global challenges and building materials play a major role in achieving energy efficiency with the built environment. Knowing the probable future building stock for commercial buildings in India, higher electrical energy demand is anticipated. To cater such demand, significantly enormous amount of electrical energy needs to be generated, which seems impossible according to the current situation. One of the measures that the Government of India might come up with is making 'Energy Conservation Building Code' mandatory (current status – voluntary). If ECBC becomes mandatory then following practices will be followed in the construction industry:

- a. Energy-efficient lighting design
- b. Energy-efficient HVAC design
- c. Energy-efficient building envelope and fenestration design
 - Wall
 - Roof
 - Fenestration and shading
 - Finishes

ECBC is still in voluntary stage. Before making it mandatory it is imperative to analyse the market preparedness for energy-efficient building materials. Thus, it is a timely initiative by United Nations Development Programme (UNDP)- BEE to assess and identify the sales of energy-efficient building materials in India.

III. PROJECT APPROACH

A. Approach

Project team followed a three-step approach to assess the building material market in India and its possible coherence with ECBC in India. The schematic step-wise approach is presented in Figure 18.3.





Figure 18.3: Approach for market assessment

B. Identification of building materials

Energy efficiency in buildings is driven by efficient building design, followed by selection of efficient building materials and energy-efficient appliances for efficient operation. While building envelop comprises different building materials, building aesthetics points to selection of glass and other related products. In electrical appliances, air conditioning and lighting loads are major energy consuming loads in buildings. All these components work together to provide efficient performance of a building (see Figure 18.4).



Figure 18.4 Building materials

Building envelops design, electrical and mechanical systems and building aesthetics together not only reduces the energy consumption but also helps in downsizing lighting and air-conditioning requirements. Materials covered under building aesthetics are also covered under building envelop. Building materials were identified and categorized into following building components (see Table 18.2).

Table 18.2 Building material category

Building aesthetics	Building envelope	Electrical & mechanical systems
High performance glass	Wall materials AAC Blocks Hollow clay blocks	Efficient lighting systems Compact fluorescents T5 fluorescent lamps LED
Energy - efficient windows	Fly ash bricks	Lighting Controls Occupancy sensors
External movable blinds for shading of glass façade	Wall and roof insulation materials	HVAC
Reflective paints	<ul style="list-style-type: none"> • XPS • EPS • Glass wool • Mineral wool • PUF 	High efficient chillers (Centrifugal, Screw, etc.) Water cooled as well as air cooled chillers Economizers Heat recovery system VRV and VRF VFD's
	Insulated Pre-fabricated wall and roof panels	Service hot water
	High performance glass and energy efficient windows	Energy efficient motors & transformers
	External movable blinds for shading of glass façade	

C. Development of key performance indicators

Key performance indicators (KPIs) for different materials were developed to capture information regarding various indicators from the market. The performance indicators were divided into following three sub indicators to compare their performance, assess availability and its associated benefits (see Figure 18.5).

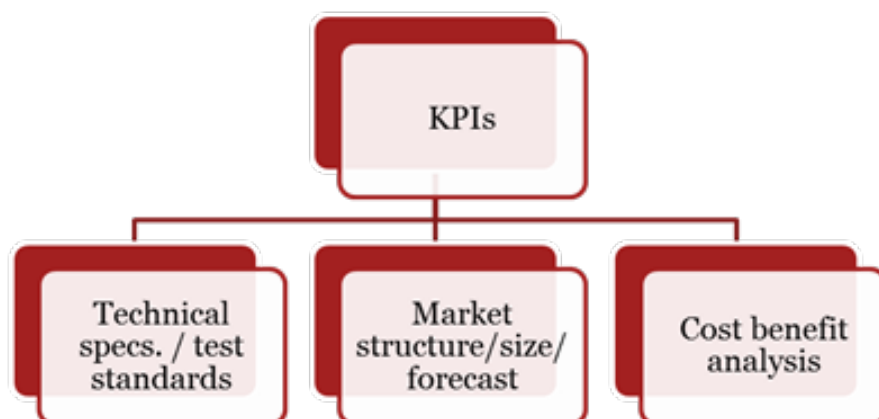


Figure 18.5: Key performance indicators for building materials

D. Availability of building materials

After freezing the KPIs, the availability of all identified building materials applicable for commercial real estate sector was assessed. The market analysis was divided into the following sub-heads to assess the availability and performance of different building materials in India.

- Market structure and size of identified materials
- Supply chain and availability
- Key technical specifications
- Identification of applicable test standards and labs
- Cost benefit analysis and its applicability
- Recommendations and next actions

Stakeholder consultations were undertaken with a number of stakeholders for each building material to arrive at the market data. Based on the above data points, KPIs were finalized for different building materials.

IV. BUILDING MATERIAL – MARKET ASSESSMENT

Major building materials, which are covered as part of ‘building envelope’ for commercial building sector are presented below:

1. Wall material
2. Insulation (Wall & roof)
3. Fenestration
4. Cool roofs/reflective paints

A. Wall material types

Different types of wall materials are used in commercial buildings. Few of the important materials and their applicability are presented in Tables 18. 2–18.4 below:

Table 18.2: AAC block

Major Application	Applicability to commercial real estate buildings	Market structure
Masonry work in commercial buildings	Yes (one of the best wall material option)	Almost 50 % organized

Table 18.3: Fly ash bricks

Major Application	Applicability to commercial real estate buildings	Market structure
Mostly applicable to small to medium houses and buildings	Stakeholder interaction suggested that fly ash bricks are not that popular in commercial real estate sector. Need more efforts to make it suitable for commercial constructions	Highly unorganized

Table 18.4: Hollow clay blocks

Major Application	Applicability to commercial real estate buildings	Market structure
Mostly applicable to small household where normal bricks are available at slightly higher cost	Stakeholder interaction suggested that hollow clay blocks are not popular in commercial real estate sector	Highly unorganized

It can be inferred that, of the three wall materials AAC block is the one that is mostly preferred for commercial real estate construction.

AAC Market and Demand forecast

The overall AAC block market stood at 3.5 million cubic metre. This comprised both residential as well as commercial sector applications. It was established through stakeholder consultations that the overall market grew at a CAGR of almost 10 per cent from 2008 to 2010. However, in the last two to three years, this growth dipped to a CAGR of 5 per cent, owing to the slowdown in the real estate market. The negative growth can also be attributed to the preference of glass over AAC blocks and other construction materials. The market analysis suggests that out of total 3.5 million cubic metre market, the market of AAC blocks in commercial building sector stood at 1.22 million cubic metre in 2012-13.

Demand-supply gap assessment: The current capacity of the AAC block manufacturers and suppliers is 5 million cubic metre. Out of this, approximately 35 per cent caters to the commercial market (as assumed in the analysis above). This leaves the manufacturer with a capacity of 1.75 million cubic metre for the commercial real estate sector. Thus, new capacity addition will be required in 2016-17 under the moderate scenario and in 2015-16 in the optimistic scenario.

Fly ash bricks Market and Demand forecast

As established that, fly ash is an industrial waste of thermal power stations using pulverized coal. Currently, there are about 40 major thermal power plants in India producing around 15 million tonne of fly ash every year. Such enormous quantities need huge dumping grounds, and can create pollution problems. Using fly ash in producing bricks for household construction enables to resolve this issue of dumping to a great extent.

The fly ash brick market is highly unorganized and confined to few regions of India. The location of manufacturing units is dependent on vicinity to thermal power plant whose by product 'residual fly



ash' is available as a feeder to these units. This makes it viable to carry out fly ash brick production and distribution with respect to economies of scale. However, fly ash bricks are yet to make its mark as a commercially viable option to the conventional bricks.

The market for fly ash bricks is more confined to the eastern and south eastern regions of India. Interaction with stakeholders pointed out to the fact that the cost of clay bricks is high in these regions, ranging from INR 8–10 per piece. Thus, as a cheaper and better alternative, locals of these regions have diverted to fly ash bricks which are available at half the price of former.

B. Insulation materials – Wall and roof

Insulation industry is more confined to industries and HVAC application, and hence, building insulation market is relatively a small but a significant part of the overall insulation market. Major wall and roof building insulation materials are:

- Rockwool
- Glasswool
- Polyurethane Foam (PUF)
- Extruded Polystyrene Foam (XPS)

Availability of building insulation materials in India vis-à-vis the companies producing or supplying insulation materials in India were identified in consultation with different stakeholders. The number of plants for each producer and their corresponding locations were also assessed. During stakeholder interactions it was established that all these plants were operating at 50 per cent capacity utilization. Stakeholder interaction suggested that the demand for insulation material is construction driven, and hence, the market is confined to the west and northern region of India.

Market and Demand forecast

The insulation market primarily depends on capital projects such as airports, malls, stadiums, etc. Post 2008 till 2012, the market in India grew at 15 per cent annually. However, it is estimated that from 2012 to 2015 that the market is expected to grow at 10 per cent.

The building insulation segment forms a minor part of the overall insulation market. Thus, end-users (from the building sector) do not procure insulation materials directly from producers, and have to purchase them from intermediaries. These intermediaries deal in various kinds of insulation materials and do not exclusively deal with building insulation materials. It is hence, a difficult task to estimate the building insulation market in India. However from stakeholder interaction it can be estimated that the building insulation segment has a 10 to 15 per cent share of the current total insulation market.

Stakeholder interactions and forecasting suggests that in terms of future growth of the insulation market in India, it was evident that there is a gap in supply and demand for this product, with supply on the higher end. And currently with close to 50 per cent utilization by manufacturers, future growth on the demand side for insulation does not seem to be a big challenge.

The building insulation market in 2013-14 stood at 0.53 million m², and if it follows the BAU scenario, no additional capacity is required till 2020. However, in case the optimist growth takes place, capacity

addition will be required in 2019. In any case no additional capacity is required for the next five years since the plants are 50 per cent utilized till date.

C. Fenestration/Glass

Glass as a material has been a crucial ingredient for the real estate industry for centuries. With technology, its use and popularity has increased widely in the last three decades owing to its several benefits. Most of the glass finds application in real estate as well as automobile sector. This glass category is further categorized to conventional glass and high-performance glass.

Market and Demand forecast

Indian glass market is estimated at 1.19 billion USD (Global: 75 billion USD). Estimated volume is 150,000 MT/month. High performance glass is approximately 10 per cent of the overall glass usage in India. The market players in the glass industry are categorized into four broad categories:

Manufacturers

- The most organized link of the chain
- Accountable for designing the glass framework for the entire building

Processors

- Responsible for enhancing glass quality and making it energy-efficient
- Approximately 130 to 140 players across India with 30 per cent of them in the organized bracket
- Government intervention and policy reforms required to improve the remaining 70 per cent of the unorganized processing plants

Fabricators

- Conscientious for proper installation on site
- Currently the weakest link of the chain
- Highly unorganized and unskilled

The manufacturing capacity for basic float glass in India is 6,000 MT per day (excluding glass production for containers, crockery, bottles and others). The glass manufacturing industry is completely organized with five major players and their nine manufacturing plants in total.

Stakeholder interactions suggested that the only 30 per cent of the glass manufacturing capacity has been exploited till date. The glass industry in India is well equipped with sufficient capacity to cater to the demand for the next eight years without any capacity addition. According to the estimates, there will be no need of further capacity addition to glass production until 2025-26 under the BAU scenario and until 2022-23 under the optimistic scenario (see Figure 18.6). Thus, there is no supply side constraints to the growth of glass used in the commercial sector over the next decade considering all the growth scenarios.



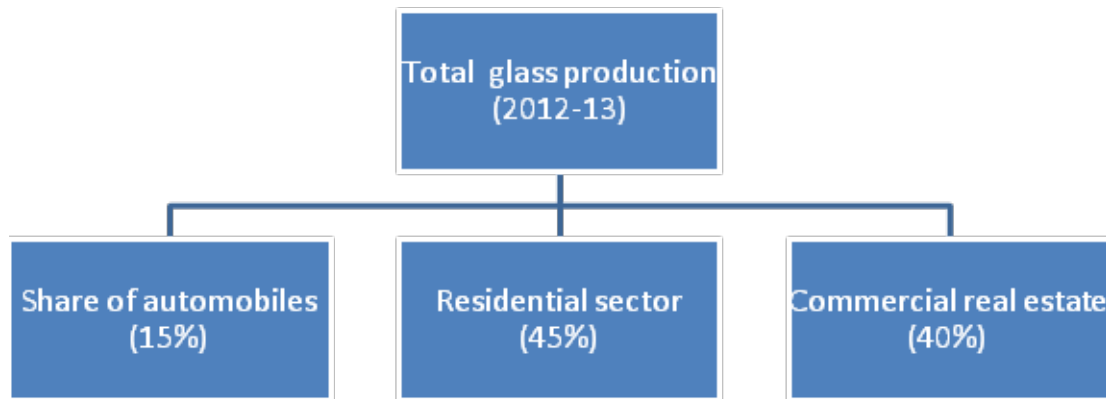


Figure 18.6: Total glass production in 2012-13.

