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A Sustainable Consumption and Production Approach to Green Building and Housing:

Development of an Action Plan for Bangladesh

Acknowledgement

This study was prepared on behalf of the EU SWITCH-Asia Sustainable Consumption and Production Facility (SCP Facility), by green building expert Prof. Md Ashikur Rahman Joarder with his team members, and by Jessica Weir and Anton Barckhausen from adelphi consult GmbH under the supervision of Cosima Stahr, Key Expert of the SWITCH-Asia SCP Facility and Dr Zinaida Fadeeva, Team Leader, SWITCH-Asia SCP Facility.

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List of Abbreviations

AP	Action Plan
BDT	Bangladeshi Taka
BEER	Building Energy and Environment Rating
BEEER	Building Energy Efficiency & Environment Rating
BNBC	Bangladesh National Building Code
BUET	Bangladesh University of Engineering and Technology
CUET	Chattagram University of Engineering and Technology
DoA	Department of Architecture
EDGE	Excellence in Design for Greater Efficiencies
EE&C	Energy Efficiency and Conservation
EECMP	Energy Efficiency and Conservation Master Plan
EPBD	Energy Performance of Buildings Directive
EU	European Union
FAR	Floor Area Ratio
GB	Green Building
GBC	Green Building Code
GBIG	Green Building Information Gateway
GHG	Greenhouse Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GrACe	Green Architecture Cell
HBRI	Housing and Building Research Institute
IFC	International Finance Corporation
LEED	Leadership in Energy and Environmental Design
MoEFCC	Ministry of Environment, Forests, and Climate Change
MoHPW	Ministry of Housing and Public Works
MoPEMR	Ministry of Power, Energy and Mineral Resources
NDC	Nationally Determined Contribution
NGO	Non-Government Organisation
NHA	National Housing Authority
nZEB	nearly Zero Emissions Building
NZEC	Net Zero Emissions Communities
neZECom	nearly Zero Emission Communities
neZECoRI	nearly Zero Emission Communities Research Institute
POE	Post Occupancy Evaluation
R&D	Research and Development
RMG	Ready-made Garments

RUET	Rajshahi University of Engineering and Technology
SCP	Sustainable Consumption and Production
SCPF	Sustainable Consumption and Production Facility
SDGs	Sustainable Development Goals
SMEs	Small and Medium Enterprises
SREDA	Sustainable and Renewable Energy Development Authority
UN	United Nations
USGBC	United States Green Building Council
UNFCCC	UN Framework Convention on Climate Change
WGBC	World Green Building Council
ZEB	Zero Energy Building

1. Introduction

In 2018, the second phase of the SWITCH-Asia Sustainable Consumption and Production Facility (SCPF) was launched with European Union (EU) funding. The programme aims at providing a platform to promote sustainable consumption and production (SCP) policies and principles in Asia, and enhance the awareness and dialogue of local stakeholders on the theme. To achieve these goals, the SCPF fosters exchange through platforms, key experts, entities and stakeholders who share the interest for impactful actions to further enable sustainable housing, a top priority for Asia and Asian countries, through relevant responsible consumption and production patterns. SCPF enables discussion of ideas and lessons learned, which consequently helps identify and develop joint actions.

Already, during the SCPF assignment on Green Buildings in Bangladesh, a status report on Green Building (GB) adoption has enhanced the understanding of its current status, gaps, constraints and opportunities. In addition, a report on international practices of GB relevant to Bangladesh has been developed to improve the understanding of GB policy implementation and adoption, and linkages have been strengthened between stakeholders through expert meetings and consultations.

This report aims to further familiarise government institutions with the technical aspects and policy options for GB implementation, focusing on the planning and implementation of a GB code. Figure 1 demonstrates how, through desk research and numerous stakeholder meetings and consultations, the Roadmap and Action Plan have been developed to provide recommendations for the next steps required for a successful GB policy application.

Figure 1: Timeline of SCPF assignment on GB in Bangladesh

1.1 Background

1.1.1 Importance of Green Buildings for Bangladesh

Globally, buildings account for more than 30% of total energy use and almost 40% of carbon emissions, a higher share than any other sector. As much as half of the nonrenewable raw resources used by humankind go into construction of the built environment. Increasing energy efficiency and reducing the use of resources throughout the life cycle of a building can have a profound outcome, not only on the planet, but also on human health. The development of a Green Building Code (GBC) can be the key to reducing or eliminating the impacts that buildings have on the environment and natural resources, especially in countries most vulnerable to climate change, such as Bangladesh. Green building concepts are not limited to buildings, but can also be applied to site planning, land use, and socio-cultural connections. The concept of GB, however, is still developing in Bangladesh and therefore lacking professional experience.

The International Finance Corporation (IFC) estimates a US$172 billion climate investment opportunity for Bangladesh among South Asian countries (IFC, 2017). The largest opportunity, of more than $118 billion, is projected in the GB sector in Bangladesh, of which the residential sector accounts for the majority. **However, overarching strategies or regulations with general provisions related to GB are underdeveloped in Bangladesh.** No national policies exist to provide comprehensive regulations or standards for GBs. It is common practice to rely on western systems and designs that are often outdated, energy inefficient, expensive, inappropriate and inadequate for local climatic conditions. Therefore, a redirection towards the importance of learning from vernacular architecture practices that use traditional, low-carbon, regional techniques and building materials to develop effective sustainable solutions is needed. **GB in tropical climate zones, such as Bangladesh, should focus on efficient energy systems to reduce cooling loads, sustainable consumption and production throughout the life cycle of the building (Figure 2), and on passive design elements in architectural designs.**

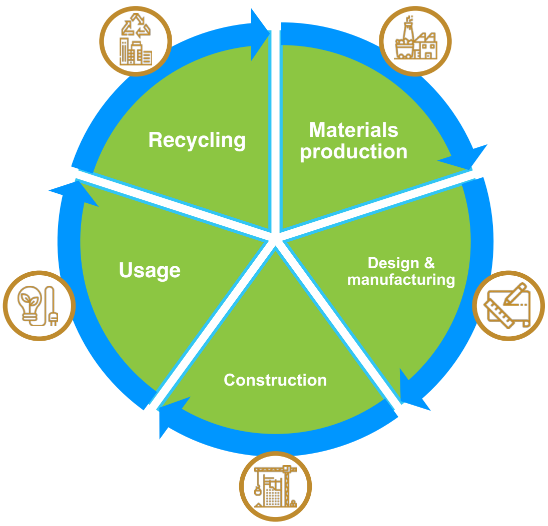


Figure 2: Building life cycle

Source: EU, 2019

1.1.2 International initiatives and guidelines

Many international initiatives have already been taken towards GB, most notably the World Green Building Council (WGBC), which catalyses the implementation of sustainable buildings globally. At present, there are 70 Green Building Councils around the world. There are three membership levels for Green Building Councils: Established, Emerging and Prospective. Bangladesh is still not a member of the WGBC at any of these levels (WBGC, 2021). Excellence in Design for Greater Efficiencies (EDGE) is an innovation of the IFC, a member of the World Bank Group. Considering that current rating systems are focused on top-tier clients, EDGE was created to respond to markets that need a simple, quick and affordable rating system for market transformation, and to make GB accessible to a larger share of the building industry (EDGE, 2021). Although this system is geared towards emerging GB markets, at present there are no completed EDGE projects in Bangladesh. Further to voluntary certifications, governments around the world have established regulations, policies and programmes to incentivise the development of GBs; for example, the EU's Energy Performance of Buildings Directive (EPBD), Nepal's National Building Code and Germany's Building Energy Act – to name a few. The details of these and other instruments to promote GBs are described in a report on *International Good Practices in Green Building and Housing: Lessons for Bangladesh* (see the companion report).

1.1.3 Applicability of international standards in Bangladesh

Because of the perceived high costs of international certification systems, and their incompatibility with local passive design (e.g., low cost, naturally lit and ventilated buildings), they are not feasible in the context of Bangladesh to cover the needs of the residential sector (Mahmud, 2011). Still, the WGBC affiliated Leadership in Energy and Environmental Design (LEED) remains the most widely used green building rating system in Bangladesh. As of the beginning of 2022, there are about 174 LEED certified registered buildings in Bangladesh (GBIG, 2022). More than 130 of these are readymade garment (RMG) factories in the apparel sector, and hundreds more have registered in the LEED certification system. Bangladesh has the highest number of LEED RMG factories certified by the United States Green Building Council (USGBC), with seven of the top 10 in the world located in Bangladesh (Mirdha, 2018).

