GOVERNMENT OF INDIA
MINISTRY OF POWER

ECO-NIWAS SAMHITA 2021

(Code Compliance and Part-II: Electro-Mechanical and Renewable Energy Systems)

Bureau of Energy Efficiency
(Ministry of Power, Government of India)
www.beeindia.gov.in

GOVERNMENT OF INDIA
MINISTRY OF POWER

Eco-Niwas Samhita 2021

(Code Compliance and Part-II: Electro-Mechanical and Renewable Energy Systems)

Bureau of Energy Efficiency
(Ministry of Power, Government of India)
www.beeindia.gov.in

Eco Niwas Samhita 2021

Code Compliance and Part II – Electro-Mechanical and Renewable Energy Systems (Energy Conservation Building Code for Residential Buildings)

© 2021 Bureau of Energy Efficiency

Published by

Bureau of Energy Efficiency

4th Floor, Sewa Bhawan, R K Puram, New Delhi, India

No portion (graphics or text) of this Code may be reproduced, translated, or transmitted in any form or manner by any means – including but not limited to electronic copy, photocopy, or any other information storage and retrieval system without explicit written consent from Bureau of Energy Efficiency, New Delhi.

All rights reserved

Printed in New Delhi, India

1st Printed: July 2021

Printed on 100% recycled paper.

Contents

List of Steering Committee Members ..... *I*

List of Technical Committee Members ..... *III*

Code Development Team Members ..... *V*

Introduction *1*

Scope *3*

Code Compliance *5*

Mandatory Requirements *9*

Prescriptive Requirements *11*

Point System Method *15*

Terminology & Definitions *24*

Annex A-Embodied Energy *28*

Annex B-Best Construction Practice *31*

Annex C- Retrofitting of Residential Buildings *32*

Annex D- Improved Air Cooling *35*

Annex E-Smart Home *40*

अभय बाकरे, आईआरएसईई
महानिदेशक
ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

Preface

Bureau of Energy Efficiency has always believed that residential energy efficiency is the one of the most important aspect to ensure a sustainable tomorrow. Indian residential sector accounts for 25% of the current usage of energy and is projected to constitute 39% of the overall demand for energy in the country by 2047.

There are various challenges in implementing energy efficiency in residential sector. Residential sector is an unorganised sector with wide diversities. Standard of living, family structure, urban landscape, and individual preferences play a big role in residential energy use. Thus, the biggest challenge in front of BEE was to develop a single code which can fulfil the requirements within these diversities and yet have a simple compliance ground.

Ministry of Power and BEE has launched Eco Niwas Samhita 2018 (Part-I: Building Envelope) in 2018 focusing on the residential envelope design. I am happy to announce that Eco Niwas Samhita 2021 (Code Compliance and Part-II: Electro-Mechanical and Renewable Energy Systems). The vision of BEE for this code is to development a framework which addressed the wide diversity of residential building sector which is simple and implementable across the country with ease. Eco Niwas Samhita 2021sets the minimum standards for achieving code compliance and the benchmarks to achieve the minimum energy efficiency measures for buildings in two simple approaches – prescriptive system and point based system. These two approaches will ensure flexibility for designers for designing and constructing energy efficient residential buildings. The prescriptive approach is a set of standard check list to offer ease to compliance seeker where was the point based system is a comprehensive approach to ensure design flexibility, trade-offs, and innovative design decisions to ensure energy efficient built environment on optimised manner. The objective is to encourage design with passive design strategies and use of energy efficient electro- mechanical systems.

On behalf of BEE, I would like to thank the technical committee members, stakeholders and GIZ for their contribution. I hope this code will be useful to the policy makers, private sector and other key stakeholders.

Abhay Bakre
(Abhay Bakre)

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of Self and Nation
चौथा तल, सेवा भवन, आर.के.पुरम, नई दिल्ली–110 066 / 4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066
टेली / Tel.: 91 (11) 26178316 (सीधा / Direct) 26766700, फैक्स / Fax: 91 (11) 26178328
ई–मेल / E-mail : dg-bee@nic.in, abhay.bakre@nic.in, वेबसाईट / Website : www.beeindia.gov.in