D. Cool roof/reflective coatings

A cool roof is a roof which reflects or emits the sun's heat back into the sky instead of transferring it into the building below. Green roofs are defined as roofs that support vegetation. They consist of vegetation and soil, or growing medium, planted over a waterproofing membrane. They may require additional layers such as drainage layer, roof barrier and irrigation system.

Market and Demand forecast

Cost of such reflective coating varies from INR 22–INR 35/sq. ft. Major factors affecting the cost of reflective coatings are location of the building, height of the building, type of roof surface, conditioned area below roof surface, roof condition.

According to stakeholders, current consumption rate of reflective coatings in commercial buildings in India is less than 1 per cent. This is owing to the fact that there is lack of awareness about the product and technology. Due to regular maintenance requirement, green roof is adopted mainly in the residential buildings and not in the commercial buildings of India. As per stakeholders, less than 5 per cent of the commercial buildings in India have adopted this method.

V. HVAC

HVAC is very complex system with lots of products/appliance system available (see Figure 18.6).

A. Market structure, size and forecast

The room air-conditioner (RAC) market comprises window and split air-conditioners. The total size of the RAC market in India stood at 3.3 million units in 2013-14 and has been on a high growth trajectory. It grew from a market size of 1.25 million in 2005-06 to 3.3 million units in 2013-14 registering a CAGR of 12.9 per cent. Considering the assessment carried out, it was established that there is a clear decline in the window air-conditioner (WAC) market as customers are increasingly opting for split air-conditioners (SAC).

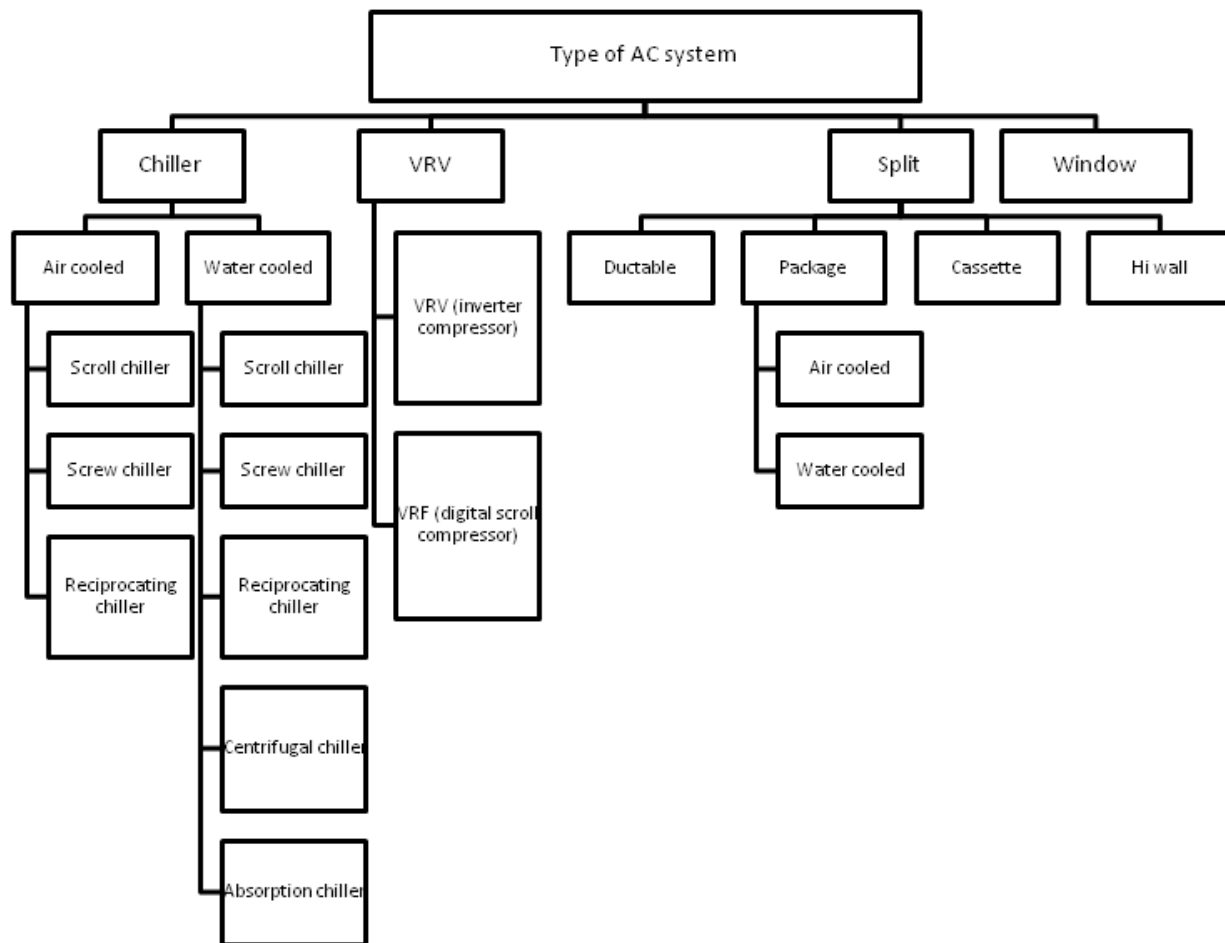


Figure 18.6: Types of HVAC systems

The analysis of data of forecasted sales shows an upward trend with the 2020-21 sales value reaching 7 million. This result is consistent with the literature available on the market forecast for Indian RAC industry which predicts a 10 to 13 per cent CAGR growth in the next five years. Market sentiments regarding the growth of the RAC industry in India are optimistic, with manufacturers expecting the growth witnessed in the past decade to continue in the future as well.

The market for VRF/VRV stood at 25,000 units in 2013-14 and was expected to reach 30,000 units by 2014-15. The market for VRF/VRV systems has grown by over 30 per cent in value terms and total cooling capacity sold, due to a fall in average selling prices. The growth rate in market volume is higher. The growth rate till 2015 is predicted to be around 20 per cent. VRFs/VRVs are fast replacing ducted split systems in offices, small commercial and high-end residential sectors due to better part load efficiencies, associated energy savings and competitive prices. The price difference between VRF/VRV systems and similar but less efficient technology is small.

Light commercial segment in India mainly constitutes cassette and floor standing ACs. Analysis of the data and stakeholder interaction suggested that light commercial AC market in India is largely dominated by Cassette ACs constituting around 90 per cent of the total light commercial AC market. Cassette AC market grew rapidly with a CAGR of around 27 per cent, growing from 40,000 units in 2011 to 65,000 units in 2013. Data reveals that the floor standing AC market has grown even faster,

with a CAGR of around 30 per cent. The market of floor standing ACs was 4,156 units in 2011 and it grew to 7,000 units in 2013. The industry specialists and manufacturers are optimistic that the growing commercial and high-end residential space would boost the sales even further in coming years. Based on the assumption that this growth will continue in the future at the same rate, the forecasted sales for Cassette ACs for 2020 comes to be around 350,000 units.

Sales of chillers in 101 to 350 kW and above 700 kW capacities dominate the market. Sales decreased in 2012 primarily because of the global economic downturn and the resultant decrease in demand from Indian customers (see Figure 18.7).

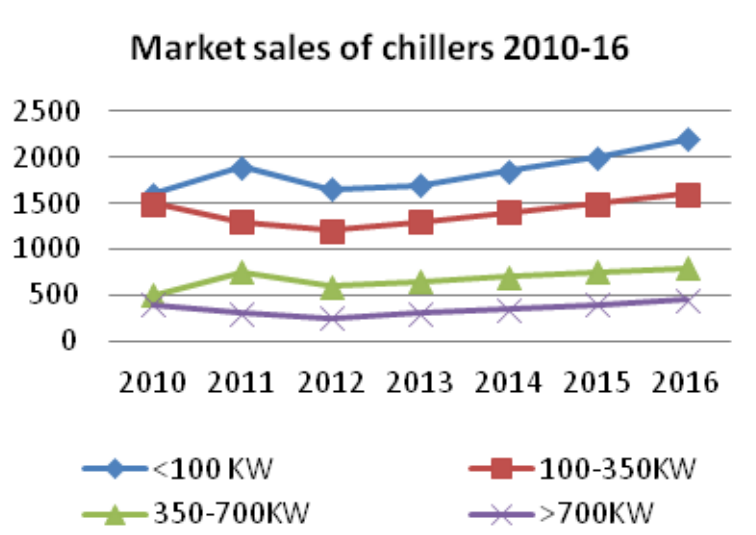


Figure 18.7: Market for chillers and sales projection

With the most optimistic growth, the chiller market is expected to reach close to 7,000 units in 2019-20.

The AHU market expanded nearly 48 per cent by volume from 2010 to 2012. The FCU market, on the other hand, has echoed this trend, registering a growth of 33 per cent in sales by volume. Lately, local brands have overtaken international brands in Indian markets, both in the AHU and FCU sectors. By reducing manufacturing costs, these local brands have also driven the selling prices.

Stakeholder interaction suggested that economizers are supplied in India as per the demand from different building owners, commercial real estate developers, etc. Manufacturing or supplying economizers is not a concern, but the only barrier is proper awareness about the associated benefits. Nowadays, all the major builders and real estate developers are opting for economizers in their HVAC system.

Till date no facility is available to test air-conditioners above 5 TR in India and no National Accreditation Board for Testing and Calibration Laboratories (NABL) accreditation is available for category above 3 TR for capacity and power consumption testing. As such the test standards for upper end products of HVAC are not in place and testing facilities are also not equipped to test these products. Thus it becomes most important to develop test standards and facilities for testing HVAC products in India.

VI. SERVICE HOT WATER HEATING

Water heating is one of the major loads in any commercial building such as hotels, hospitals, hostels, offices etc. Solar water heating (SWH) systems can easily heat water to a temperature of 60–80 °C. SWH is one of the most successful and simplest ways to harness renewable energy and can contribute both to climate protection and sustainable development efforts. SWHs for commercial building sector are basically classified into two types:

1. Flat Plate Collectors (FPC)
2. Evacuated Tube Collectors (ETC)

A 100 litre capacity SWH can replace an electric geyser for residential use and saves 1,500 units of electricity annually and can prevent emission of 1.5 tonne of CO₂ per year. Hence, the use of 1000 SWHs of 100 litre capacity each can contribute to a peak load shaving of 1 MW.

The most common barrier to water-heater efficiency technologies includes extensive retrofit requirements and the high first cost of equipment. The solar water heating system is comparatively expensive to install. Therefore, the SWH systems are mostly found in new establishments in comparison with retrofit arrangements. The government of India through the MNRE has been providing various support measures and incentives for both manufacturers and users towards the installation of the SWH system.

A. Market size and mapping key manufacturers

The SWH collector area as on 2010-11 stood at around 4.51 million m². The Ministry of New and Renewable Energy (MNRE) plans a capacity addition of 6 million m² during 2012-17 (12th Plan) and 8 million m² by 2017-22 (13th Plan). Once achieved, these capacity additions will lead to a cumulative collector surface area of 20 million m² in the country by 2022.

Significant quantity of hot water is required in the commercial building sector such as in hotels, hostels, restaurants, hospitals and other institutional buildings and encourage a great potential for the installation of SWHs. Under the optimistic scenario, the SWH collector area may reach up to 93 million m² by 2019-20. Considering the initiatives undertaken by the MNRE and other policy makers at the central and state levels, percentage increase in collector area may be even more than the optimist growth of 66 per cent CAGR. Under BAU, the collector area may reach around 33 million m² by 2019-20.

Labs for testing solar thermal application are present in the northern, southern, western as well as central regions of India. Considering the growth and opportunity for solar potential in the country and initiatives undertaken by the MNRE, it is imperative to have regional presence of labs.

VII. LIGHTING

Lighting accounts for more than 17 to 20 per cent of the world's energy costs. With the usage of the right combination of advanced lighting solutions such as efficient lamps, high-performance luminaries, electronic drivers and controls, etc., consumers can achieve energy savings of up to 60–70 per cent. Lighting system in India is divided into three main types (see Figure 18.8):

1. General lighting services



2. Automotive and
3. Backlighting

Lighting systems in India consumes 18 per cent of the overall power. Major lighting types in commercial building are LED, FTL and CFL. Commercial buildings also use lighting controls and sensors for controlled lighting.