The Sustainable and Renewable Energy Development Authority (SREDA), established in May 2014, is a national organisation for promoting Energy Efficiency and Conservation (EE&C) in the country. In 2016, SREDA developed the Energy Efficiency & Conservation Master Plan (EECMP) for up to 2030 (SREDA, 2015). All related policies, programmes, legal documents (Standards, Regulations, Circulars, Rules, Act, etc.) and frameworks are to be established under this plan. In 2018, the Building Energy and Environment Rating (BEER) System (Version-1) for Bangladesh was drafted. The 4th revision of Building Energy Efficiency & Environment Rating (BEEER) for Design and Construction of Buildings was submitted for review by SREDA in November 2020. In addition to the environmental footprint of buildings (water, waste, resources), the rating system also considers social standards, working and safety conditions, gender equality, rights of minorities, and low-skilled workers for the development of a sustainable construction sector in Bangladesh. Both the drafts are publicly available and are being reviewed by different experts and organisations in the development process. The rating system, which will be voluntary at the initial stage, still requires an institutional setup, more research, experiments and continuous updating, definition of operational policy guidelines, and broader applicability and acceptability across all regions of Bangladesh. **The national rating system is still undergoing revisions and is yet to be finalised.** Figure 3 depicts a timeline for the development of GB standards by SREDA.

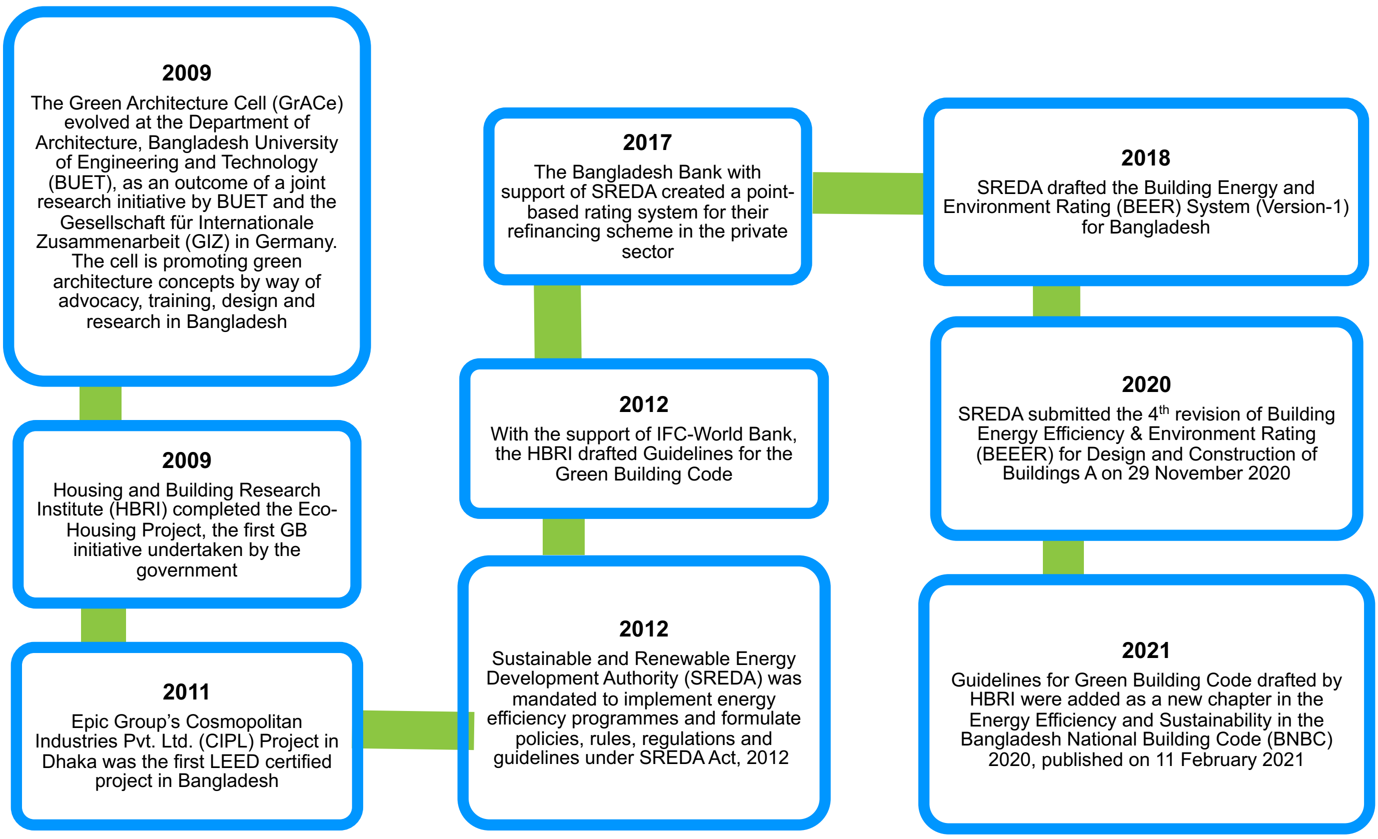


Figure 3: Timeline of development and implementation of Green Building standards

1.1.4 Key aspects of green and zero emissions buildings

A Zero Emissions Building (ZEB) itself produces energy equal to or more than the amount it consumes in a year (Torcellini et al., 2006; Renewcapa, 2012). On the other hand, Net Zero Emissions Communities (NZEC) are a cluster of buildings fulfilling the net zero balance in total using an identical local energy infrastructure (Salom et al., 2014). The cluster uses benefits from economies of scale, levelling out the load and generation profiles of each building. Though reducing energy consumption is important, reduction of GHG (Greenhouse Gas) emissions remains the ultimate concern for zero-emission communities (Röck et al., 2020). Coal, oil and gas are all fossil fuels, and as a group are the largest generator of emissions (Das et al., 2011). In zero-emission communities, energy will therefore only be generated from emissions-free renewable energy sources, which will be equal to or more than the energy it uses from emissions-producing sources (Torcellini et al., 2006). Nearly zero-emission communities will use minimum energy and water, avoid waste, require less maintenance, improve indoor environment quality, ensure comfort and place no environmental or health burden on the community. In a nutshell, **zero emission buildings can be achieved by integrating environment-friendly, passive design features and conservation measures; increasing energy efficiency; producing renewable energy; preventing and reducing environmental pollution; and providing mitigation or clean-up of environmental pollution** (Chel and Kaushik, 2018; Owusu and Sarkodie, 2016).

1.1.5 The Bengali house: Tradition meets future

The traditional 'Bengali House' can already be considered a zero energy and zero emissions building in a closed loop ecosystem, and it also satisfies the definition of sustainability as it meets the needs of the present without compromising the ability of future generations to meet their own needs**. Successful GB design initiatives need to engage the interconnectedness of land, water, vegetation and the ethos of the people through the use of traditional and vernacular architecture**. It is believed that South Asian ancestors understood ecological architecture deeply (Wares, 2018). The functional, social and environmental aspects of a traditional Bengali House evolved from thousands of years' wisdom (as described in ancient literary texts such as Kalidasa's Topoban, Khonar Bachan, and Vastu Shastra[1]) should be manifested in multi-storeyed nearly Zero Emissions Building (nZEB) design and construction. It should portray the transformation of mud walls, courtyard, pond and greenery to insulation walls, atrium, pools and vertical farming in an urban, compact, residential, zero emissions house. Rainwater harvesting, waste and water recycling, solar and kinetic power need to be used to reduce energy cost of the building. Minimal GHG emissions can be ensured by turning the building as an on-grid, all-electric building. On-site generation of electricity from emission-free renewable sources can offset imported and often more carbon-intensive energy. Protection of the inside of buildings from outdoor heat can be offered by thermal mass (e.g., cavity walls) appropriate for the climate of Bangladesh, where the temperature is never very low even in winter. The operational cost can be reduced significantly by a passive system for cooling and ventilation; and by water and waste disposal systems as shown in Figure 4, as they do not consume much energy or need complex maintenance. They can be maintained by the occupants with a little knowledge, such as manually cleaning floor/duct vents to keep ventilation and air supply at the highest efficiency. On the other hand, conventional mechanical ventilation (i.e., HVAC) has a high cost of energy and maintenance.