Dr Winfried Damm
Cluster Coordinator Indo German Energy Program

India's aim is to reduce the emissions intensity of its gross domestic product (GDP) by 33 to 35 percent by 2030 from 2005 level. Any effort to achieve this target is contingent upon the increase in efficiency of energy use across all sectors, especially in the building sector. The building sector in India consumes over 30% of the total electricity consumed in the country annually and is second only to the industrial sector. With nearly two-third of the built infrastructure yet to come up till 2050, the nation calls for advancement and innovation in the construction sector. Out of the total electricity consumed in the building sector, about 75% is used in residential buildings. The energy demand in the domestic sector has been on the rise since the late 2000s, with increasing demand for appliance ownership, especially of fans and televisions in urban and rural areas, and an increase in refrigerators and air conditioners in urban areas. Electricity consumption increased from 146 BU in 2009-10 to 280 BU in 2018-19 with CAGR of 6.74%. According to India Cooling Action Plan, approximately 8% of the current households have room air conditioners. This is anticipated to rise to 21% and 40% in 2027-28 and 2037-38 respectively. The demand for air-conditioning will continue its exponential growth with improvement in household incomes and will become the dominant contributor of GHG emissions nation-wide owing to increased electricity consumption. This situation calls for an immediate energy conservation action plan. Building energy codes have been adopted as a regulatory measure for ushering energy efficiency in the building sector by many countries. In India, Energy Conservation Act, 2001 provides the basic framework for regulating all initiatives relating to the efficient use of energy include building energy codes. The commercial sector among buildings has been addressed through Energy Conservation Building Code (ECBC) for Commercial Buildings. Given the current and anticipated rapid growth in the residential building stock across India and the consequent opportunities as well as the necessity for energy conservation in this sector, the Energy Conservation Code for residential Buildings (EcoNiwas Samhita Part I) was launched by the Ministry of Power to set minimum building envelope performance requirements to limit heat gains (for cooling dominated climates) and to limit heat loss (for heating dominated climates), as well as for ensuring adequate natural ventilation and daylighting potential.

GIZ is implementing the Indo-German Energy Programme (IGEN) on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). The Energy Programme promotes measures to improve energy efficiency and integrate renewable energy into the grid. Under this programme, The Eco-Niwas Samhita (Part II) has been developed and is an integrated code specifying minimum energy performance requirements for building envelope as mentioned in ENS Part I, building services, electrical end-use and renewable energy system. The code also provides five appendices for annualised embodied energy, better construction practices, retrofitting of residential buildings, improved air cooling and Smart Home, which are recommendatory in nature and envisaged to be added in future revision of the code. The purpose of EcoNiwas Samhita Part-II is to provide the minimum requirements for building envelope, building services, indoor-electrical end-use and renewable energy systems for new residential buildings. As a policy driver for guiding building construction, the EcoNiwas Samhita is a progressive and future-fit code and will push the residential building sector towards net zero energy targets. The code also supports many of the Government of India's objectives for achieving energy security, economic growth

and environmental sustainability. GIZ is proud to be associated with Bureau of Energy Efficiency and the Ministry of Power on such a progressive and innovative residential building energy code, EcoNiwas Samhita (Part II).

I congratulate Bureau of Energy Efficiency and the Ministry of Power on the launch of EcoNiwas Samhita (Part II). This code can be a transformative and guidance tool for integrating energy efficiency in all new residential buildings.

Winfried Damm

Acknowledgment

Sh. Saurabh Diddi
Director, Bureau of Energy Efficiency

Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India has been engaged in several initiatives to design and implement energy efficiency programs. To set the minimum performance standard for residential buildings, BEE in association with Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) India has developed Eco Niwas Samhita 2021 (Code Compliance and Part-2: Electro-Mechanical and Renewable Energy Systems) and is now ready for launch.

India is rapidly urbanising because of the accelerating economy. In the future, these changes will have implications for energy demand especially in the residential sector. The electricity demand in residential sector has been increasing at a CAGR of 8% per year on average. The residential sector will become the largest consumer of electricity in the country with 36.5% share of the total electricity consumed in 2032.

Recognising this, Eco Niwas Samhita 2018 (Part-I: Building Envelope), the residential building energy code, was launched by the Ministry of Power in December 2018. Eco Niwas Samhita 2021 (Code Compliance and Part-II: Electro-Mechanical and Renewable Energy Systems) is developed to set the minimum benchmark to achieve energy efficiency in residential buildings. The code is focused on electro-mechanical and renewable services in addition to the envelope parameters as prescribed in Eco Niwas Samhita 2018.