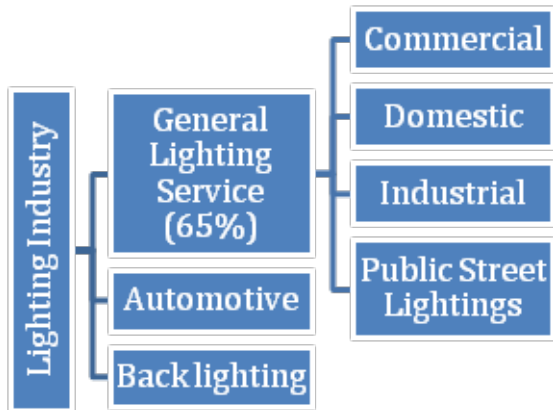


Figure 18.8: Lighting Industry classification

A. Market structure and mapping

When it comes to commercial building lighting, fluorescent lamps (FTL) continues to be the growth driver with 60 per cent share followed by compact fluorescent lamp (CFL). The advent of reliable light emitting diode (LED) products will play a significant role in growth in the coming years. Significant players in the industry are already offering good value propositions in the market, making this segment vibrant and dynamic.

It is clear that CFL and FTL have been dominant in the commercial sector. However, the LED market is evolving very fast in the Indian market, and hence, it is difficult to envisage the future course of lighting industry. Based on the current growth rate one can estimate an indicative growth of the new age technology of lighting (see Figure 18.9).

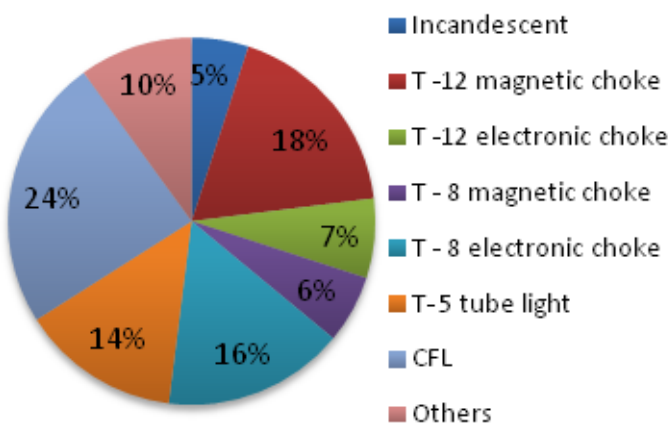


Figure 18.9: Percentage share of lamps in the commercial sector – 2013

The demand for energy-saving CFLs has grown by 25 to 30 per cent in the last decade, while demand for regular (or incandescent) bulbs has stagnated. Bulbs are estimated to be the second-largest consumer of power in households, offices and power utilities after air-conditioners. Stakeholder interaction revealed that the Indian CFL industry saw proficient growth from 67 million units in 2005-06 to 500 million in 2013-14.

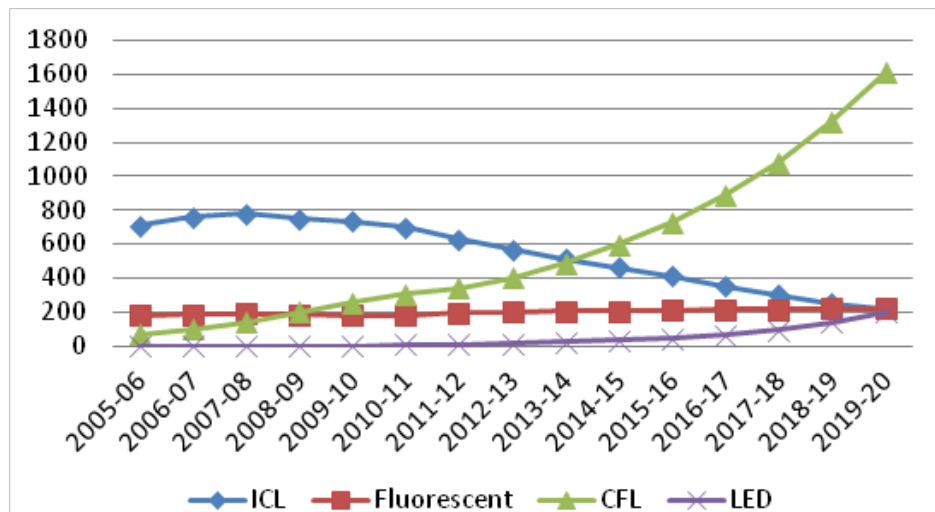


Figure 18.10: Manufacturing trends of lighting industry in India

LED lighting technology has been globally recognized as efficient and ecofriendly as compared to the incandescent lamps (ICLs) and FTLs, CFLs. The penetration of LEDs in India could significantly reduce lighting load, peak demand and overall energy consumption without compromising on the output. The opportunity for general space illumination of residential and commercial buildings purposes has emerged recently. The Indian LED market is anticipated to grow at 45 per cent till 2020 based on the estimates of the major lighting manufacturers. Despite growing consumption volumes, the absence of indigenous LED labs results in complete reliance on imports. Indigenous manufacturing volumes of LED lights in 2012 were estimated to be 5.2 million units in 2012 and are poised to scale to 20.35 million units by 2015 growing at a CAGR of 45 per cent.

One interesting conclusion that can be drawn from Figure 18.10 is that the total domestic manufacturing of LED in India is growing at 57 per cent, and hence, with market growth of LED at around 45 per cent, it is clear that dependence on imports would gradually reduce by the end of a decade (see Figure 18.11).

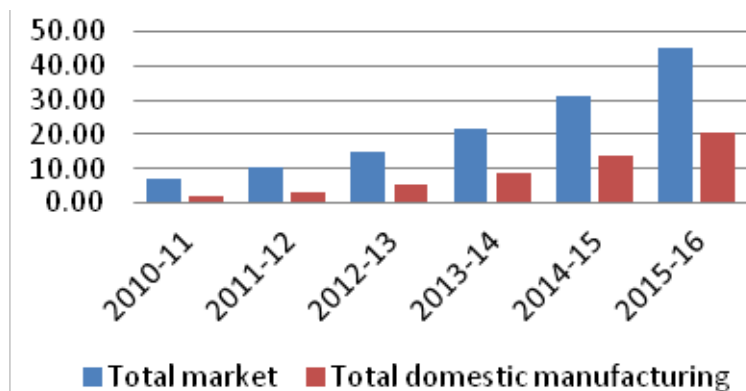


Figure 18.11: Market growth for LED

Recognizing the growing demand for LED and benefits of this technology, BEE is working with lighting associations to define standards, and is testing protocols and certifying parameters for different lighting applications.

LED is fast penetrating in Indian market. There are few facilities coming up in India to test LED lamps, but it requires more capacity addition in near future to test these products. Also there is a need to standardize LED products and there may be policy action in India to standardize this product.

VIII. LIGHT CONTROLS

Lighting control and systems are defined as energy-saving components used to control the light output either manually or automatically. The lighting control and systems market consists of lighting control gears and lighting control devices integrated to form a system.

A. Market structure, size and forecast

Escalating investment in the real estate and construction industry, coupled with the growing need to reduce energy consumption across the commercial, residential and government sectors, is propelling the Indian lighting control systems market (see Figure 18.12). Green building projects are illuminating avenues for lighting control systems since they have to comply with various national standards set by the BEE, ECBC Green Rating for Integrated Habitat Assessment (GRIHA), and Indian Green Building Council (IGBC) along with international standards such as Leadership in Energy and Environmental Design (LEED). Lighting control market earned revenues of 2.50 billion INR in 2012 and is estimated to reach 4.06 billion INR by 2017 at a CAGR of 10.2%.

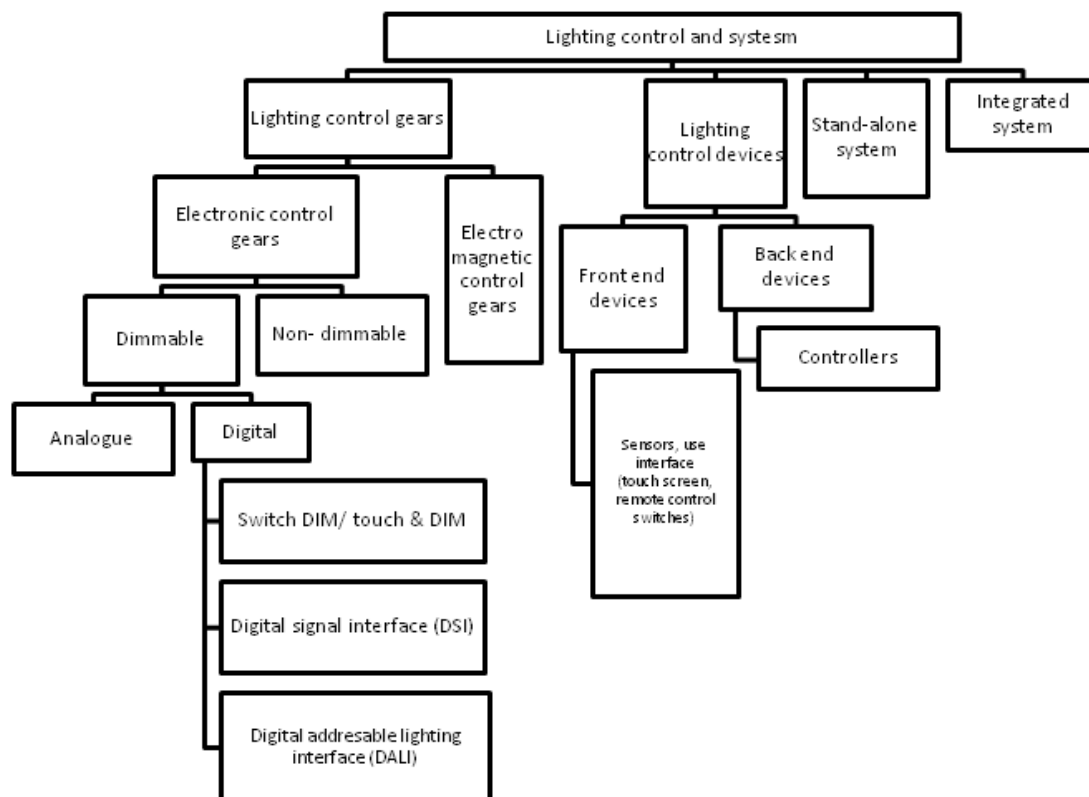


Figure 18.12: Lighting control and system

Traditional lighting controls are mainly used by medium and small scale stakeholders (typically measuring less than 5000 m²), while the more expensive automatic controls are mainly deployed by large users (more than 5000 m²). With increasing penetration of information and communication technologies, buildings are expected to become smarter and more intelligent.

IX. ELECTRICAL POWER AND MOTORS

Some of the major electrical power components in a commercial building include:

1. Transformers
2. Motors

A. Transformers

Transformer is an electrical device that transforms the voltage level without changing the frequency of electric power to be used in the building.

The cores of conventional transformers consist of stacks of laminations that are made from silicon steel with an almost uniform crystalline structure (CRGO). In transformers with amorphous cores, a ribbon of steel is wound forming the core. The big benefit of amorphous metal core transformers is that amorphous steel has lower hysteresis losses. Simply put this means that less energy is wasted in magnetizing and demagnetizing it during each cycle of the supply current. As per one of the stakeholder, since over a decade, the demand of Amorphous Metal Transformers have increased (in comparison to CRGO) around 34 per cent. Around 56,458 Single Phase and 37,162 3-Phase Transformers were supplied in the fiscal year 2006-7.

In India, generally developers constructing commercial buildings (core and shell type/self-occupied and are aware of energy conservation) opt for energy efficient transformers, where in several builders who are not comfortable in investing more at the initial stage, opt for conventional transformers.

Stakeholder interaction suggested that Indian manufacturers/suppliers manufacture or supply the energy efficient transformers as per the demand from different building owners, commercial real estate developers etc. Manufacturing or supplying energy efficient transformers is not a concern, but the only barrier is proper awareness about the associated benefits of opting energy efficient transformer instead of the conventional one.

B. Motors

Induction motors are the most commonly used prime mover for various equipment in commercial buildings. Major applications of motors in commercial building sector include:

1. Fans – (exhaust Fans – mainly parking & toilet areas)
2. Air handling units (AHUs)
3. Pumps (mainly for water usage in toilets, transferring of water from one location to the other).
4. HVAC
5. Chillers (motors are in-build)



An energy-efficient motor, simply put, is a motor that gives the same output strength by consuming lesser amount of power. Major differences between standard motor and energy efficient motors are as follows:

- More copper in the windings in energy-efficient motors
- Reduce losses
- Energy-efficient motors operate with efficiencies that are typically 2–6 per cent higher than the standard motors.