1 Kalidasa (between 4th-5th CE) is a classical Sanskrit writer. In his play "Shakuntala", also the main character of the play, built her forest house with wood and natural materials; and transformed the forest into a 'Topoban', an ecological and spiritual forest.

Khona's bachan (aphorism) are short but rich with witty meanings (between 8th – 12th CE). Khona provided profound insight into the geo-climatic and cultural context of dwellings.

Vastu Shastra is the ancient Indian science of architecture. These texts describe principles of design, layout, measurements, ground preparation, space arrangement and spatial geometry (Wikipedia).

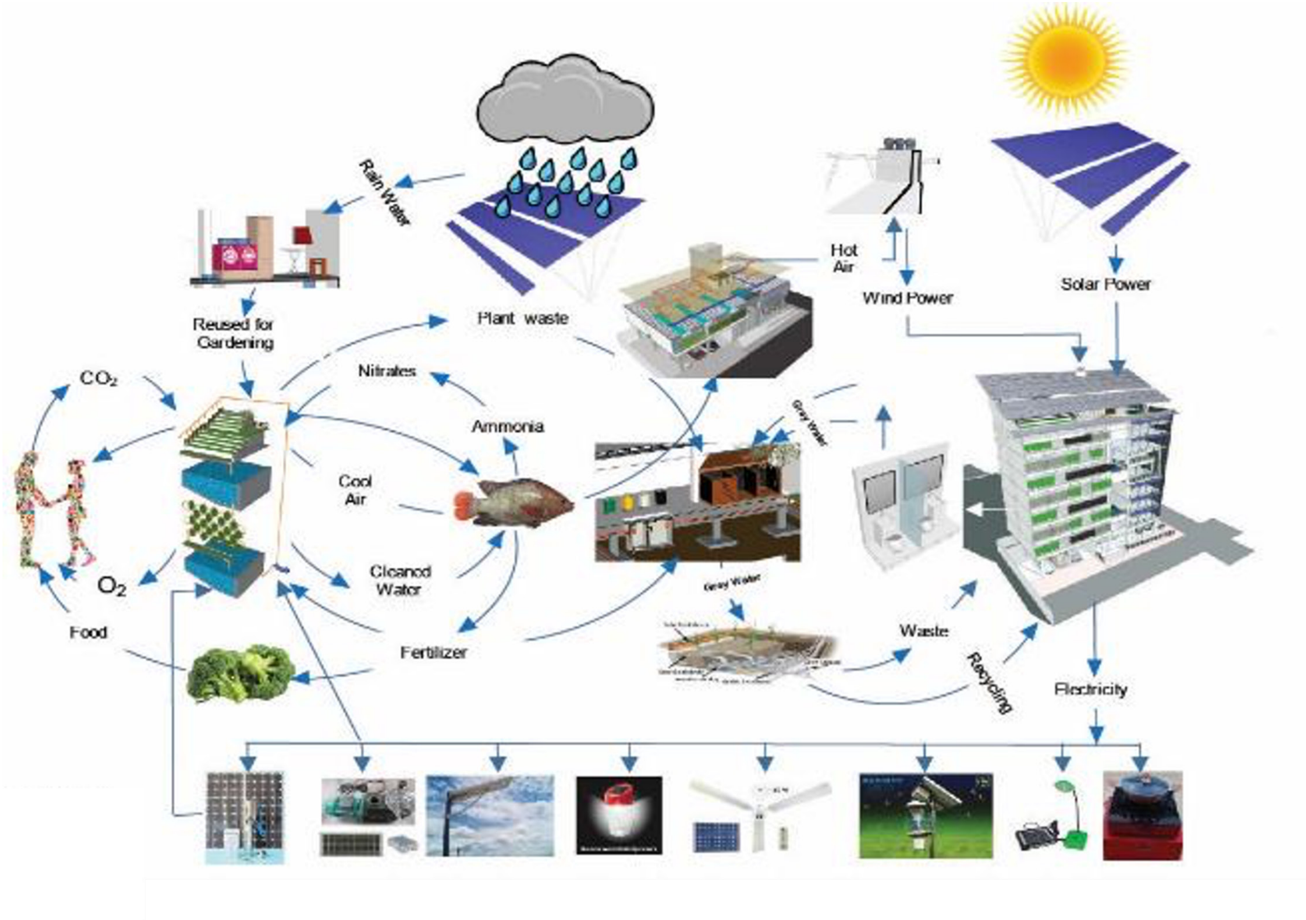


Figure 4: Modern use of tradition beyond biomimicry in a closed-loop ecosystem

1.1.6 Way forward

An Action Plan (AP) is an essential part of a strategic policy planning process. It defines the way forward by: 1) recommending tasks and steps that need to be carried out; 2) highlighting key actors and experts who should be involved in the different tasks; 3) listing resources that are needed; and 4) evaluating progress. Importantly, it ensures that deadlines, targets and milestones are Specific, Measurable, Attainable, Relevant and Timely (SMART). In particular, the Roadmap and Action Plan for GB explores the idea of building life cycle costing and focuses on planning areas such as:

1. **Social aspects:** enabling (urban) SCP housing and meeting basic needs;
2. **Climate change mitigation:** energy efficiency, resource efficiency and climate change adaptation; and
3. **Finance:** Policy support for SCP financing ecosystem accessible to construction and building small and medium enterprises (SMEs), assessment of financial instruments and project pipeline development.

Considering the current situation for GBs in Bangladesh and learning from international best practices, the importance of an adaptable GB rating and certification system that can be tailored to the context of the country and its regions is necessary. The following Action Plan should act as a guide for decision- and policy-makers to advise how to move forward towards a fully implemented GB code for Bangladesh.

2. Action Plan

2.1 Key stakeholders

Throughout the SCPF assignment, ongoing stakeholder dialogues helped to shape a clear picture of the key stakeholders for GB in Bangladesh. The matrix in Table 1 outlines these actors. Those in bold represent stakeholders who were consulted directly during the assignment, and therefore they helped to formulate the recommendations for developing the Roadmap and Action Plan. The participants were categorised into the following five groups, representing the different stages of a building life cycle:

1. **Professional bodies, practitioners (including architects and town planners) and academics**

   Focus: Planning, Design & Technology

2. **Builders and developers**

   Focus: Construction

3. **Civil society and NGOs**

   Focus: Use of building; access to affordable housing; living standards; urban context/community

4. **Government agencies**

   Focus: Nurturing an environment for a GB policy

5. **Corporate/private sector and Investors**

   Focus: Financing

During the consultations with the key stakeholders, the next steps for integrating GB concepts into future policies were investigated.

Table 1: Matrix for mapping of stakeholders

Stakeholders	STATE	PRIVATE SECTOR	CIVIL SOCIETY
KEY	**Ministries and government agencies** • **Ministry of Environment, Forests & Climate Change (MoEFCC)** • Ministry of Housing and Public Works (MoHPW) • Ministry of Power, Energy & Mineral Resources (MoPEMR) • Ministry of Road Transport and Bridges • **Sustainable and Renewable Energy Development Authority (SREDA)** • Public Works Department (PWD) • **Department of Architecture (DOA)** • Department of Environment (DOE) • Power Division • Local Government Division • Economic Relations Divisions • Ministry of Industries • Road Transport and Highways Division • Capital Development Authority of the Government of Bangladesh (RJAUK) • Regional Authorities	**Professional Institutions** • **Institute of Architects Bangladesh (IAB)** • Institution of Engineers, Bangladesh (IEB) • **Bangladesh Institute of Planners (BIP)**	**Associations of sustainability** • Bangladesh Environmental Lawyers Association (BELA) • **RAiN Forum** (for sustainable water management) • **ASHRAE Bangladesh Chapter**
PRIMARY	**Financial institutions** • Bangladesh Bank • Bangladesh House Building Finance Corporation (HBFC) • Bangladesh Infrastructure Finance Fund Limited (BIFFL) • **Infrastructure Development Company Limited (IDCOL)**	**Private and development banks** • **World Bank** • **French Development Agency (AFD)** • **Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)** • European Investment Bank (EIB) • Entrepreneurial Development Bank (FMO) • KfW Development Bank	**NGOs** • **Oxfam** • **Jagorani Chakra Foundation (JCF)** • Palli Karma Sahayak Foundation (PKSF)
SECONDARY	**State Universities and research institutions** • **Bangladesh University of Engineering and Technology (BUET)** • **University of Dhaka (DU)** • **Housing and Building Research Institute (HBRI)**	**Private Universities and Research institutes** • Ahsanullah University of Science and Technology (AUST) • **Center for Housing and Building Research (HBRC)**	**Developers** **Assure Group** (leading real estate company)

2.2 Roadmap

To provide an overview of targets, deadlines and milestones for an Action Plan towards achieving green and/ or nZEB buildings and communities in Bangladesh, a Roadmap (Figure 5) was developed. The development process comprised desk research and consultations with the key actors (KAs), and further details were added based on this project's results and the SWITCH-Asia SCP approach for the implementation of nZEB in the context of Bangladesh. Besides understanding the challenges and hurdles that can come up for stakeholders in the implementation of GBs and the possible mitigation measures to tackle them, it is important to look at case studies for methods and techniques that have achieved positive results in this field. Therefore, international and regional best practices were reviewed to learn from their successes. These examples showed different aspects of the process of implementation of the code, including financial mechanisms, compliance methods, and strategies for stakeholder engagement. The successful methods and techniques were assessed for their transferability to the Bangladesh context.