This code has been possible with 8 consultation meetings in various cities namely – Chandigarh, Lucknow, Vijayawada, Chennai, Bangalore, Mumbai, Ahmedabad, and Jaipur. I want to thank the State Designated Agencies, Urban Development Departments, and professional experts in all these cities for giving their comments in the development of the code. I also want to thanks the officials from Urban Local Bodies, Public Works Departments, Confederation of Real Estate Developers Association of India, National Real Estate Development Council, The Indian Society of Heating, Refrigerating and Air Conditioning Engineers, and Indian Institute of Architects for giving time and sharing expertise in the various one to one meeting organised in Shimla, Lucknow, Chandigarh, Mumbai, Pune, Bengaluru, and Chennai. Their comments have shown us the correct path for the code development and what exactly is needed by the industry. I want to also thank the Steering Committee and Technical Committee members for all their valuable feedback

The development of code was a comprehensive exercise completed within a strict deadline and needed technical expertise and innovative ideas to meet the different challenges. Eco Niwas Samhita 2021 would not have been possible without the commitment and support of officers from BEE beginning with Mr. Abhay Bakre, Director General, BEE, and Ms. Akanksha Krishan, Sector Expert, BEE. I also acknowledge the efforts of Mr. S. Vikash Ranjan, Programme Manager, GIZ, Mr. Govinda Somani, Technical Expert, GIZ and Mr. Abdullah Nisar Siddiqui, Technical Expert, GIZ towards the development and finalisation of Eco Niwas Samhita 2021.

I strongly believe that this code will be helpful in enhancing the growth of energy efficiency in residential buildings and making India energy efficient.

List of Steering Committee Members

Mr. Abhay Bakre, Director General – Chair
Bureau of Energy Efficiency

Mr. Saurabh Diddi, Director
Bureau of Energy Efficiency

Mr. G. K. Gupta, Joint Secretary,
Ministry of New and Renewable Energy (MNRE)

Mr. Amrit Abhijat, JS & Mission Director (HFA)
Ministry of Housing and Urban Affairs (MoHUA)

Mr. Sanjay Pant, Scientist and Director (Civil Engg),
Bureau of Indian Standards

Mr. Srinivas/Dr. Pawan Kumar, Town Planner,
Town and Country Planning Organization (TCPO)

Mr. V. Ramudu, Director
CRDA Office

Mr. Sunit Mathur, General Manager (EC)
Rajasthan Renewable Energy Corporation Ltd (RRECL)

Mr. G.V Balaram, Managing Director
Karnataka Renewable Energy Development Limited (KREDL)

Ms. Smita Kudarikar, General Manager
Maharashtra Energy Development Agency

Mr. Balkar Singh,
Punjab Energy Development Agency

Mr. Geetambar Anand, Chairman
Confederation of Real Estate Developers Associations of India (CREDAI)"

Ms. Preeti Singh, Deputy Director General
NAREDCO

Mr. Sanjay Seth, CEO,
Green Rating for Integrated Habitat Assessment (GRIHA)

Mr. S. Vikash Ranjan, Project Manager, Energy Efficiency Building Programme
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Dr. Anand Shukla, Senior Thematic Advisor (Energy),
Swiss Agency for Development & Cooperation

Dr. Apurva Chaturvedi, Project Specialist-Climate Change & Clean energy
United States Agency for International Development (USAID)

Mr. Vijay Garg, Vice-President,
Council of Architecture (COA)

Ms. Mili Majumdar, Managing Director
Green Business Certification Inc. (GBCI)

Mr. M. Anand, Principal Counsellor
Indian Green Building Council, CII-Sohrabji Godrej Green Business Centre

Mr. Gohul Deepak,
Glazing Society of India (GSI)

Ms. Shruti Narayan,
International Finance Corporation

Mr. Autif Mohammed Sayyed
International Finance Corporation

Mr. Reginald John Sinclair
Confederation of Real Estate Developers' Associations of India

Mr. Mahesh Manisamy
Karnataka Renewable Energy Development Limited

Ms. Priyam Tewari
The Energy and Research Institute

List of Technical Committee Members

Mr. Saurabh Diddi, Director, Chair
Bureau of Energy Efficiency

Ms. Akanksha Krishan, Sector Expert
Bureau of Energy Efficiency

Mr. Jyotirmay Mathur, Professor
Malviya National Institute of Technology, Jaipur

Mr. Vishal Garg, Professor
IIIT Hyderabad

Ms. Mili Majumdar, Managing Director
Green Business Certification Inc. (GBCI)

Mr. Sanjay Seth, CEO,
Green Rating for Integrated Habitat Assessment (GRIHA)