Usually energy efficient motors cost 15-30 per cent more than the normal motors so consumers were reluctant to use them. But lately, due to awareness several commercial buildings (new construction and retrofit in existing buildings) are opting, rather have opted for energy efficient motors. Due to this change in demand, now, the energy efficient motors cost around 5–10 per cent more than the normal motors.

To promote energy efficient motors in building sectors, organizations like Indian Green Building Council have defined in their standards that motors installed in the building shall have an efficiency equivalent to BEE 3-star rating or more.

Stakeholder interaction suggested that Indian manufacturers/suppliers manufacture or supply the energy efficient motors as per the demand from different building owners, commercial real estate developers etc. In recent years, the change in demand has led to the energy efficient motors cost around 5–10 per cent more than the normal motors which used to be 15-30 per cent earlier.

X. CONCLUSION - KEY OBSTACLES TO EE INVESTMENT

Stakeholder interaction identified the following obstacles for energy efficiency investment:

Obstacle 1:

- Lack of market demand for EE buildings
(100 per cent considered this as the biggest obstacle)

Obstacle 2:

- Energy efficiency is not perceived to increase a building's value as an investment
(100 per cent considered this as the second biggest obstacle)

Obstacle 3:

- The business case is not compelling
(67 per cent considered this as the third biggest obstacle)
- Lack of sufficient technical know-how
(33 per cent considered this as the third biggest obstacle)

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19.A PARADIGM OF SELF-SUFFICIENCY— INDIRA PARYAVARAN BHAWAN

- *Deependra Prashad and Saswati Chetia; Principal Architect and Sustainable Design Consultant, DPAP, India*

Abstract

In this era of a visible debate on climate change, a large variety of mitigation measures include initiatives targeting sustainable building. These include the construction of green buildings, utilization of building rating systems, energy codes and many other prescriptions. Within this overall scenario, there are projects which have been developed at the cutting edge of sustainable building and are developing a new paradigm of self-sufficiency. Net Zero Energy Building projects (NZEBS) are targeting to push the envelope further, by being self-sufficient not just in terms of their electricity consumption, but an overall minimal dependence for their other resource requirements. IPB is India's cutting-edge project, the first time in the world, is an urban large scale project for 1,000 persons, designed as a NZEB with complete solar dependence.

I. BACKGROUND

Indira Paryavaran Bhawan, the new building housing the Ministry of Environment, Forests, and Climate Change (MoEFCC) is targeted as the first large scale building in the country to achieve the NZEB and Energy Positive tag and also the first government building to do so. This building, which includes the minister's office and various administrative sections of the ministry, is built at Aliganj, on Jorbagh Road in south Delhi. The structure has been located quite near to landmark structures like Mausam Bhawan and India Habitat Centre which define the institutional architecture of the area.

The land on which the building is constructed, was originally a single storey decrepit government housing which under a change of land use was reassigned to the government office function. Despite the change in land use, the mandate of the ministry's building remained as providing minimum change and disturbance to the surrounding ecosystem, including the predominantly green character of the surroundings, while still creating an optimum utilization of the tight urban site of almost a hectare.

This building reflects the growing role of the ministry in regulating and channelizing India's development into a sustainable paradigm. This mandate was carried forward by, the Central Public Works Department (CPWD) and the sustainable design consultants, Deependra Prashad, Architects and Planners (DPAP) at every level to design a building which is not just energy efficient but goes far beyond to reach the level of being energy positive, i.e., to be able to create more energy on site than it consumes over a functional year. Apart from aiming to be a NZEB, the project has also achieved the 5-star GRIHA Green Rating and is targeting the LEED India NC Platinum rating system through a slew of measures both in the passive and the active design of building envelope, the usage of materials, service provision and also by following a range of environment friendly processes within the construction programme.

II. DEVELOPING INDIRA PARYAVARAN BHAWAN

One of the first design considerations was to try and preserve as many numbers of the existing trees as possible, given the site constraints of the building without compromising on the building's functional efficiency and user comfort. The building design went through various iterations with the final design being twin north-south facing blocks with a large open space court in the centre. The maximum allowed ground coverage was used to keep the building height comparable to the surroundings. Although permission was granted for cutting down 46 trees, the proposed design and measures helped reduce the cut to only 19 trees. Even so, a large number of native trees, much higher than the basic GRIHA requirement of three times those cut, have been replanted onsite. The project landscaping has been designed not just to act as a climate modifier but to also showcase the plant diversity within the country (see Figure 19.1).

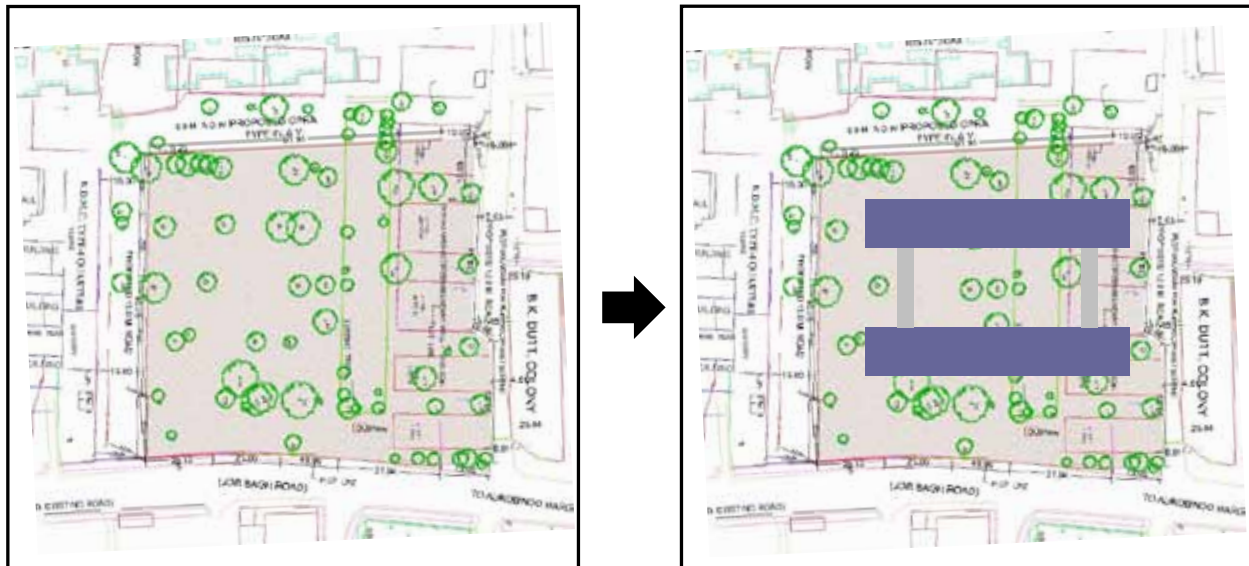


Figure 19.1: Project Landscaping

A. Water efficiency

The site management and landscaping also contribute to a water efficient site. Planting native species and utilization of efficient irrigation systems lead up to a 50 per cent reduction in landscaping water requirement. This reduced demand will be met by recycling, re-using the building waste-water and rain water harvesting. The building water requirement has been brought down by usage of water-efficient fixtures. The emphasis here is not just on water efficiency but effective site water management and zero-discharge with no water being let out into the city storm water system or the sewer system (see Figure 19.2).

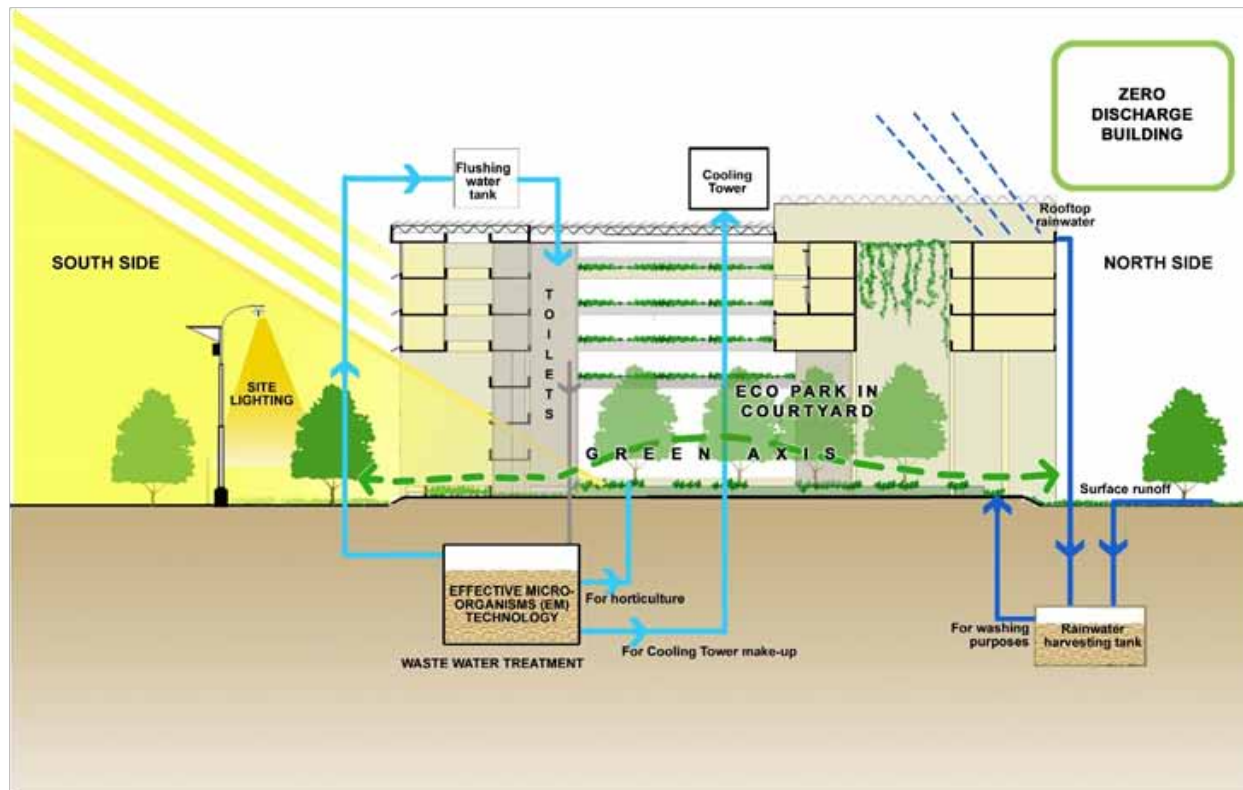


Figure 19.2: Efficient water use and re-use cycle in Indira Paryavaran Bhawan makes it a zero-discharge building

Besides being water efficient in design, the building's construction managers, i.e., the CPWD have also innovated in its construction process, which has involved a large dewatering process of the construction pit, due to the site groundwater level being quite high at 9 m. To ensure that the dewatering process does not deprive the local ecosystem of water, the extracted water was recharged into the ground at a distance of 250 m from the site. In addition, this extracted water was also supplied free of cost to NDMC municipal water tankers on a regular basis to augment the water supply of the city. This contrasts with the usual practice of pushing the water into municipal drains which creates an added burden to the city's infrastructure.

Another major design intervention was the zero tolerance to surface-parking as planned by the design team. A state-of-the-art three level parking is provided to cater to peak load during office hours with preferred parking for CNG / electric vehicles and carpools. This along with the proximity of the site to the bus and metro-transit lines would provide incentive to use the public transport system rather than private vehicles. The building is also planned to provide preferred front entrance directly, in a way creating a 'priority for the pedestrians'. Vehicles enter from the side and need to go to the back for entering the basement. This decision taken by the client and the architect has resulted in less paved area on the site, wherein grass pavers have been provided all around. Instead of the usual concrete grass pavers, a large number of polymer plastic grids have been provided, which make the surface completely soft, resulting in reduced surface run-off and increasing water percolation. Another tangible benefit of less paved area is a lower contribution of the building to the Urban Heat Island (UHI) effect. The UHI effect leads to an overall build-up of temperatures in highly urbanized/concretized areas by the absorption and re-radiation of solar heat on hard surfaces. The parking itself has been planned as a compact robotic parking, which due to efficient usage of space, accommodated the required cars

within three storeys, as compared to the six basement storeys required in usual basements. It also removes the need to use large amounts of energy required in maintaining human use level basement ventilation provisions.

B. Building configuration and envelope: Passive means of reducing operational energy

The building configuration and the passive design of the building envelope are planned to reduce the operational energy requirements of the building. The Building Orientation, which itself is developed primarily north–south, by dividing the building into two long blocks, reduces the heat ingress into the building and develops a shaded central landscaped court. This central courtyard, along with the large lower level punctures into the building envelope, aid in cross ventilation (see Figure 19.3).