The activities of this assignment (stakeholder consultations, review of the current status of buildings, review of international good practices, and a multi-stakeholder meeting) provided an initial assessment of the constraints, gaps and opportunities that arise in the realm of GB in Bangladesh. This section elaborates how the Action Plan was developed from the activities of this assignment. From each activity, elements of the comprehensive roadmap were derived.

2.3 Tasks and work packages

2.3.1 Recommendations for key tasks

This section provides an overview of the tasks to be implemented to allow for a widespread uptake of GB and an associated GB code for Bangladesh, including recommendations from the KAs.

During consultations, stakeholders emphasised that **collaboration** is required among academic institutions and government organisations, especially those responsible for designing and constructing government buildings (e.g., Department of Architecture (DoA), Ministry of Housing and Public Works). Shortage of manpower in government organisations to work or research on green building can be mitigated by support from academia. Buildings designed by DoA, MoHPW, could be guided, vetted, evaluated and assessed by systematic research conducted by BUET. BUET could also arrange necessary training programmes for government architects for nZEB design and implementation. There is, therefore, a need to establish a bridge between academia and industry, and with time gradually strengthen the connection.

Community Involvement was identified as the first step of the bottom-up approach. The KAs suggested to start by **raising awareness on GB**, especially through community involvement from an early stage, to create a market demand for adoption and implementation of SCP in the building sector. To involve **private sector actors in different regions,** motivational meetings should take place with building owners, manufacturers and suppliers in each division of Bangladesh. Training programmes need to be organised for architects, engineers and planners all over the country. Quantitative data should be used to show the financial benefits of GB. Activities should include raising awareness among all stakeholders, engaging women in the decision-making process, launching programmes in all forms of media, conducting professional training programmes, promoting education, running campaigns, and supporting SMEs. In Bangladesh, the term 'Green Building' is often misunderstood, and is symbolised by plantation on roofs and facades of buildings. In this regard, **framing GB as nearly Zero Emissions Building** is more self-explanatory. In the future, setting targets for nZEB (instead of GB) can be helpful to communicate, disseminate and promote the use of innovative technologies to achieve sustainable goals, in addition to promoting investments in future-proof buildings.

Next, the **primary targets for GB** should be fixed, based on guidance from national and international codes but with the socio-cultural and economic conditions of Bangladesh clearly in focus. A potential GB code needs to be composed of objective measures and target-based standards. The KAs suggested at least a mandatory provision of yellow and grey water recycling and re-use, rain water harvesting, and use of efficient water fixtures. Developing a proper waste segregation and disposal policy should also be required. Many good practices for Green Building Codes exist within the EU and Asia; for example, the EU Energy Performance Building Directive, the EU Energy Efficiency Directive, Germany's Energy Savings Ordinance, Denmark's

Building Regulation 10, Sweden's Boverket's Building Regulation BBR18, Nepal's National Building Code, and China's 12th Five Year Plan. These could be used to benchmark the primary targets, but practitioners and experts would need to be consulted before finalisation of the primary targets.

Supplementary measures from the good practices could then be added to **inspire** developers and real estate companies to go beyond the minimum standards of the primary targets to prepare the industry towards implementation of nZEB design and development. Proposals and implementation strategies for financial support should be determined for buildings that consume less energy compared to the primary targets.

Pilot projects should then be built, and a post-occupancy evaluation carried out. Major or full subsidies for construction costs of GBs should to be provided by the government or international donors. Good practices suggest that demonstration and installation of pilot GB projects should be done with a life-cycle cost analysis to justify higher initial cost. After construction, validation and post-occupancy evaluation, necessary websites (for simple and typical cases) and software (for unique and complex cases) would need to be developed to help evaluate objectively the level of energy demand of a building or project for different sites and contexts. Another milestone to be added from the good practices would be that of **updating primary targets,** considering the actual consumption of pilot projects or model buildings constructed. The standards would need to be transferred to a performance-based rating system, and the rating system aligned with the global network.

The next step would be the development of a proposal and implementation strategies on how major or full **subsidy** for the construction cost of GB projects can be supported by government or international donors. The percentage of subsidy may be based on the level of energy/carbon efficiency achieved with respect to the pilot GB/nZEB projects or the estimated efficiency calculated by the developed website or software.

Investments for GB/nZEB projects would have to be promoted by **incentives,** such as affordable long-term financing; technical and construction assistance; favourable tax, VAT and import policies; and direct cash incentives. To design and construct GBs it is recommended that the GB code be followed. As an incentive, green channels in all government service offices, institutes and banks should give priority to GB projects for processing. Electricity sanctions could be based on cubic metre (volume of space), depending on the category of buildings. Finally, funds for new ideas and research on GB should be ensured.

The proposal and implementation strategies should be developed so that all **new buildings** are legally bound to be constructed according to the targeted standards. The use of renewables and energy efficient materials should be made mandatory. Flexibility and practicality have to be ensured by developing different GB codes for urban, suburban and rural areas and/or by building typology. A proposal and implementation strategies would also need to be developed to strengthen the code periodically through a public participation process.

Learning from good practices, green building implementation strategies for **existing buildings** are recommended to be added as a separate step. An Existing Buildings GB code for refurbishment, renovation and retrofits needs to be developed separately from the code for existing buildings. Post-occupancy energy verification should be carried out for compliance via measured values. Certification options need to be opened for existing buildings, and gradually for all buildings, using mandatory energy labelling with the option for upgrading.

The final step, as identified by the KAs, would be to ensure that all new buildings have an **energy label**. At the same time, objectively measured criteria for GB, for example, energy-use intensity (EUI); performance-based design; more mechanised processes of construction; and favourable tax, VAT, import policies and subsidies -- would need to be maintained.

2.3.2 Work packages

In order to put the recommended tasks into clear, achievable steps for the Action Plan, they have been arranged into 11 suggested Work Packages (WPs). To carry out the Action Plan, the KAs recommended that a Task Force be set up to lead the work. The focal point to lead such a Task Force should be a research-focused public university or a relevant government organisation. The lead organisation will form the Task Force with support from other educational, government, NGO and industrial partners. The 11 WPs should each be led by a partner organisation and be supported by one or two other organisations, as described below.

WP1: Formation of neZECoRI

Implementation of SCP in the housing and buildings sector in Bangladesh in the form of nZEB is needed to be achieved under a new Task Force set up at the national level proposed as the nearly Zero Emission Communities Research Institute (neZECoRI). The overall aim of the institute will be to implement nearly Zero Emissions Communities (neZECom). WP1 should be led by a public university or relevant government organisation and should be supported by an additional two partners. Ideally, three public universities, two government organisations, two NGOs, and five industrial partners would form the neZECoRI Task Force. Other organisations will be included if and when needed at different stages of the Action Plan. Further, an Executive Board will work alongside the neZECoRI. The Board will be composed of members from partner organisations.

Outputs

- Institutional setup of neZECoRI
- Formation of an Executive Board

WP2: Community involvement

WP2 should be led by NGOs and supported by government organisations. Under this WP, stakeholders should be involved from an early stage for adoption and implementation of SCP through different activities. The activities would include awareness raising among stakeholders; engaging women in the decision-making process; launching programmes in the media; widely displaying the importance of conservation; conducting training programmes; promoting education; running campaigns; improving the quality of life; providing safe, secure, affordable and accessible housing; developing livable urban spaces and buildings as part of the infrastructure, and therefore part of sustainable lifestyles; and supporting SMEs.