Mr. Sanjay Pant, Scientist and Director (Civil Engg),
Bureau of Indian Standards

Mr. S. Vikash Ranjan, Project Manager, Energy Efficiency Building Programme
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Mr. Govinda Somani, Technical Expert, Energy Efficiency Building Programme
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Mr. Abdullah Nisar Siddqui, Technical Expert, Energy Efficiency Building Programme
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Ms. Snigdha Devi, Technical Consultant, Energy Efficiency Building Programme
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Dr. Anand Shukla, Senior Thematic Advisor (Energy),
Swiss Agency for Development & Cooperation,

Mr. Sunit Mathur, General Manager (EC)
Rajasthan Renewable Energy Corporation Ltd (RRECL)

Mr. G.V Balaram, Managing Director
Karnataka Renewable Energy Development Limited (KREDL)

Ms. Smita Kudarikar, General Manager
Maharashtra Energy Development Agency

Mr. Balkar Singh,
Punjab Energy Development Agency

Mr. Sushil Kumar Patel, Director
Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA)

Mr. T C Sharma, Senior Manager
Energy Efficiency and Renewable Energy Management Centre, Delhi

Mr. Navjot Pal Singh Randhawa, PCS Chief Executive
Punjab Energy Development Agency (PEDA), Punjab

Mr. G C Modgil, Founder
Sterling India

Mr. Ashok B Lall, Principal Architect
A B Lall Architects

Mr. Tanmay Tathagat, Executive Director
Environmental Design Solutions

Ms. Hina Zia, Dean, Architecture and Ekistics
Jamia Millia Islamia

Ms. Shweta Manchanda, Associate Professor
School of Planning and Architecture, Delhi

Mr. Reginald John Sinclair, General Manager-Projects
CREDAI

Ms. Preeti Singh, Deputy Director General
NAREDCO

Mr. Abhijit Dutta, General Manager
DLF Ltd

Mr. Sandeep Roy, Head-Design
AIPL

Mr. Hisham Ahmad
Environmental Design Solutions

Mr. Gurneet Singh
Environmental Design Solutions

Mr. Sameer Maithel
Greentech Knowledge Solutions Pvt. Ltd.

Ms. Vernica Prakash Kapoor
Greentech Knowledge Solutions Pvt. Ltd.

Mr. Apoorv Vij
Green Business Certification Inc.

Mr. Ranjan Mishra
VMC Management Consulting

Mr. Prashant Bhanware
GKSPL

Code Development Team

Bureau of Energy Efficiency

Mr. Abhay Bakre, Director General

Mr. Saurabh Diddi, Director

Ms. Akanksha Krishan, Sector Expert

Ms. Anju Singh, Project Engineer

Ms. Meenal Anand, Sector Expert

Ms. Shatakshi Suman, Sector Expert

Mr. Vineet Mall, Sector Expert

Ms. Meenakshi, Project Engineer

Mr. Pankaj Sharma, Project Engineer

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Mr. S. Vikash Ranjan, Project Manager

Mr. Govinda Somani, Technical Expert

Mr. Abdullah Nisar Siddqui, Technical Expert

Ms. Snigdha Devi, Technical Consultant

Legal Team

Mr. Vedant Pujari, Accures Legal

Ar. Jatinder Kaur, School of Planning & Architecture

Introduction 1

1.1 India's aim is to reduce the emissions intensity of its gross domestic product (GDP) by 33 to 35 percent by 2030 from 2005 level. Any effort to achieve this target is contingent upon the increase in efficiency of energy use across all sectors, especially in the building sector. The building sector in India consumes over 30% of the total electricity consumed in the country annually and is second only to the industrial sector.

1.2 As per Energy Statistics 2020 released by Ministry of Statistics and Programme Implementation (MoSPI), total energy demand by various sectors for FY 2018–19 is about 569.5 Mtoe[1], out of which residential (domestic) sector consumes about 52.04 Mtoe, which is 9.1% of total primary energy consumption.

1.3 The total electricity demand for FY 2018–19 is about 1158 Billion Units (BU)[2]. Domestic sector consumes about 280 Billion Units which is about 24.2% of total electricity consumption. The energy demand in the domestic sector has been on the rise since the late 2000s, with increasing demand for appliance ownership, especially of fans and televisions in urban and rural areas, and an increase in refrigerators and air conditioners in urban areas. Electricity consumption increased from 146 BU in 2009-10 to 280 BU in 2018-19 with CAGR of 6.74%.

1.4 It is estimated that, domestic sector will consume about 769 TWh[3] of electricity and 98.6 Million toe[4] of energy in 2031. Out of the total electricity consumed in the building sector, about 70% is consumed in the residential buildings.