Figure 19.3 Final plan developed with emphasis to the north–south axis and the central courtyard

C. Other significant design measures

These include:

- Fenestration shading design appropriate for all directions and reduction in the window-to-wall ratio to reduce heat gain, as well as reduction in the requirement for high efficiency glass.

- The window shading as well as the courtyard openings is designed to reduce summer heat gain as well as to allow in winter sun. Most of the fenestration and habitable areas are located on the outer periphery, which allows good daylighting and views of the outdoors from most of the locations of the office floorplate.
- A large number of spaces including passages and lobbies are developed as non-conditioned spaces with provision for natural cooling and shading through stone jaalis. These jaalis and their designs would also be a showcase of this strong tradition of craft within the country (see Figure 19.4).

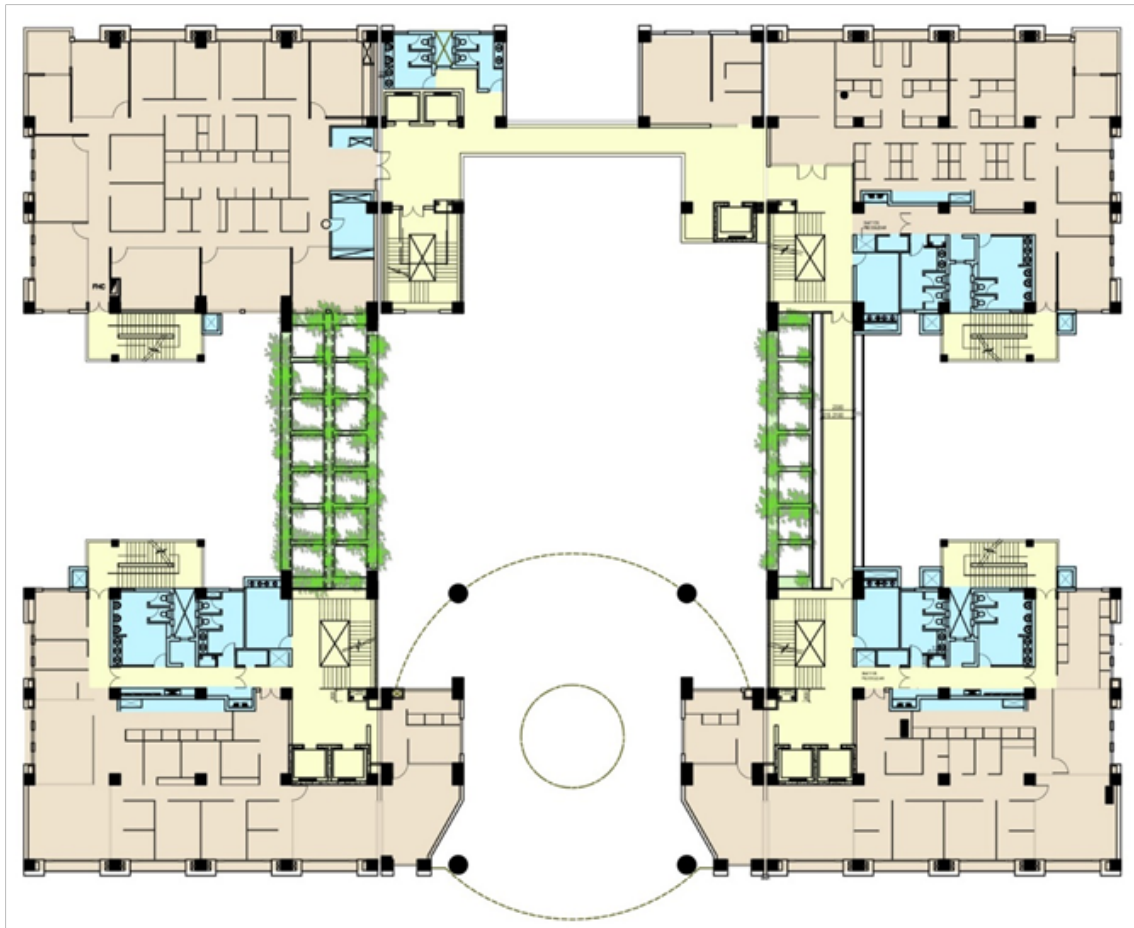


Figure 19.4 The shaded and vegetated passages in one of the upper floor plans

D. Green Material Choices

The choice of materials is governed by two main criteria—reduction in embodied energy of the construction and further reduction in the operational energy. The first criteria necessitated using materials with

- Recycled content, namely, PPC (fly ash-based cement), AAC blocks which uses fly ash in its constitution in place of the normal bricks for the walls, Terrazo Tile flooring which includes reusing waste stone pieces.
- Local availability of materials, namely, Kota stone, marble from Rajasthan, Jhansi granite and simultaneously avoidance of granite from afar, say South India.

- Rapidly renewable content, namely, bamboo jute composite doors wherein bamboo is a natural resource which can be replenished faster than regular timber trees.

Reduction in operational energy by reduced HVAC loads works by utilizing good insulation to the building interiors, say by using AAC blocks for the walling have been chosen. Similarly, high albedo tiles are used on the roof and UPVC windows with composite sections are used for better insulation which reduces the cooling requirements of the building.

III. ACTIVE MEASURES OF PROMOTING ENERGY EFFICIENCY

As lifestyle aspirations evolve for all classes in India, we have started seeing air-conditioning getting installed as an add-on into existing buildings, where the loads are very high due to lack of appropriate building orientation, zoning and a complete lack of insulation.

With the building designed to reduce the energy demand, the next step was to provide efficient mechanical and lighting systems within the building. The HVAC system at IPB, instead of using the temperature and humidity limits normally utilized, has used the adaptive comfort model that accounts for our physiological capacities to adapt to a wider range of temperature and humidity conditions in real life. Using this model, the performance parameters for different electrical uses was made more efficient in comparison to conventional standards: air-conditioning load is designed for 450 sq ft per TR instead of 150 sq ft per TR, lighting power density at 0.5 W per sq ft instead of 1.1 W per sq ft and other electrical loads at 4.5 W per sq ft instead of 10 W per sq ft.

An important decision by the ministry was to regulate the set point temperature to $26.0\text{ C} \pm 1$ with an emphasis on lowering thermal shock when moving between the outdoors and the indoors. This is more appropriate than the usual 20–22.0 C and also promotes a climatically appropriate lifestyle and climate appropriate clothing. The other measures proposed for making the space conditioning in the building energy efficient are (see Figure 19.5):

- Part condenser water heat rejection by Geothermal Mechanism with a closed loop piping which minimizes the need for make-up water. This will also help in water conservation in cooling towers for HVAC system.
- Chilled beam technology which reduces energy consumption by utilizing radiative cooling panels that depend on localized induction cooling by chilled water. This also reduces AHU/FCU fan power consumption as it avoids the need for large quantities of air travel from the user space to the heat exchange point.
- Chilled water pumping system through DPS (Differential Pressure Sensor) & VFD (Variable Frequency Drive) which allows for separate control for the various spaces
- VFD on cooling towers fans and air handling units
- Pre cooling of fresh air from toilet exhaust air through sensible and latent heat energy recovery wheel.

Other measures promoting energy efficient systems include:

- Better daylight into the workspaces



- Energy efficient lighting fixtures fittings (T-5/T-8/LED lamps etc.) bettering the requirements as enshrined in the Energy Conservation Building Code, 2007 to reduce energy demand
- Use of Lux level sensor to optimize operation of artificial lighting
- Integrated Building Management System (IBMS) for optimizing energy consumption, performance monitoring, etc.
- High efficiency Cast Resin Dry Transformers for electric substation. DG sets for captive power generation
- Regenerative lifts which also produce some power in the course of their functioning
- Entire hot water generation through Solar Hot water heating system
- Shared usage of office equipment
- Promotion of usage of BEE rated appliances within the building
- Usage of 'thin client' systems which provide only terminals to the end user with common servers for groups of terminals. This highly reduces power usage of separate computer CPUs
- Solar powered external lighting

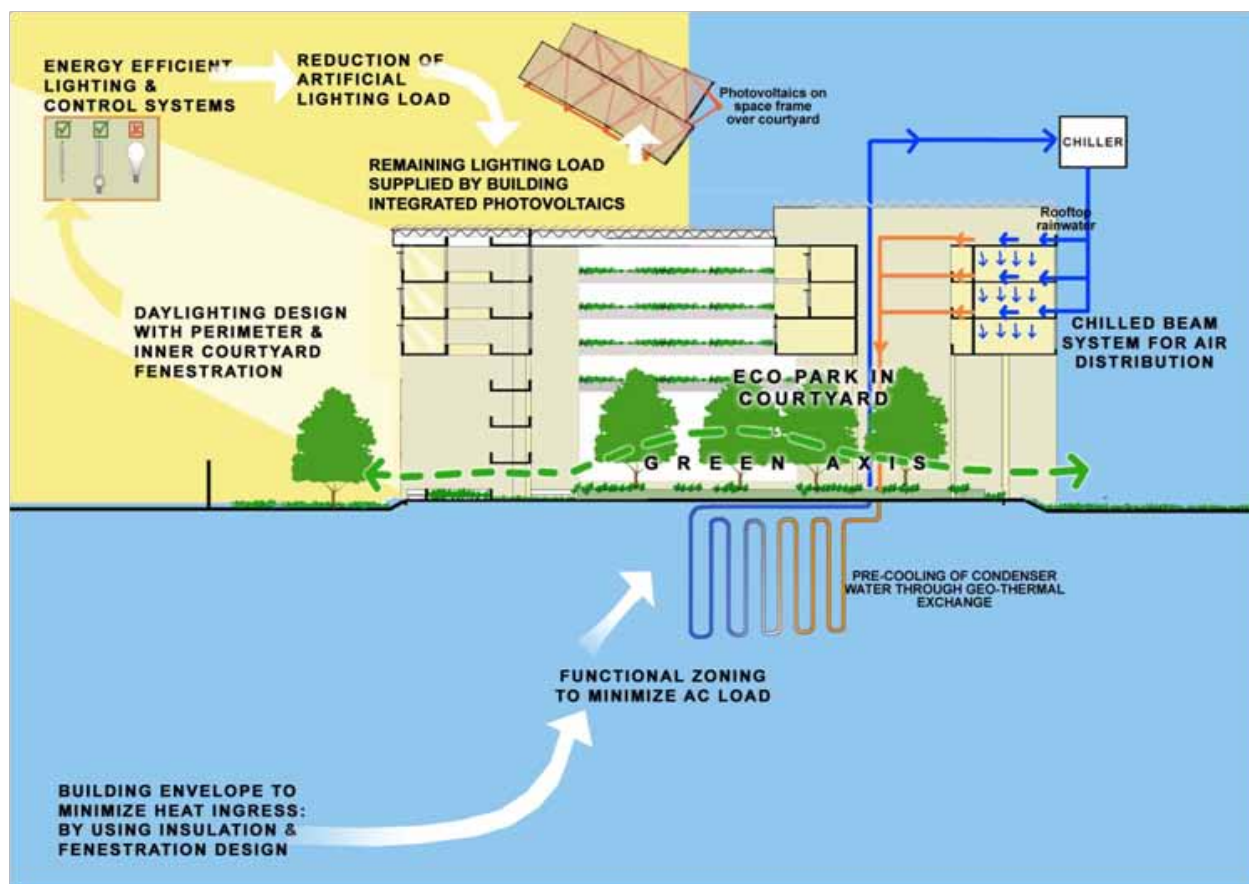


Figure 19.5: Energy use in Indira Paryavaran Bhawan

IV. GOING BEYOND ENERGY EFFICIENCY

With the goal of not just being energy efficient but also energy-positive, the MoEFCC seeks to set an example of energy conservation and best practices regarding the same. A solar photovoltaic system of 930 kWp is installed on the rooftop and on cantilevers protruding out from the building. Highly efficient solar panels above the terrace and the southern façade would produce more energy than that required by the building over the period of a functional year. The photovoltaic panels, besides producing energy, also shade the roof, some parts of the walls and the courtyard, helping create a cooler ground space. It is hoped that this endorsement of large scale roof top photovoltaics shall lead to R & D and manufacture of indigenous high-efficiency solar panels in the future and their widespread usage in a decentralized manner.

V. CONCLUSION: THE LARGER VISION

The Indira Paryavaran Bhawan is an ambitious endeavour to direct future building growth towards a path that is sustainable in all respects, be it self-sufficiency in energy and water or in ensuring the least possible environmental damage in developing urban areas. As a best practice for disseminating ideas incorporated, a separate website has been created for the project, which has highlighted its construction updates, features and green provisions.