Outputs

- Posters, media programmes, training, and campaigns on neZECom

WP3: Primary targets

Public universities should lead WP3, and be supported by industrial partners. Primary targets for neZECom should be set by reviewing national and international standards, codes and rating systems (e.g., BEER and BNBC in Bangladesh, and nZEB in the EU). The code should be composed of objective measures and target-based standards that should be Specific, Measurable, Attainable, Relevant and Timely (SMART). Stakeholders pointed out that the building energy-efficiency standard widely practiced in Bangladesh (e.g., LEED), and also other standards available regionally, cannot be fully applicable or suitable in the local context, and would need further research and experimentation to change the threshold values. The primary targets for nZEB could be set from BEER developed by SREDA. BNBC could be further revised, updated and corrected in line with international compliance criteria. Different codes would be needed for rural areas. Universal accessibility, biological safety (e.g., from COVID), building safety (e.g., electrical safety, structural safety, safety from fire, explosions, chemicals and from climate change impacts) also need to be integrated with energy efficiency. Implementation of nZEB should be consistent with national policies, for example, National Adaptation Plan (NAP), Detailed Area Plan (DAP), Bangladesh Climate Change Strategy and Action Plan (BCCSAP), and Mujib Climate Prosperity Plan, all discussed in the GB Assessment Report of this SCPF assignment. Targets might vary for different time frames. Practitioners and experts should be consulted before finalisation of the primary targets.

Outputs

- Version 1: neZECom standard

WP4: Inspiration

WP4 should be led by industrial partners and supported by government organisations and NGOs. Under this work package, developers and real estate development companies should be encouraged to go beyond the minimum standards of 'Version 1: neZECom standard' developed under WP3, to prepare the industry towards implementation of an neZECom design. A proposal and implementation strategies for financial support should be determined for buildings that consume less energy compared to the 'Version 1: neZECom standard'. Innovative technologies and solutions, circularity of buildings, changes in lifestyle to reduce consumption and emissions, should also be promoted along with a voluntary labelling programme.

Outputs

- Proposal and implementation strategies for financial support
- Version 1: Outline of voluntary labelling

WP5: Pilot neZECom

WP5 should be led by public universities and supported by government organisations and industrial partners. Under WP5, demonstrations and installations of neZECom pilot projects should be carried out with a life-cycle cost analysis. After construction, a validation and post-occupancy evaluation website tool (for simple and typical cases) and software (for unique and complex cases) should be developed that can be used to evaluate the level of energy demand of a building or project objectively, for different sites and contexts.

Outputs

- Showcase neZECom projects
- Website and software to evaluate objectively the level of energy demand of a building or project for different sites and contexts

WP6: Updated targets

WP6 should be led by public universities and supported by government organisations and industrial partners. Thresholds and criteria for 'Version 1: neZECom standard' developed under WP3 should be updated after considering the actual consumption of pilot projects and model buildings constructed under WP5. neZECom standards should be transferred to a performance-based rating system, which will be aligned with the global GB network. For example, USGBC has already developed LEED Zero, a complement to LEED that verifies the achievement of net-zero goals in existing buildings. Under WP6 a Technical Committee composed of high-level government officials and experts should be formed to review and approve the updated targets. This committee should act as a standing committee, which will be responsible for approval of the GB code and legal framework over time.

Outputs

- Version 2: neZECom standard
- Version 2: performance-based rating system
- Formation of Technical Committee for review and approval

WP7: Government buildings

WP7 should be led by government organisations and supported by public universities. Under this work package all new government buildings and public buildings become "lighthouse" projects that showcase building types and technologies adapted to local contexts, and should start being designed as nearly Zero Emissions Buildings. Guidelines would be developed for neZECom design under different contexts and for different building types.

Outputs

- Showcase neZECom projects in each district, suburban and rural areas
- Guidelines for neZECom design under different contexts and for different building types

WP8: Subsidy

WP8 should be led by government organisations and supported by NGOs and industrial partners. A proposal and implementation strategies on how major or full subsidy of the construction cost can be supported by the government or international donors should be determined. The amount of subsidy should be based on the level of achieved energy/carbon efficiency with respect to the pilot neZECom projects or the estimated efficiency calculated by the website or software developed under WP5.

Outputs

- Proposal and implementation strategies for GB subsidies

WP9: Incentives

WP9 should be led by government organisations and supported by industrial partners. Investments for neZECom projects already proofed under WP5 should be promoted by affordable long-term financing; technical and construction assistance; favourable tax, VAT and import policies; and direct cash incentives.

Outputs

- Policies for incentives to support neZECom projects

WP10: New buildings

WP10 should be led by public universities and supported by government organisations and industrial partners. Under WP10, proposals and implementation strategies should be developed so that all new buildings will be legally bound to be constructed according to neZECom standards. Use of renewables and of only sustainable/local/circular materials will be mandatory. Flexibility and practicality should be ensured by developing different codes for urban, suburban and rural areas and/or by building typology. Proposals and implementation strategies should be developed to strengthen the codes periodically through a public process.

Outputs

- Different codes for urban, suburban and rural areas and/or by building typology
- Proposals and implementation strategies to strengthen the codes periodically

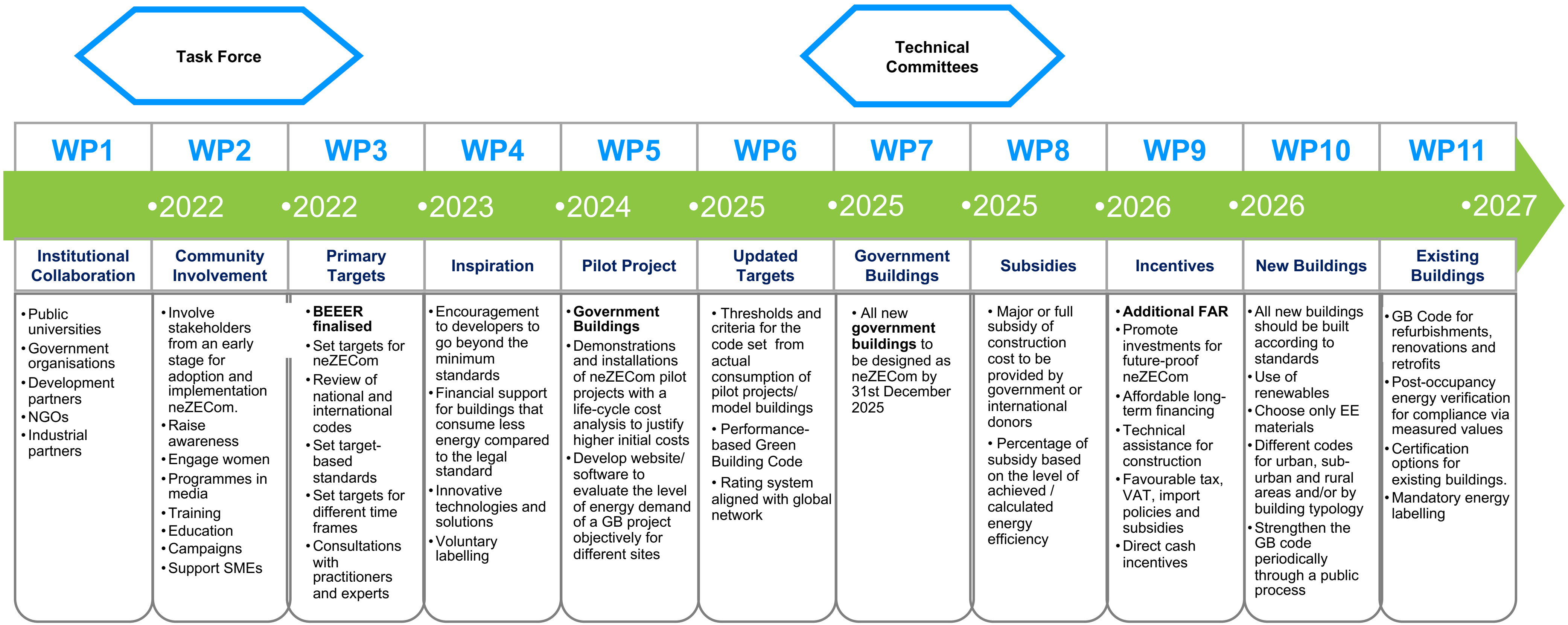
WP11: Existing buildings

WP11 should be led by public universities and supported by government organisations and NGOs. An neZECom code for refurbishments, renovation and retrofits should be developed. Post-occupancy energy verification should be done for compliance via measured values. Certification options should be open for existing buildings, and gradually all buildings will be stamped under a mandatory energy labelling. There will be scope for upgrading the label for an existing building by incorporating additional renewable sources, by reducing energy demands or by any effective measures.