1.5 According to India Cooling Action Plan, approximately 8% of the current households have room air conditioners. This is anticipated to rise to 21% and 40% in 2027-28 and 2037-38 respectively. The demand for air-conditioning will continue its exponential growth with improvement in household incomes and will become the dominant contributor of GHG emissions nation-wide owing to increased electricity consumption. This situation calls for an immediate energy conservation action plan.

1.6 Energy codes for new buildings are an important regulatory measure for ushering energy efficiency in the building sector. ***Eco Niwas Samhita 2018 (Part-I: Building Envelope)*** was launched in 2018 to set minimum building envelope performance requirements to limit heat gains (for cooling dominated climates) and to limit heat loss (for heating dominated climates), as well as for ensuring adequate natural ventilation and daylighting potential.

1.7 The ***Eco Niwas Samhita 2021 (Code Compliance and Part-II: Electro-Mechanical and Renewable Energy Systems)*** is a code specifying code compliance approaches and minimum energy performance requirements for building services, indoor electrical end-use and renewable energy system.

1 Energy Statistics 2020, Ministry of Statistics and Programme implementation
2 Energy Statistics 2020, Ministry of Statistics and Programme implementation
3 UNlocking NATional Energy-Efficiency potential (UNNATEE), Bureau of Energy Efficiency, Ministry of Power
4 UNlocking NATional Energy-Efficiency potential (UNNATEE), Bureau of Energy Efficiency, Ministry of Power

1.8 The code also provides following five appendices which are recommendatory in nature and envisaged to be added in future revision of the code.

Annex A: Annualized embodied energy

Annex B: Better construction practices

Annex C: Retrofitting of residential buildings

Annex D: Improved air cooling

Annex E: Smart Home

Scope 2

2.1 The purpose of ***Eco Niwas Samhita 2021 (Code Compliance and Part-II: Electro-Mechanical and Renewable Energy Systems)*** (hereinafter referred to as ***'ENS-C&2')*** is for code compliance and to provide the minimum requirement(s) for building services, electro-mechanical and renewable energy systems for new residential buildings.

2.2 The code applies to –

2.2.1 Residential buildings built on a plot area[5] of ≥ 500 m^2

2.2.2 Residential part of Mixed land-use building projects[6], built on a plot area of ≥ 500 m^2.

2.3 The code is also applicable for all additions made to existing residential buildings where the existing building exceeds the threshold defined in section 2.2 of the ENS-C&2. For this purpose, the addition together with the existing residential building is required to show compliance with ENS-C&2 with the authority having jurisdiction.

2.4 The code is also applicable for all alterations made to existing residential buildings where the existing building exceeds the threshold defined in section 2.2 of the ENS-C&2 and the alteration, part of the building or its system, is been done for an area more than 1000 square feet. For this purpose, the part of the building or its systems that are being altered is required to show compliance with ENS-C&2 with the authority having jurisdiction.

2.6 The code sets minimum requirement for all building envelope parameters as mentioned in ***Eco Niwas Samhita 2018 (Part I: Building Envelope).***

2.7 The ENS-C&2 sets minimum requirements for electro-mechanical systems used in building services (i.e. common area and exterior lighting, elevators, pumps, basement ventilation, transformers, power distribution losses, power factor correction, electrical vehicle supply equipment etc.) and indoor electrical end-use (i.e. indoor lighting, comfort systems, service hot water etc.).

2.8 The ENS-C&2 sets minimum requirements for renewable energy systems (Solar hot water requirements and Solar Photovoltaic) integration.

2.8 If a building project has more than one building block in multiple orientations, then compliance must be sought by showing that building block meet the performance requirements in each of the four-cardinal orientation (north, south, east, west). However, for identical building blocks with the same orientation, the compliance must be shown for one building block.

5 States and municipal bodies may change the plot area based on the prevalence in their area of jurisdiction.

6 However, residential accommodation in a building, where the carpet area of the residential part is not more than 30 m2 for caretakers or persons employed in connection with the building, is exempted.

2.9 The following codes, programs, and policies will take precedence over the code in case of conflict:

2.9.1 Any policy notified as taking precedence over this Code, or any other rules on safety, security, health, or environment by Central, State, or Local Government.

2.9.2 BEE's Standards and Labelling for appliances and Star Rating Program for buildings, or any reference standard prescribed by the Code, provided both or either are more stringent than the requirements of this Code.