As described above, the challenges of creating a NZEB on a tight urban site are not just to do with a provision of an on-site energy generation, in this case, a solar photovoltaic system, but more to do with a systematic reduction of electrical loads through passive and active measures at all levels of building and service design. The success of this endeavour is expected to pave the way for many other decentralized urban initiatives at self-sufficiency in energy and other resources within the built environment.



20. ENERGY EFFICIENCY IN A LARGE ENTERPRISE

- Guruprakash Sastry, Regional Manager – Infrastructure/Green Initiatives, Infosys

Abstract

Infosys is the second largest Information Technology (IT) company in India with over 187,000 employees and revenues of about USD 9 billion (Q2 FY2016). The sustainability agenda of Infosys focuses on social, environment and economic dimensions, and is based on the foundation of values. Infosys has always been at the forefront in environmental conservation with many certificates, recognitions and awards. Infosys has the highest rated green buildings, 14 LEED Platinum rating and 4 buildings with GRIHA 5-star ratings. Energy conservation is the prime focus of 40+ green team of professionals in Infosys.

I. INTRODUCTION

Infosys is the second largest IT company in India with over 187,000 employees and revenues of about USD 9 billion (Q2 FY2016). The sustainability agenda of Infosys focuses on social, environment and economic dimensions, and is based on the foundation of values. Infosys has always been at the forefront in environmental conservation.

The sustainability journey of Infosys started when the company took voluntary goals at the UN in 2008:

1. To reduce per capita electricity consumption by 50 per cent by 2018 (baseline year 2008)
2. To source 100 per cent of our electricity from renewable sources by 2018
3. To become carbon neutral by 2018

Focused efforts on sustainability started with setting up of a dedicated 'green initiatives' team at Infosys. The team, being a part of the Infrastructure team, is responsible for design and construction of all physical infrastructure for Infosys, and ensuring efficiency in designs as well as operations.

The green initiatives team started as a four-member team in 2008 and now has strength of over 40. The team comprises experts in different fields of building construction and operations. The team reports to the Head of Infrastructure (see Figure 20.1).



Figure 20.1: Green Team at Infosys

II. TRANSFORMATIVE GREEN CHANGES 2008 TILL DATE

Highlights of major achievements between Financial Year 2008 to financial Year 2015 are listed in the following text:

A. Increase in employees vs. energy consumption

From 2008 to 2015, Infosys has undergone a complete transformation in Infrastructure, with high energy efficiency, water efficiency, building automation, waste management, renewable energy installations, biodiversity and carbon offset projects. The main objective of the team is to question every assumption, push the boundaries and redefine benchmarks, through continuous research and innovation (see Figure 20.2).

890 million kWh avoided

0.75 million Tons of CO₂ emissions avoided

100 million USD worth electricity conserved

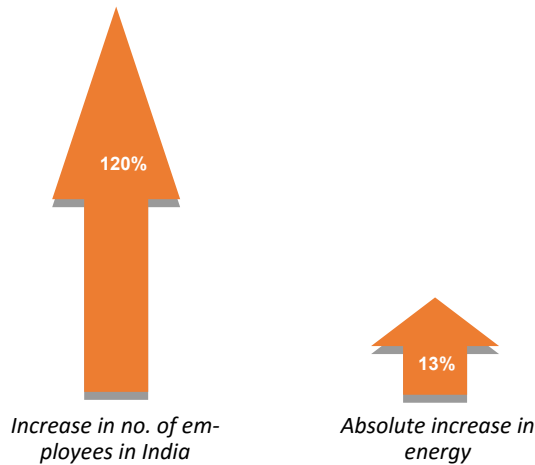


Figure 20.2: Relative comparison of employees vs energy conservation

B. Per capita electricity consumption

Our per capita electricity consumption has steadily decreased over the last seven years, and we are on track to reach our goal of 50 per cent reduction from FY08 before the year 2018. This has been possible due to super-efficient new buildings, deep retrofits of existing buildings and operational optimization (see Figure 20.3).

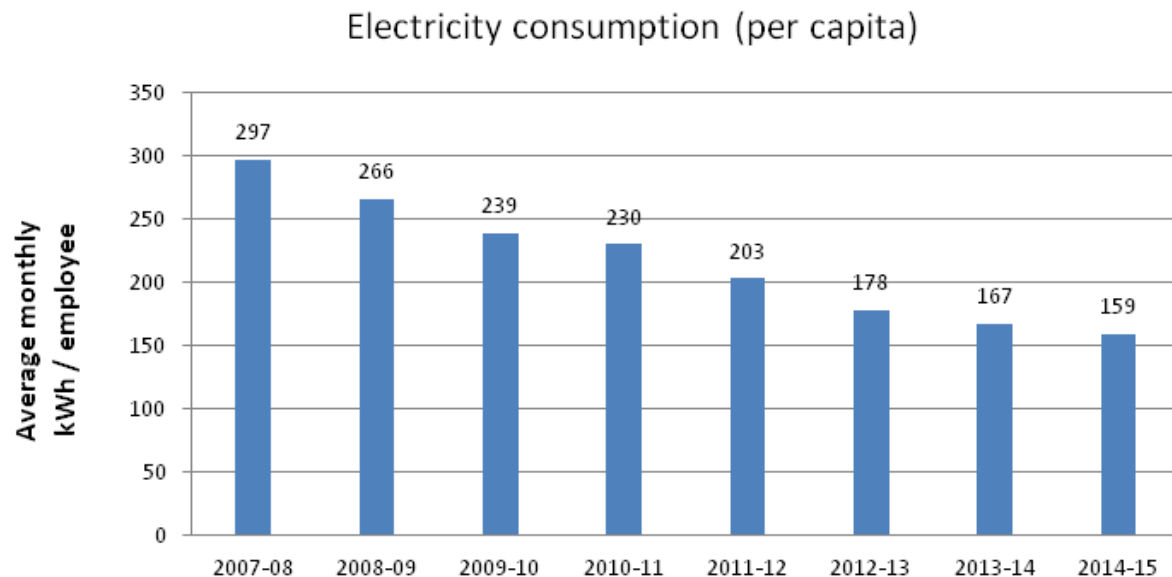


Figure 20.3: Electricity consumption per capita

C. Redefining building efficiency standards

Infosys designs have set new standards in building energy efficiency, and is the benchmark for the industry to follow. Table 20.1 gives a comparison of key metrics between a regular building and Infosys building.

Considering 10 billion sq.ft of commercial space expected in India by 2030, Infosys design standards can avoid 45,000 MW of electrical capacity addition.

Table 20.1: Redefining buildings standards

	Performance metric	Standard design	Infosys design	% Reduction
1	Building energy consumption	250 kWh/m ² /year	75 kWh/m ² /year	70%
2	Lighting design	1.2 W/sq.ft	0.48 W/sq.ft	60%
3	Air-conditioning design (Reduction in heat load)	300 sq.ft per TR	750 sq.ft per TR	60%
4	Total building electrical design	8 W/sq.ft	3.5 W/sq.ft	56%

D. Super-efficient buildings at lower capital cost

Over the last seven years, new buildings at Infosys have been 70 per cent more efficient than older buildings, but at a lower capital cost. Cost of different construction materials has increased significantly (by 50 per cent and above) since 2008, but the total cost of Infosys buildings has gone up by just 20 per cent. This has been achieved through efficient designs and frugal engineering.

The deep retrofit program at Infosys has contributed greatly in reducing energy consumption. Retrofits were taken up in HVAC, UPS and lighting systems to realize huge energy savings with a payback of about two years in most of the cases.

HVAC retrofits at Infosys, consisting of re-engineering chiller plants, replacing pumps, chillers and fans, have reduced connected load by 15 MW.

UPS retrofits at Infosys, consisting of replacing the conventional UPS with high-efficiency modular UPS have reduced connected load by 10 MW.

E. Water efficiency

Efforts on water efficiency include water efficient fixtures, 100 per cent treatment and recycling of wastewater, extensive rainwater harvesting and awareness programmes. Water consumption (per capita) at Infosys has reduced by 30 per cent compared to the 2008 levels (see Figure 20.4). Infosys saw an increase in the water consumption in financial year (FY) 2015 due to leakages in pipeline in a few campuses, and immediately rectification has been initiated. So, we expect to see a reducing trend again in FY16.



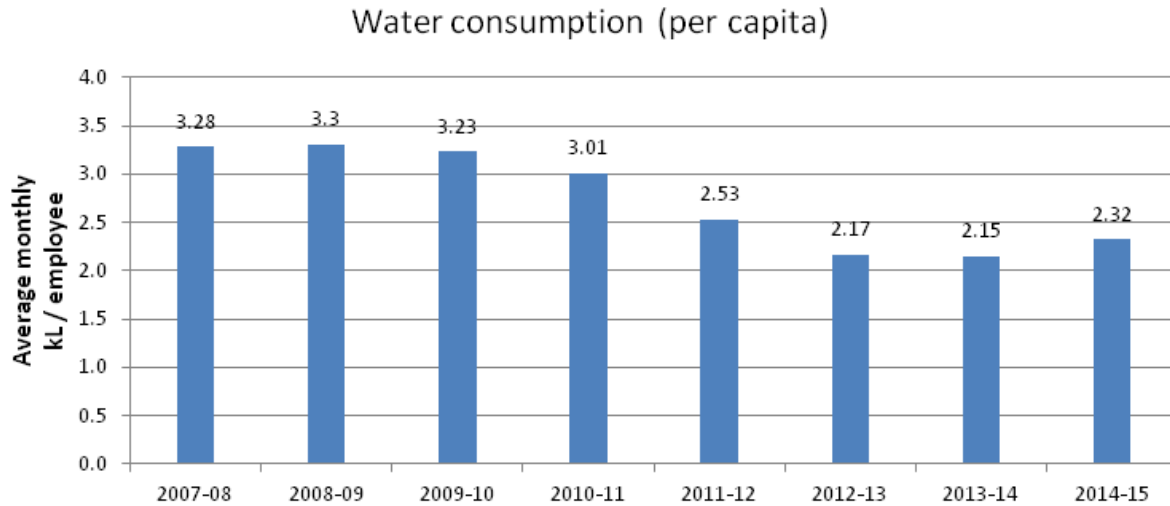


Figure 20.4: Water Consumption per capita

F. Renewable energy

Currently, Infosys has two pronged strategy for renewables. Purchase of green power and installing onsite renewable energy.

- In FY15, 29 per cent of electricity at Infosys was from renewable sources, out of which 1 per cent was from onsite solar power plants and 28 per cent was purchased green power.
- Currently Infosys has about 10 MW of installed solar power plants in campuses, and another 5 MW is in design/installation stage.
- Infosys plans to install about 160 MW of offsite solar power plants to enable to be 100 per cent on solar energy.

G. Solid waste management

Infosys goal for solid waste management consists of:

- 100 per cent segregation at source
- Organic waste to be treated within campus
- All other waste to be given to authorized recyclers to avoid disposal in landfills
- Currently, we have 3.75 tonne/day of biogas plants installed in our campuses
- 5.5 tonne/day capacity of biogas plants are in different stages of installation

H. Research and collaboration

Infosys partnered with the best experts in the world such as Amory Lovins-RMI, Lee Lock-Singapore, Peter Rumsey-Stanford and Tom Hartman-US to continuously push the boundaries and pursue

innovation. We are also the preferred partners for several companies and research institutes for research on new building technologies due to our robust measurement and verification methodology.

III. CONCLUSION: THE RECOGNITION SO FAR - CERTIFICATIONS AND AWARDS

- 5.3 million sq.ft. of highest rated green buildings, No. 1 in India.
- 14 buildings with LEED Platinum rating and 4 buildings with GRIHA 5-star rating.
- Over 30 awards for our efforts in sustainability, including Ashden International award, Golden Peacock, NDTV and Economic Times.
- Patent filed (US, Europe and India) for new radiant cooling system developed inhouse.
- Articles on our initiatives published in various national and international journals and magazines.
- Published article on radiant cooling comparison, with complete technical and cost details to demonstrate benefits of radiant cooling to the industry (ASHRAE journal, vol. 56, May 2014).



SPEAKERS' BIO







ANAND SHUKLA

(Senior Thematic Advisor; Swiss Agency for Development and Cooperation, New Delhi, India)

Dr Anand Shukla is working with the Swiss Agency for Development and Cooperation (SDC) as Senior Thematic Advisor. He is responsible for Climate Change mitigation projects in the field of renewable energy and energy efficiency. Anand has about 20 years of work experience on conceptualization, project planning and management, implementation and monitoring of energy projects.