Outputs

- neZECom code for refurbishments, renovation and retrofits
- Outline of mandatory energy labelling

Figure 5: Proposed Roadmap for implementation of a GB code in Bangladesh



Note: FAR: Floor Area Ratio; neZECom: nearly Zero Emission Communities; WP: Work Package.

2.3.3 Case study and provisions for the recommended GB pilot projects

Based on the focal areas of the Action Plan (social aspects, climate change mitigation and finance) the following provisions are presented as a case study for the implementation of GBs in Bangladesh.

Primarily partners from public universities, government organisations, NGOs and industry can form the neZECoRI with financial support from development partners (e.g., the European Delegation to Bangladesh, GIZ, World Bank). Other organisations can be included if and when needed at different stages of the operation. Innovative technologies and solutions will be promoted with voluntary or mandatory labelling/rating system under a Design for Environment and Sustainable Habitations (DESH) programme. The Bengali meaning of 'DESH' is 'country', as in the last part of the country's name BANGLA-DESH. The objectives of DESH will be to:

- Ensure that the design concept is appropriate to the local context;
- Eliminate negative environmental impact over the life cycle;
- Ensure sustainability for the future generation;
- Minimise energy demand during the life cycle of the development of habitations.

According to the Bangladesh Power Development Board (BPDB, 2016-2017), 50% of the total electric energy during the fiscal year 2016–17 was consumed by the domestic sector (Figure 6).

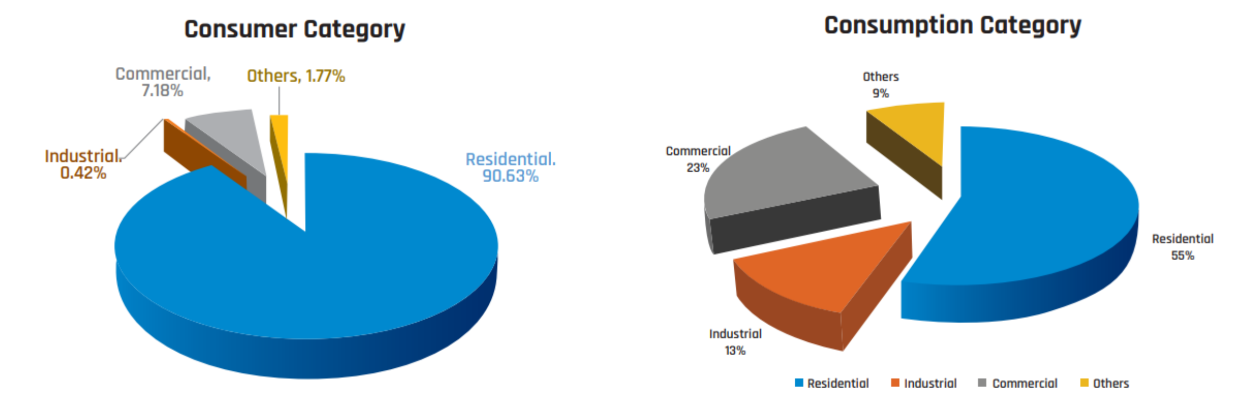


Figure 6: Sector-wise electric energy consumption

Source: DESCO, 2021

Similarly, according to the Annual Report 2020-2021 of Dhaka Electric Supply Company (DESCO), 90.63% of Dhaka's consumers were residential consumers and they consumed 55% of the total electricity (DESCO, 2021).

Some key reasons for energy inefficiency are:

- Ignoring the microclimate of the area and its characteristics in the process of designing building forms, their orientation and in zoning;
- Absence of passive architectural solutions to encourage low energy consumption;
- Relying on active electrical and mechanical systems for ventilation, lighting and cooling, such as air conditioning;
- Lack of knowledge of new or emerging technologies adaptable to or suitable for the local conditions;
- Failure to learn from the traditional and the local vernacular architecture for regional solutions;
- Lack of research-based design trials to adapt modern building technology to local architectural requirements.

With rapid development and increasing commercial and economic activities, a large number of buildings need to be accommodated in Dhaka. Deep plans are a common practice in medium and high-rise building designs. Many of the existing buildings in Dhaka have been constructed too close to each other, and the gaps between buildings and apartments are not enough to allow natural light and sufficient ventilation to ensure health and comfort, even though the building codes and setback rules set by the city authority, RAJUK, are followed (Paul et al., 2020). Natural light and ventilation not only conserve energy, they produce positive effects, both physiological and psychological (Edwards & Torcellini, 2002). To address green architecture under dense urban constraints, three goals can be set for architectural design:

- Integrating passive design features and energy conservation measures;
- Increasing energy efficiency; and
- Preventing and reducing environmental pollution.

It is important to reduce electricity consumption significantly as the first step towards nearly zero energy/emissions. In an experimental project at Mohammadpur in Dhaka, passive green architecture design features, such as the internal layout and window size of the apartments were changed during construction to reduce the need for artificial lighting, cooling and the use of certain electrical appliances. These design elements influenced the electricity consumption of the apartment significantly, as was found by a post-occupancy evaluation (POE). Daylight harvesting in the entire apartment helped to perform household tasks (even peeling and chopping tiny fish at floor level) without the help of artificial light. Daylight simulation analysis shows (Figures 7a & b), the internal deep spaces of the changed layout are well lit during the daytime all round the year. Artificial light is, therefore, not needed during daytime, and energy for lighting is needed only from evening to night.

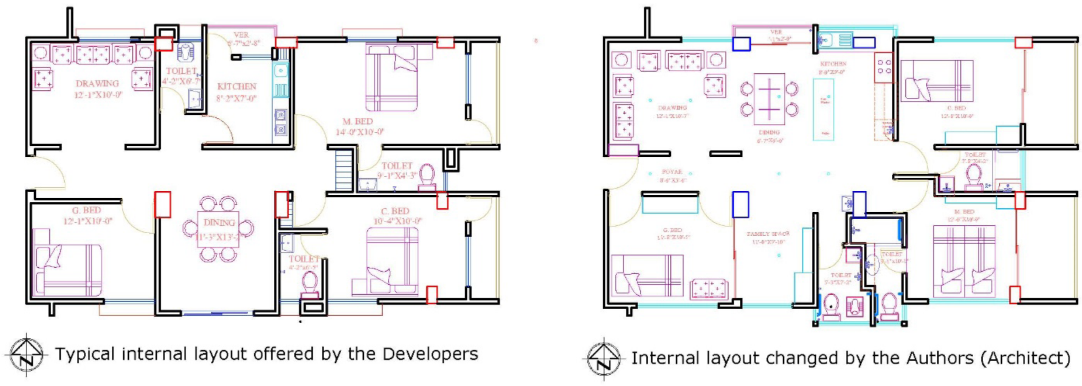


Figure 7a: Internal layout and window size of apartment changed to reduce the need of artificial lighting and cooling

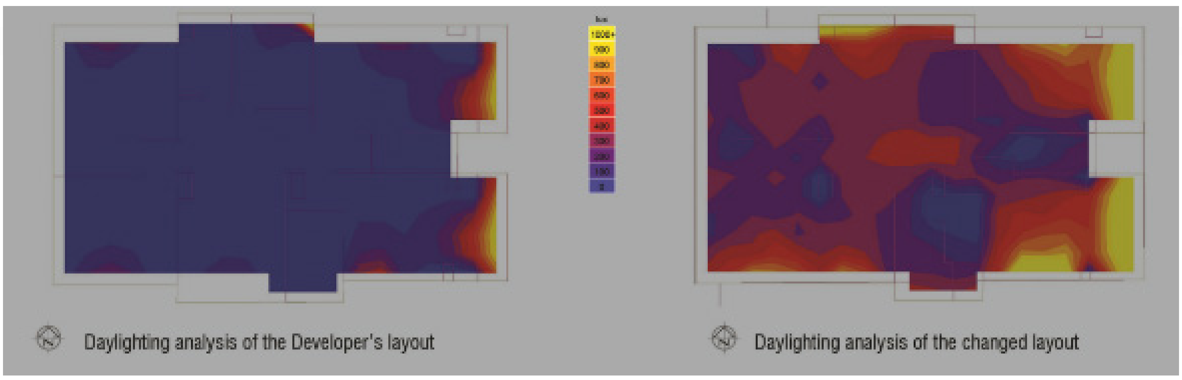


Figure 7b: Illumination maps of the changed layout of the apartment show significant increase in daylight

Provision of ample daylight ensures sufficient lighting throughout the daylight hours and cross ventilation throughout the year, which reduces the annual electricity use for lighting and cooling, and thus also the electricity bills of the apartment significantly. Monthly electricity bills ranged from Bangladeshi Taka (BDT) 143 (approx. US$ 2) in January 2020 (winter) to BDT 409 (approx. US$ 5) in August 2019 (summer) (Figure 8) (Joarder and Hossain, 2020).