Code Compliance 3

3.1 Compliance Approaches

3.1.1 In order to demonstrate compliance with the code, the building shall comply with all of the mandatory requirements stated in Chapter 4 along with either of the two approaches

a) Prescriptive approach as mentioned in Chapter 5

b) Points based system approach as mentioned in Chapter 6

3.1.2 Table 1 below gives the minimum ENS score required to be obtained as per eligible project category:

Table 1: Minimum ENS Score Requirement

Project Category	Minimum ENS Score
Low rise buildings	47
Affordable Housing	70
High rise buildings	100

3.1.3 Low Rise Buildings: A building equal or below 4 stories, and/or a building up to 15 meters in height (without stilt) and up to 17.5 meters (including stilt).

3.1.4 Affordable Housing Projects: Affordable houses are Dwelling Units (DUs) with Carpet Area less than 60 sqm. It also includes Economically Weaker Section (EWS) category and Lower Income Group (LIG) category (LIG-A: 28-40 sq. m. and LIG-B 41-60 Sq.m.). For details, refer chapter 7.

3.1.5 High Rise Buildings: A building above 4 stories, and/or a building exceeding 15 meters or more in height (without stilt) and 17.5 meters (including stilt).

3.1.6 Compliance for Mixed Mode Buildings

a) In a mixed-use building, having both commercial and residential building use, each category of a building use must be classified separately, and –

i. If a part of the mixed-use building classification (residential or commercial) is less than 10% of the total above grade floor area, the mixed-use building part shall show compliance based on the building sub-classification having higher percentage of above grade floor area.

ii. If a part of the mixed-use building has different classification (residential or commercial) and one or more sub-classification is more than 10% of the total above grade floor area, the compliance requirements for each sub-classification,

having area more than 10% of above grade floor area of a mixed-use building, shall be determined by the requirements for the respective building classification.

iii Basement and common area services, designed for a particular building use or documented with respective buildings for compliance with authority having jurisdiction, needs to show compliance with the clauses for the respective building requirement.

b) In a mixed mode building with different category of residential buildings in the same project and including one or more category listed in 3.1.2 (low rise building, affordable housing, and/ or High-rise building)

i. Compliance for site marked for affordable housing, as per the applicable bye law, shall be shown separately.

ii. The overall point to be achieved for ENS building for site marked for affordable housing is 70.

iii If the site area with low rise buildings in the overall project is more than or equal to 20% of the total site area, the site marked for low rise building, as per the applicable bye law, shall be shown separately to other residential building type. The overall point to be achieved for ENS building for the site marked for this low-rise building is 47.

iv. If the site area with low rise buildings in the overall project is less than 20% of the total site area, the site marked for low rise building, as per the applicable bye laws, shall be shown together with other residential building category. The overall point to be achieved for ENS Compliance for the overall site is 100. In such projects:

1. Mandatory points – compliance to be shown only for the components which are provided in the project and is necessary as per the applicable building bye law.

2. Additional points –

a. to claim the additional points of any component in building services and indoor area services mentioned in section 6.5 and 6.6, except for requirements for basement lighting, project needs to install the component for minimum 80% of the total above grade area (AGA) or for component designed for 80% of total AGA.

b. to claim the additional points for requirements of basement lighting mentioned in section 6.5, ENS building to show compliance for total basement area designed in the project and as per applicable building by-law.

c. to claim the additional points of any component in building envelope mentioned in section 6.4, project needs to install the component as mention in section of the component for overall project.

3.1.7 Prescriptive Method

i. In order to demonstrate compliance with the code through the Prescriptive Method, the ENS building shall meet mandatory requirements specified under chapter 4 and all prescriptive requirements as per chapter 5, for compliance purpose.

3.1.8 Point System Method

i. In order to demonstrate compliance with the code through the Point System Method, the ENS building shall meet all applicable mandatory requirements specified in chapter 4 and obtain a minimum ENS Score as per section 6.1 in chapter 6, for this purpose:

- All Low-rise residential buildings must obtain minimum 47 points from 'Building Envelope' under section 6.4.
- All Affordable housing scheme must obtain minimum 70 points from 'Building Envelope', and 'Building Services' under section 6.4 and 6.5 respectively.
- All High-rise residential buildings must obtain minimum 100 points from 'Building Envelope' and 'Building Services', 'Indoor Electric End-Use' and 'Renewable Energy Systems' under section 6.4, 6.5, 6.6 and 6.7, respectively.
- The Table 2 below gives the component wise distribution of points for each building component to achieve minimum ENS Score.