His PhD thesis is on 'Off-grid Electrification through Distributed Generation in Developing countries' from the University of Osnabrueck, Germany.

Prior to SDC, he has served for more than five years in GIZ (German International Cooperation) focused on commercialization of solar energy in urban and industrial areas and, access to renewable energy based electricity in rural areas for the productive applications. Previously, he worked with the Wuppertal Institute for Climate, Environment and Energy in Germany where he was responsible for managing the small grant projects on renewable energy and efficiency. At Ernst & Young, Anand served as Manager where he was responsible for business development in the CDM (Clean Development Mechanism) sector. Started his professional career from The Energy and Resources Institute (TERI), New Delhi, he played a key role in the development of renewable energy projects in rural areas of India.

Anand has written several research papers and articles in various journals and edited three books covering various dimensions of renewable energy.



RAM KUMAR

(Project Officer, UPNEDA and incharge of ECBC Cell of UPSDA)

Graduated from IET Lucknow in Civil Engineering (1986), Ram Kumar is M-Tech (Honors) in Civil Engineering from IIT Roorkee (erstwhile University of Roorkee). He is Certified Energy Auditor by BEE, Govt of India. Ram Kumar has 27 years of experience in building construction and renewable energy and energy conservation. Presently he is heading the ECBC Cell of UPSDA as well as looking after other renewable projects in solar, small hydro and wind energy as project officer.

Ram Kumar is a life member of professional institutions like The Institution of Engineers (India); Indian Water Resources Society; Indian Society of Geo-Technical Engineers; and Indian Society of Rock Mechanics and Tunnelling Technology.



DODONOV ANDREY

(Energy Management System Consultant in UNDP-GEF Project 'EE in Buildings in North-West Russia')

Andrey has more than 14 years of practical work experience in heating, ventilation, air-conditioning and HVAC areas in CIS countries (Armenia, Azerbaijan, Uzbekistan, Kyrgyzstan, Belorussia, Kazakhstan and Russia) in collaboration with the international and local stakeholders. His key qualifications, including the complex range of engineering work, are: consultant service, energy assessments and technical expertise, design and development of the engineering infrastructure for public and industrial facilities, and installation and maintenance of EE technical solutions, EE software development. The main core professional area is City Energy Management System development.



DEEPENDRA PRASHAD

(Principal Architect and Sustainable Design Consultant, DPAP, India)

Mr. Deependra Prashad is the principal Architect at DPAP, a firm working in the highly specialized arena of Green and Net Zero Buildings. He has 20 years of experience in designing and delivering projects all over the country. The firm is currently taking up some of the most important and prized projects in the Net Zero arena in India and promoting sustainable design at various levels including the government, non-profit sectors and academia. The firm is highly awarded, having received national and international awards for their projects in India and won national architectural competitions. Mr. Prashad, besides engaging in his architectural practice, teaches sustainable design at the School of Planning and Architecture, in New Delhi India. He is also the founder member and secretary, INTBAU India (The International Network of Traditional Building, Architecture and Urbanism), a sister foundation of the Prince of Wales's Foundation for Building Community, UK, an organization working on spreading the word on traditional and sustainable methods in architecture. He has worked as consultant in government projects and those monitored by NGOs on issues of appropriate building materials, water harvesting and community-based planning for educational infrastructure development. He has lectured in universities and has been associated with academic committees in various Indian states and countries, including Sweden, US, UK, Israel, Iran, UAE, Cyprus and Poland.



KUDAKWASHE (KUDA) NDHLUKULA

(Consultant/RE expert)

Kudakwashe (Kuda) Ndhlukula is presently a consultant/RE expert for a number of organizations including, AfDB, IRENA and UNDP. Earlier he was Programme Officer – Capacity Building for the IRENA in Abu Dhabi since November 2012. In this position, he managed various projects including the

Africa Clean Energy Corridor, Photovoltaics Promotion in West Africa and Capacity Building in Small Hydropower Development.

Before joining IRENA, Kuda was the Director/Coordinator of the Renewable Energy and Energy Efficiency Institute (REEEI) in Namibia where he formulated and executed various projects on concentrated solar power, wind mapping, renewable energy and energy policy and regulatory frameworks, training of installers and energy experts, amongst many others and was associated with the Green Building Council Namibia. Kuda also comes from the power utility background having worked for the Zimbabwe Electricity Supply Authority as an electricity trader.

Kuda is a certified Energy Manager and Certified Energy Auditor. He possess an MSc in Renewable Energy Engineering and an MBA, amongst other qualifications.



DR. BHASKAR NATARAJAN

(Deputy Chief of Party, Energy Efficiency, PACE-D TA Programme)

He is Fellow of the Indian Institute of Management, Bangalore (1985) with a specialization in Energy Management. Having done his B.E (Electrical) from the Victoria Jubilee Technical Institute, University of Bombay (1976), he has worked for over 25 years in climate change, renewable energy, energy efficiency and environment sectors and allied areas. His key career experience areas are: analysis of policy issues in the field of energy and environment;

climate change related issues in the energy sector; environmental issues relating to the energy sector; reforms and restructuring of the power sector; programme implementation for energy efficiency and renewable energy; power sector regulation and private sector participation; energy efficiency project implementation, monitoring and assessment; techno-economic analysis of energy sector projects; and market mechanisms for energy conservation and energy efficiency projects and programmes.

He has worked on various projects, supported by MoP, MNRE, BEE, World Bank, USAID, ADB, UNDP and DFID. among others. He has been a part of a number of official government and industry committees of energy and environment. He has written and published in national and international journals and publications.

Prior to his present position, he has been Advisor with IT Power India and Alliance for an Energy Efficient Economy; Managing Director, C-Quest Capital Green Ventures P. Ltd.; Country Coordinator, USAID Eco-Asia Project.





HENRIETTE FAERGEMANN

(Environment, Climate and Energy Counsellor in the European Union Delegation to India)

Henriette Faergemann, Environment, Climate and Energy Counsellor in the European Union Delegation to India, is based in New Delhi. She is responsible for cooperation between the EU and India in these areas and in the area of Urbanization and Smart Cities.

Prior to joining the EU Delegation she was working in the European Commission in Brussels since 1998: From 1998-1999 she has worked as a Member of Cabinet for Environment Commissioner Ritt Bjerregaard. From 1999- 2008 she was working in the European Commission's Directorate for Environment, responsible for cooperation with new EU member states, preparing them for accession to the EU by developing and implementing EU Environmental Law and by developing their administrative capacity. From 2008 to 2014 Ms. Faergemann was team leader responsible for inter-alia water scarcity and droughts, water and agriculture, water efficiency, adaptation to climate change and water innovation in the Unit responsible for protection of water resources within Directorate General for the Environment of the European Commission.

Ms Faergemann has a Master of Science in chemical and environmental engineering from the Technical University of Copenhagen.



JIRAYUT CHAROENCHATCHAI

(Assistant Project Manager, PEECB Project UNDP Thailand and Manager, Energy Efficiency - Bright Management Consulting Co.,Ltd.)

Jirayut with 18 years of engineering and energy management experience has conducted over 80 energy audits, set up energy policy and strategic plan, conduct energy management training and implementation projects in the last 10 years. He has undertaken project leadership responsibility in numerous energy management and efficiency projects.

He had involved in applying Good Practice Guidance and Uncertainty Management for GHG Inventory and report development for industrial sector for Department of Industrial Works, Ministry of Industry (2009). He also provided Good Practice Training for industries during developing the project and also co-developing GHG manual for industrial sectors.

Currently, he is an assistant project manager of Promoting Energy Efficiency in Commercial Building, PEECB Thailand which has started in 2013.



MIROSLAV LESJAK

(BSEEP Energy Efficiency Financing Consultant, UNDP GEF Project Malaysia)

Mirosław Lesjak has a seven-year track record with various UNDP building sector EE projects where he was responsible for developing energy efficiency financing and incentive models, managing implementation of smart metering projects and implement 'low cost/no cost' and investment energy saving measures. He holds a Masters in electrical engineering, accreditation for energy certification of buildings with complex technical systems and public lighting, and is a certified measurement and verification professional with the Association of Energy Engineers.



MOHAMED BERDAI

(Morocco, Consultant UNDP)

Mohamed Berdai has a PhD in Physics Opto Electronic from the University des Sciences et Techniques Lille, France, and has 25 years' experience in the energy sector. He has been an independent consultant since 2012 on Sustainable Strategies for Energy and Environment (new cities zero emission approach, green buildings, energy audits). He has provided technical assistance for RE & EE project developers, expertise for GIZ, UNDP, Holding AI OMrane and ESCO Market development. He has taught Sustainable Energy Management as professor at the Akhaouayne University of Ifrane. He has been the National Coordinator of Energy Efficiency Programme in Building Sector for the UNDP & GEF and the Deputy Chief Executive Officer at CDER/Director of Programmes and International Cooperation.



SAMEER MAITHEL

(Director, Greentech Knowledge Solutions Pvt.. Ltd , India)

Sameer has a PhD in Energy Systems Engineering from Indian Institute of Technology (IIT), Bombay. He has more than 25 years of work experience in industry, research and consultancy. He is the Director of Greentech Knowledge Solutions Pvt. Ltd—a clean energy research and advisory firm which offers services across decentralized renewable energy, energy efficiency, and green buildings domains. He is Head of Indian Project Management and Technical Unit of the Indo-Swiss Building Energy Efficiency Project (BEEP).

Prior to Greentech, he worked at The Energy and Resources Institute (TERI) and Oil and Natural Gas Corporation (ONGC). He has been a visiting faculty at IIT, Bombay and Annual Summer School organized by the UK Energy Research Centre. Apart from India, he has contributed in energy sector projects in several other developing countries including Vietnam, Nepal, Bangladesh, Bhutan, Rwanda, Uganda and South Africa.



VAHRAM JALALYAN

(Project Manager, UNDP Armenia)

He has more than 12 years' practical work experience in heating, energy, buildings' energy efficiency, energy conservation, renewable energy, biofuels and climate change in Armenia in collaboration with international and local stakeholders.

His main key qualifications include a complex range of engineering work—consultant service, design and development of the engineering infrastructure for residential, public and industrial facilities, energy management, energy audits; design of envelope insulation for public, residential and office buildings, industrial and public facilities; conduct energy audits for public, residential and office buildings, industrial and public facilities; technical expertise for public facilities and municipal buildings (hospitals, schools, children care centres) in the construction direction; conduct technical trainings in the direction of energy conservation and energy efficiency, economic and investment assessment of energy-saving measures for public, residential and office buildings, industrial and public facilities; participate in the development of National Energy Efficiency Action Plan (NEEAP) for Armenia in collaboration with international and local expert's team; develop and implement technical and financial mechanism in energy efficiency for municipal and public facilities.

He has developed and conducted several trainings for local FI's, staff of administrative regions, condominium managers, state urban development inspection professionals, trainers and students on energy audit financing, green loans, and on energy conservation measures.

Apart from coordinating the project on oil and gas exploration in Armenia (2005-2006), he has led and managed the local team under the WB project on assessment of Bio-Ethanol production in Armenia (2008-2009). Since 2010 he is managing the UNDP-GEF Project Improving Energy Efficiency in Buildings in Armenia.



NARAYANAN AM

*(Head-Energy Efficiency Division,
Energy Management Centre, Dept of Power, Govt. of Kerala)*

A graduate in Electrical Engineering, Masters in Energy Management, and a PhD Scholar in power system. He is IEEE IAS Distinguished Lecturer and Certified Energy Manager and Auditor. He has more than 30 years' experience in the field of energy and infrastructure projects and technical services in India and abroad with government and multinational companies. He has worked as Director, ANERT, Govt. of Kerala, State Nodal Agency of Ministry of New and Renewable Energy, Govt. of India; Senior Staff, State Electricity Regulatory Commission, Quasi judiciary body; Chief Operating Officer, Engineering Procurement and Construction Projects and Technical Services, Multinational Consortium, USA & Middle East; and Sr. Dy. Director, Energy Management Division, NPC, Govt. of India

He has attended several seminars in India and abroad and authored and presented several papers and actively involved in various teams and committees in national and international forums. Presently, he is leading the formulation and implementation of projects and programmes at the state level in efficient use of energy and its conservation.



TANMAY TATHAGAT

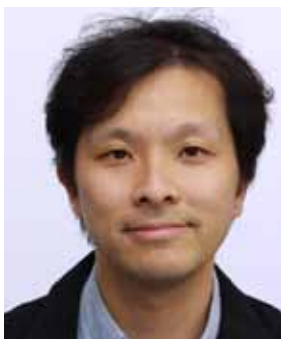
(Director, Environmental Design Solutions, Fellow USGBC)

Tanmay has a background of architecture and engineering. He has over 20 years of working experience in projects dealing with sustainable development planning, energy codes, building energy efficiency, green building design and certification, and energy efficiency policy in Asia, Africa and the US.