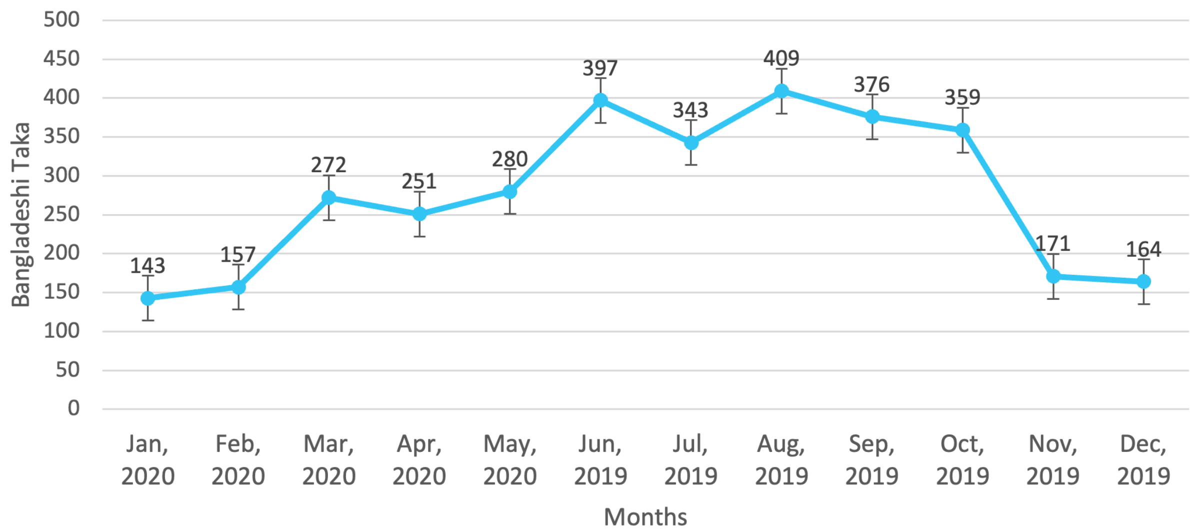


Figure 8: Actual electricity bills of the apartment round the year during 2019-2020

In this experimental project, to achieve precision, satisfy the standards and ensure sustainability, incorporation of Building Information Modelling (BIM) and Environmental Simulation experience in the decision-making process of Architectural and Mechanical, Electrical and Plumbing (MEP) design, under limited scope, resulted in a significant reduction in the monthly electricity bills of the apartment compared to those of identical apartments (Type C) located in the same building.

Figure 9 compares the monthly electricity bills of the case apartment (7C, Malancha) with those of two apartments of the same floor area located above and below the case apartment. The other two apartments have air conditioning systems installed. Electricity bills of the case apartment are 85% to 97% lower than of the other two apartments. The average of 12 months' electricity bills calculated for the three apartments showed that the case apartment's electricity bill (BDT 223 per month) was 90% lower than of the apartment located below (BDT 2193 per month), and 92% lower than of the apartment located above (BDT 2809 per month). Figure 10 shows the electricity bills of nine 'C Type' apartments in the building for September 2020. It is evident from the graphs that the electricity bills of the case apartment are 58% to 97% lower than those of the other eight apartments studied.

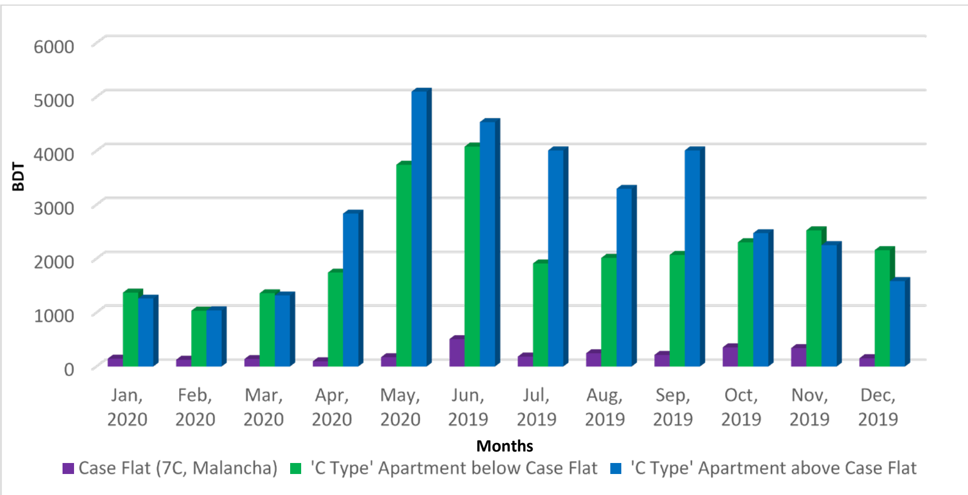


Figure 9: Comparison of actual monthly electricity bills of two 'C Type' apartments of same floor areas with the case apartment (7C, Malancha) for 2019-2020

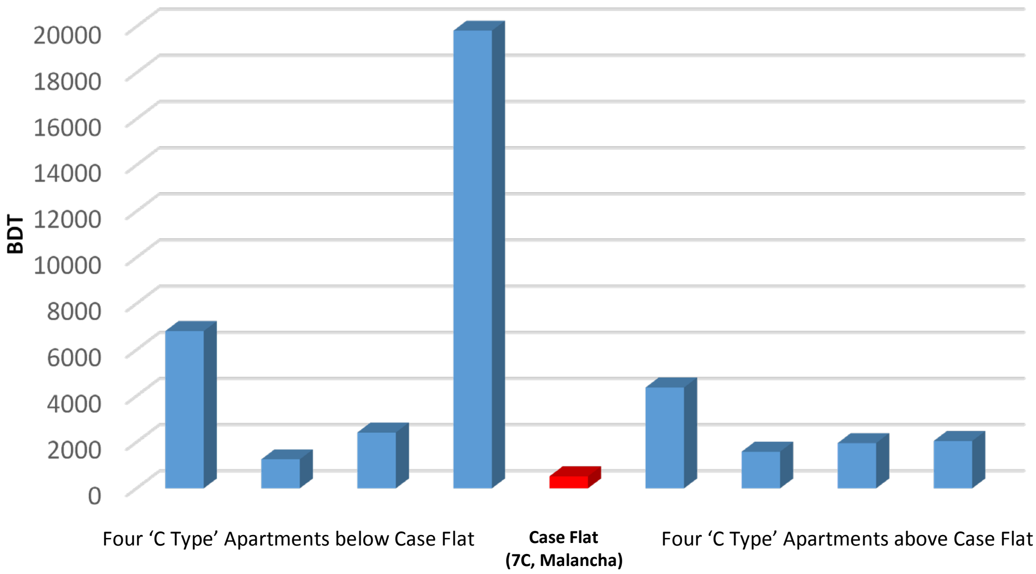


Figure 10: Comparison of electricity bills of nine ‘C Type’ apartments in the building, for September 2020

In the same apartment, it was later observed that the repair of an old deep freezer (its compressor was probably replaced with an older, energy intensive one) resulted in an increase of BDT 300 to 500 (approx. US$ 4 to 6) in the monthly electricity bills (Figure 11). This emphasises the practicality of following updated Nationally Determined Contribution (NDC) Targets (2021) for residential buildings to use using energy efficient household appliances.