Table 2: Component wise Distribution of ENS Score

Section	Components	Minimum points	Additional Points	Maximum Points
6.4	Building Envelope			
	Building Envelope	47	40	87
6.5	Building Services			
	Common area and exterior lighting	3	6	9
	Elevators	13	9	22
	Pumps	6	8	14
	Electrical Systems	1	5	6
6.6	Indoor Electrical End-Use			
	Indoor Lighting		12	12
	Comfort Systems		50	50
	ENS Score	70	130	200

ii. The code also provides additional 20 points for renewable energy as mentioned in Table 3 which can be availed after fulfilling the minimum points criteria as per Table 3.

Table 3: Score for Renewable Energy System Components

Section	Components	Minimum Points	Additional Points	Maximum Points
6.7	Renewable Energy Systems			
	Solar Hot Water Systems		10	10
	Solar Photo Voltaic		10	10
	Additional ENS Score		20	20

iii. In order to demonstrate compliance with the code using Point System Method, the ENS building must obtain the applicable minimum points as specified under section

6.1 and get remaining points by:

a. meeting the requirements labelled as 'additional points' of building envelope under section 6.4; and/or

b. meeting the requirements labelled as 'additional' of 'Building Services' & Indoor Electric End-Use under section 6.5 & 6.6; and/or

c. meeting the requirements labelled as 'additional' of 'Renewable Energy Systems' under section 6.7.

iv. The mandatory points or additional points shall be assigned as per the least energy efficient specification of all the products installed under a category in the building, unless the trade off or weighted average is allowed for the particular category.

v. In a mixed mode building category, energy efficiency measure applied in the common services and installed at a overall site level shall meet the most stringent specification requirement among the mentioned requirements in different categories of building to claim the mandatory and additional points.

vi. To claim the points under the Renewable Energy Systems section, the renewable energy system can be installed collectively at the site level or installed collectively at one or more roofs as per the total renewable energy installation requirement.

3.2 Documentation

3.4.1 Construction drawings and specifications shall show all pertinent data and features of the building, equipment, and systems in sufficient detail to permit the authority having jurisdiction to verify that the building complies with the requirements of this code.

3.4.2 Details shall include, but are not limited to:

i. Building envelope: opaque construction materials and their thermal properties including thermal conductivity, specific heat, density along with thickness; fenestration U-factors, solar heat gain coefficients (SHGC), visible light transmittance (VLT); overhangs and side fins and operable window area;

ii. Building services: Common area lighting (lamp efficacy for lamps and their controls); pump efficiencies; elevator technologies and their controls; transformer losses; power distribution losses; power factor correction devices; basement ventilation controls; efficiency of charging infrastructure and electric check metering and monitoring system;

iii. Indoor electrical end-use: Indoor lighting (type, number, and wattage of lamps and ballasts; automatic lighting shutoff, occupancy sensors, and other lighting controls); ceiling fans star labelling; service hot water type and their efficiency; air-conditioners (system and equipment types, sizes, efficiencies, and controls);

iv. Renewable energy systems: system peak generation capacity, solar water heating system; technical specifications, renewable energy zone area.

3.3 Compliance Tool

3.5.1 The compliance with the code can be demonstrated using the software/toolkit that has been approved by the BEE or authority having jurisdiction.

Mandatory Requirements 4

4.1 Building Envelope

4.1.1 All requirements for building envelope under mandatory section as mentioned in Chapter 4 of ENS Part I.

4.2 Power Factor Correction

4.2.1 All 3 phase shall maintain the power factor of 0.97 at the point of connection.

4.3 Energy Monitoring

4.3.1 Residential buildings exceeding the threshold defined under section 2.2 of this code shall monitor the electrical energy use for each of the following separately:

i. Total electrical energy

ii. Electricity consumption of following applicable end-use:

a. Common area lighting (Outdoor lighting, corridor lighting, basement lighting)

b. Elevators

c. Water pumps

d. Basement car parking ventilation system

e. Electricity generated from power back-up

f. Electricity generated through renewable energy systems

g. Lift pressurization system

4.3.2 The electrical energy use shall be recorded at an interval of minimum of every 15 minutes and reported at least hourly, daily, monthly and annually. The monitoring equipment should be capable of transmitting the data to the digital control system/ energy monitoring information system. The digital control system shall be capable of maintaining all data collected for a minimum of 36 months.

4.3.3 The metering shall display current (in each phase and the neutral), voltage (between phases and between each phase and neutral), and total harmonic distortion (THD) as a percentage of total current in case of transformers.