He led the Energy Conservation Building Code (ECBC) development, Eco-Housing programme, and EE Homes programme for the National Housing Bank, in India. He is currently working on developing Net-Zero energy programme for India and the next update of the ECBC, as a part of the USAID PACE-D programme. His experience also includes support to energy efficiency building code development and deployment in California, India, Thailand, Philippines and Vietnam.

Tanmay has received the LEED (Leadership in Energy and Environmental Design) Fellow accreditation from the US Green Buildings Council. He is working closely with the Indian Green Building Council and GRIHA for development of green building standards in India, and to support green building projects worldwide.

Tanmay leads the Environmental Design Solutions team of consultants working on climate change policies, energy efficient building design, building code development, energy efficiency policy development, energy simulation and green building certification process. Since 2003 EDS has worked on over 400 green building and energy efficiency projects worldwide.



KEVIN HOR

Kevin Hor is a registered professional engineer as well as a registered electrical energy manager. He holds two degrees from Imperial College London and has been extensively involved in the energy and environment sector. He has a track record with various energy efficiency projects where he was responsible for developing energy efficiency financing and incentive models, development of policy papers and has a proven track record in implementation of 'low cost/ no cost' and investment energy-saving measures. He has also been involved in some of the most complex billion ringgit infrastructure projects in Malaysia

and has extensive experience in the green building industry. Having GreenRE and Green Building Index certifications, he has worked on numerous energy efficient commercial and residential building designs, standard development and is a Certified Measurement and Verification Professional with Association of Energy Engineers.



NEERAJ KAPOOR

Managing Director, Kalpakrit

Neeraj, co-founder of Kalpakrit, is experienced in addressing issues of energy conservation, efficiency, thermodynamics, thermal comfort, reduction of CO₂ emissions and environmental sensitivity in the built environment. He brings to Kalpakrit an experience of more than 12 years in environmentally sensitive architectural solutions and energy efficiency. He has been involved with specialization in whole building energy simulation modeling, development of energy conservation and energy efficiency measures, analysis for demand side management (DSM) incentives, facility audits, LEEDR design and documentation assistance and facility assessments for various building types. His experience also includes modelling evaporation using CFD, doing thermal comfort assessment and daylighting analysis. He has been a presenter and published research papers in various fora.

Neeraj was the energy consultant on Indira Paryavaran Bhavan, India's first NET-0 office building, apart from having accomplished several platinum and gold-rated buildings in India. He had been involved with formulating an implementation strategy for ECBC 2007 for buildings' in Tamil Nadu. He had worked for a key market study towards devising Demand-Side Management programmes for the power sector in incentivizing building energy efficiency. Lately, he has been working with the post graduate Urban Design Department of the School of Planning and Architecture in the area of policy recommendations for Architectural Controls in the hilly ru-burbs of Himachal. He features as one of the on the Bureau of Energy Efficiency's (BEE's) ECBC Empaneled Architects. He is also keenly involved with the education sector featuring on the Task Force for Lady Irwin College, Delhi University's relatively new postgraduate programme in environment and resource management. He has been a guest lecturer for the Centre for Science and Environment, CPWD Training Institute and CEPT University in the past. He is on the visiting faculty of School of Planning and Architecture Delhi.



PUNEET MITAL

(Regional Manager-Asia Pacific & Middle East, U. S. Green Building Council)

Puneet Mital is the Regional Manager, Asia Pacific & Middle East for US, Green Building Council and works to enhance the user experience of Leadership in Energy & Environment Design (LEED) and its effectiveness for the USGBC community in the region. Based in New Delhi, he is primary on-the-ground representative for the USGBC & GBCI to proactively solve customer needs across USGBC's & GBCI's rating programmes.

Puneet was one of the key members in the launching of EDGE ratings in India. He was also deeply involved in the Market and Business development of ratings offered by GBCI such as International Finance Corporation's EDGE ratings, International Well Building Institute's WELL rating, GRESB, PEER, etc.

He acts as an interface between the council and the stakeholders for continuous improvement of the rating systems to better address the needs of green building projects in the region. This effort follows

the organization's international strategy emphasizing global consistency while allowing for regional solutions, and encompasses the current and future versions of LEED.

He is a Bachelor's of Technology in Instrumentation Engineering, Dual Masters from University of Petroleum & Energy Studies, Dehradun in Energy Systems, and PGDBA in Operations Management.

Prior to joining USGBC, Puneet had worked for over three years with India's premier Industry body where he worked on sectors including energy, climate change and sustainability, automobile, etc. He has also spent several years in the Green Building industry and has been assessor for hundreds of Green building projects where he conducted reviews, physical audits and site visits, etc. He has also worked on projects with some of the prestigious organizations including Defense Research & Development Organization, Larsen & Toubro, Bureau of Energy Efficiency, Ministry of Power, Planning Commission of India (Now known as Niti Aayog), Ministry of New & Renewable Energy, etc.

A native of New Delhi, Puneet has keen interest in sustainability concepts, energy efficiency and its application in the buildings sector and beyond.



ISAAC EMMANUEL

(Specialist in Industrial Marketing and Advocacy in Covestro, India, Pvt. Ltd)

Isaac Emmanuel heads the specialist role of Industrial Marketing and Advocacy in Covestro (India) Pvt. Ltd, the erstwhile Bayer Material Science Pvt. Ltd, the inventors of Polyurethanes and Polycarbonates. Based out of Thane near Mumbai, his work cuts across all segments of polyurethane applications and involves novel business development related to affordable housing, wood binders and functional footwear.

In the advocacy role, he has been instrumental in bringing together the India Insulation Forum which is cross-industry platform to champion the cause of building insulation as well as creating the India Spray Polyurethane Foam Alliance. Besides, he is engaged in the cause of Sustainability in Covestro through projects and activities.

He is a postgraduate in Polymer Chemistry from Chennai (Madras) University and has spent the last 23 years of his professional life in the field of engineering polymers industry in India. Having worked closely with the automotive, sports, industrial, mechanical and railway segments in developing applications with Bayer range of polymers, in roles ranging from Sales, Marketing and Business Development across the country, he spent recent years in developing new ideas for the construction and cold chain segments.



ABDULLAH NISAR SIDDIQUI

(APM UNDP-GEF)

Abdullah is a registered architect with Council of Architecture (India), with interest in scientific computing and built environment simulation. He has a Master in Building Services and Bachelor in Architecture from Jamia Millia Islamia, New Delhi. An Indian Green Building Council Accredited Professional (IGBC AP), LEED Green Associate, GRIHA Evaluator & Trainer and ECBC Master Trainer, he has authored and published several technical and research papers at national and international conferences with focus on development and application of appropriate technologies, standards, and indicators related to buildings energy performance.

Presently, he is Assistant Project Manager, UNDP-GEF project on 'Energy Efficiency in Commercial Buildings', based at Bureau of Energy Efficiency, Ministry of Power. The objective of project is to reduce GHG emissions through implementation of Energy Conservation Building Code (ECBC). He is member of the technical committees and working groups for revision of ECBC. Major initiatives under the project include (a) institutionalization of training and capacity building activities at state level, (b) creation of ECBC cell in the state PWD/UDD municipalities to assist in the notification and operationalization of ECBC, (c) market assessment of energy efficient building materials.



BUTCHAIHAH GADDE

(Technical Specialist for Global Environmental Finance, UNDP)

Dr Butchaiah Gadde is currently working as a Technical Specialist for Global Environmental Finance unit of UNDP. He has been involved in the design and supervision of technical assistance projects that are programmed under Global Environment Facility (GEF), UNDP TRAC and other donor resources. Dr Butchaiah Gadde has about 15 years of professional experience in the areas of renewable energy, environmental engineering and climate change.



SHABNAM BASSI

(Assistant Project Manager, UNDP-GEF project on 'Energy Efficiency Improvements in Commercial Buildings')

Shabnam has been associated with the building energy efficiency programme since 2007. In her present capacity, she supports the development of the framework for adoption and implementation of the Energy Conservation Building Code (ECBC) in the built environment, working closely with the State governments. The profile of her engagement involves developing rules and regulations for ECBC implementation, supporting demonstration projects to show-case compliance to ECBC, and identification of baseline of energy consumption in commercial buildings for establishing benchmarks to assess the impact of implementation.

She has a degree in Electronics and Communication Engineering and has worked with the Bureau of Energy Efficiency (BEE) for almost five years, prior to joining the UNDP. During her tenure with BEE, she has supported the work on government policies for promoting energy efficiency in the buildings sector and has had the privilege of working in close cooperation with various international agencies / experts in enhancement of these policies and programmes.

As an outcome of her training and experience in building energy efficiency, she closely follows the developments in the infrastructure sector, particularly those related to building energy/green buildings. She has also presented on the building energy efficiency initiatives in India in various national and international conferences and workshops.



SRINIVAS SN

(Programme Analyst, UNDP)

Srinivas S N has a PhD in Mechanical Engineering. He is working as Programme Analyst at United Nations Development Programme, India. He has 25 years of experience in the area of energy efficiency, renewable energy, energy access, and sustainable development. He has published about 100 papers, research reports, books, etc. He is a Certified Energy Manager. Presently, he is leading the portfolio of energy in the Energy and Environment division of UNDP, India.



SAKET SARRAF

ps Collective, Ahmedabad

Dr. Saket Sarraf works on issues related to sustainable development and energy efficiency across the fields of architecture and planning. He heads ps Collective, which is envisaged as a platform for advocacy, research, policy analysis and professional consultancy. He has over 15 years of experience in India and the USA.

He is actively involved in the 'Benchmarking and Performance Based Rating Program for Commercial Buildings in India' initiated by the Bureau of Energy Efficiency, Ministry of Power, Government of India. He has been part of various national level benchmarking initiatives in India over many years including the USAID ECO-III project, Indo-US Partnership to Advance Clean Energy (R) project, and recently in the development of the National Star Labeling model for Hospitals. His current research interests include machine learning applications in energy analytics, automated M&V, and fault detection and diagnostics; open data systems for policy making; and urban growth simulation.

Dr. Sarraf serves as the coordinator of the PhD program in Planning at the CEPT University, Ahmedabad. He is formally trained as an architect from the Indian Institute of Technology, Kharagpur and as an Urban and Regional Planner from the University of Illinois at Urbana-Champaign, USA. He received the outstanding PhD. award for his work on modeling social drivers of urban growth in 2005-2006.



He is a certified M&V professional, GRIHA trainer and evaluator, and ECBC master trainer. He is a member of number of professional bodies including ISHRAE, International Indian Statistical Association, The Indian Econometrics Society, Council of Architecture, and founding member of the International Building Performance Simulation Association – India



GURUPRAKASH SASTRY

Infosys

Guruprakash Sastry is a passionate sustainability professional with over 11 years of experience in energy efficiency and green buildings. Currently at Infosys, he is responsible for ensuring energy efficiency and overall sustainability in all buildings. He has been an integral part since the green team started at Infosys in 2008. He has been instrumental in implementing several cutting edge building technologies for the first time in India.

Prior to Infosys, Guruprakash has worked as a researcher at TERI, New Delhi in Sustainable Buildings group and as Lead – Energy and Sustainability at Johnson Controls, Bangalore.

Guruprakash has a Masters in Sustainable Energy Engineering from KTH, Stockholm. He is a LEED Accredited professional, Certified Energy Auditor and Certified M&V professional.

His objective is to set new benchmarks for environmental sustainability with every new building of Infosys, and lead the industry and society towards higher standards in terms of sustainability.

This compendium, specially brought out during the occasion of 'International Conference on Energy Efficiency in Buildings' held at New Delhi, comprises a theme paper and 20 discussion papers by project managers of UNDP-GEF projects and other expert practitioners in implementing energy efficiency in buildings across the world.

The compendium is in four sections, enumerates topics ranging from policy, regulations and its impact on implementation; challenges, barriers in designing and legislating the building codes, illustrated through many international experiences and collaborations with a focus on lessons learnt; topics of bench-marking, performance measurements and verification are discussed. A section is dedicated to bring out the perspectives and case studies from building sector stakeholders - builders, architects, consultants and large scale enterprises.

It is envisaged that the stakeholders in India and abroad interested in adopting energy efficiency practices will benefit from the narrative of this compendium. We hope this compendium would contribute knowledge and provide interesting ideas and concepts that can be taken to the next level of implementation.



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