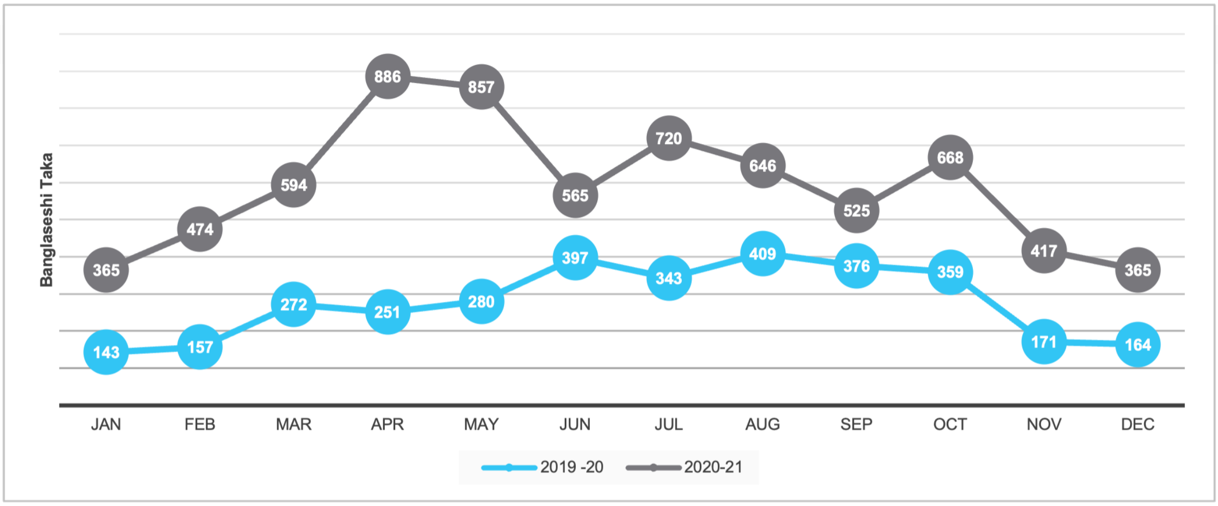


Figure 11: Comparison of electricity bills of the case apartment for 2019-20 and 2020-21

3. Conclusions

Many countries in the developed world, particularly in the EU, have achieved notable success in the implementation of GB. With several years' experience of GB practices, their knowledge, experience, technology and methodology can be transferred to the local context in Bangladesh. For speeding up the implementation of GB, both bottom-up (voluntary measures) and top-down (mandatory measures) approaches need to be considered while developing a GB Action Plan in the housing and buildings sector of Bangladesh. For the implementation of nearly zero-emission communities, a new and separate institutional setup is necessary. The institution will be responsible for undertaking collaborative research, experimenting, involving the community, setting primary targets and updating them periodically, designing and constructing pilot projects, formulating and updating policies for financing and incentives, following up for legal actions, etc. Bangladesh needs to start the process of developing a nZEB rating system in the regional context considering environmental aspects (e.g., geography, topography, site, climate, local building materials, labour experience and building techniques), use of resources available on-site, traditional technologies and involvement of the community.

This Action Plan has laid out the key stakeholders, tasks, a roadmap and steps for the successful implementation of a GB code or rating system based on an assessment of the current status of GB in Bangladesh, international best practices and numerous consultations with key stakeholders and actors from academia, professional associations, government organisations, real estate builders and developers, and civil society. The Action Plan provides a step-by-step guide for decision- and policy-makers in Bangladesh on how to institutionalise and formalise green buildings, while at the same time addressing the focal points of social, ecological and financial challenges.

References

BPDP. no date. *Annual Report 2016 – 2017*. Bangladesh Power Development Board. https://egcb.portal.gov.bd/sites/default/files/files/egcb.portal.gov.bd/page/44984a34_f32a_400f_aeb9_8118c980abfb/Annual_Report_16-17.pdf

Chel, A. and G. Kaushik. 2018. Renewable energy technologies for sustainable development of energy efficient building, *Alexandria Engineering Journal,* 57 (2), 655-669. doi: 10.1016/j.aej.2017.02.027

Das, D., R. Srinivasan and A. Sharfuddin. 2011. Fossil fuel consumption, carbon emissions and temperature variation in India. *Energy and Environment, 22* (6), 695-710. doi: 10.1260/0958-305X.22.6.695.

DESCO. 2021. *Annual Report 2020-2021*. Dhaka Electric Supply Company Limited, Dhaka, Bangladesh.

Edwards, L. and P. Torcellini. 2002. *Literature review of the effects of natural light on building occupants*. Technical Report. National Renewable Energy Laboratory. Golden, CO, USA. https://www.nrel.gov/docs/fy02osti/30769.pdf

EDGE. 2021. *What is EDGE?* Excellence in Design for Greater Efficiencies. International Finance Corporation. https://edgebuildings.com/about/about-edge/

GBIG. 2022. Bangladesh. Green Building Information Gateway. http://www.gbig.org/places/77

Joarder, M.A.R. and M. Hossain. 2020. Green ARCHITECTURE in absence of GREEN Color: Case study of real-life establishment under dense urban conditions. In M. Tamim et al. (eds). *Towards a Sustainable Future*, 45-61. Mujib Year Special Publication. SREDA. Dhaka, Bangladesh.

Mahmud, F. 2011. Buyers fleeced in name of ‘green buildings’. *The Independent*. 24 November 2011. Dhaka.

Mirdha, R.U. 2018. Green garment factory owners left frustrated. *The Daily Star*, 23 September 2018. https://www.thedailystar.net/business/news/green-garment-factory-owners-left-frustrated-1637248

Owusu, P.A. and S. Asumadu-Sarkodie. 2016. A review of renewable energy sources, sustainability issues and climate change mitigation. *Cogent Engineering,* 2016 (3). http://dx.doi.org/10.1080/23311916.2016.1167990

Paul, S., M.A.R. Joarder and S. Chowdhury. 2020. Exploring potentiality of lightpipe: Daylighting deep plan office buildings in Dhaka. Presented at 35th Passive and Low Energy Architecture (PLEA) Conference: Planning Post Carbon Cities. 1-3 September, 2020. A Coruña, Spain.

Renewcapa. 2012. Net Zero energy homes and Zero energy buildings. *energyPub*, November 1, 2012. https://energypub.blogactiv.eu/2012/11/01/net-zero-energy-homes-and-zero-energy-buildings/

Röck, M., M.R.M. Saade, M. Balouktsi, F.N. Rasmussen, H. Birgisdottir, R. Frischknecht, G. Habert, T. Lützkendorf and A. Passer. 2020. Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation. *Applied Energy,* 258. doi: 10.1016/j.apenergy.2019.114107

Salom, J., A. J. Marszal, J. Candanedo, J. Widén, K. B. Lindberg and I. Sartori. 2014. Analysis of load match and grid interaction indicators in net zero energy buildings with high-resolution data. *Towards Net Zero Energy Solar Buildings.* A report of Subtask A, IEA Task 40/Annex 52, March 2014.

SREDA. 2015. *Energy Efficiency and Conservation Master Plan up to 2030.* Sustainable and Renewable Energy Development Authority (SREDA) and Power Division, Ministry of Power, Energy and Mineral Resources, Government of the People’s Republic of Bangladesh.

Torcellini, P., S. Pless and M. Deru. 2006. Zero energy buildings: A critical look at the definition. *ACEEE Summer Study on Energy Efficiency in Buildings Conference,* Asilomar, Pacific Grove, California, August 2006, 417-428.

Wares, S. 2018. Climate change, sustainable tropical architecture and Bangladesh. Keynote paper presented at the 2nd International Conference on Green Architecture: Green Architecture in Achieving Sustainable Development Goals, 12-14 July 2018, Dhaka, Bangladesh. In Joarder, M.A.R. (editor). 2018. *Knowledge Dissemination, Utilization and Integration. GrACe Biennial Review: 2016 – 2018,* 32-33. Green Architecture Cell (GrACe), Department of Architecture (DoA), and BUET. https://online.fliphtml5.com/durxc/teqb/

WBGC. 2021. *Members Directory*. World Green Building Council. https://www.worldgbc.org/member-directory

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