4.4 Electric Vehicle Charging System

4.4.1 If an Electric Vehicle Charging Infrastructure is installed in the premise, it shall be as per revised guidelines issued by Ministry of Power for Charging Infrastructure for Electric Vehicles on 1st October 2019, or any subsequent amendments.

4.5 Electrical Systems

4.5.1 The power cabling shall be sized so that the distribution losses shall not exceed 3% of the total power usage in the ENS building. Record of design calculation for the losses shall be maintained. Load calculation shall be calculated up to the panel level.

4.5.2 Voltage drop for feeders shall not exceed 2% at design load. Voltage drop for branch circuit shall not exceed 3% at design load.

Prescriptive Requirements 5

5.1 Building Envelope

5.1.1 All requirements for building envelope including Openable Window-to-Floor area ratio, Visible Light Transmittance, as mentioned in chapter 4 of ENS Part I.

5.1.2 The Residential Envelope Transmittance Value (RETV) for the building envelope (except roof) for four climate zones, namely, Composite Climate, Hot-Dry Climate, Warm-Humid Climate, and Temperate Climate, shall comply with the maximum RETV of 12 W/m^2. Thermal transmittance of building envelope for cold climate shall comply with the maximum U value of 1.3 W/m^2·K.

5.1.3 Thermal transmittance of roof shall comply with the maximum U_{roof} value of 1.2 W/m^2·K.

5.2 Common Area and Exterior Lighting

5.2.1 The Lighting power density (LPD) and Luminous efficacy (LE) of permanently installed lighting fixtures in common area of the ENS compliant building shall meet the requirements of either maximum LPD or minimum luminous efficacy given in Table 4.

Table 4: Common Area Lighting Requirements

Common Areas	Maximum LPD (W/m^2)	Minimum luminous efficacy (lm/W)
Corridor lighting & Stilt Parking	3.0	All the permanently installed lighting fixtures shall use lamps with an efficacy of at least 105 lumens per Watt
Basement Lighting	1.0	All the permanently installed lighting fixtures shall use lamps with an efficacy of at least 105 lumens per Watt

5.2.2 When the exterior lighting load is more than 100 W, the permanently installed lighting fixtures shall use lamps with an efficacy of at least 105 lumens per Watt or meet the maximum LPD requirements given in Table 5.

Table 5: Outdoor Lighting Requirement

Exterior Lighting Areas	Maximum LPD (in W/m^2)
Driveways and parking (open/ external)	1.6
Pedestrian walkways	2.0
Stairways	10.0
Landscaping	0.5
Outdoor sales area	9.0

5.2.3 Lamps for all exterior applications apart from emergency lighting shall be controlled by photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available, or the lighting is not required.

5.3 Elevators, if applicable

5.2.1 The Elevators installed in the ENS compliant building shall meet the following requirements:

i. Install high efficacy lamps for lift car lighting having minimum luminous efficacy of 85 lm/W

ii. Install automatic switch-off controls for lighting and fan inside the lift car when are not occupied

iii. Install minimum class IE 4 high efficiency motors

iv Installing the variable voltage and variable frequency drives

v Installing regenerative drives.

vi Group automatic operation of two or more elevators coordinated by supervisory control

5.4 Pumps, if applicable

5.4.1 Either hydro-pneumatic pumps having minimum mechanical efficiency of 70% or BEE 5 star rated Pumps shall be installed in the ENS building.

5.5 Electrical Systems, if applicable

5.5.1 Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. The permissible loss shall not exceed the values listed in Table 6 for dry type transformers and BEE 5-star rating in Table 7 for oil type transformers.

Table 6: Permissible Limit for Dry Type Transformers

Rating kVA	Max. Losses at 50% loading W*	Max. Losses at 100% loading W*	Max. Losses at 50% loading W*	Max. Losses at 100% loading W*
	Up to 22 kV class		33 kV class	
100	940	2400	1120	2400
160	1290	3300	1420	3300
200	1500	3800	1750	4000
250	1700	4320	1970	4600
315	2000	5040	2400	5400
400	2380	6040	2900	6800
500	2800	7250	3300	7800
630	3340	8820	3950	9200
800	3880	10240	4650	11400
1000	4500	12000	5300	12800
1250	5190	13870	6250	14500
1600	6320	16800	7500	18000
2000	7500	20000	8880	21400
2500	9250	24750	10750	26500

*The values as per Indian Standard/BEE Standard & Labeling notification for dry type transformer corresponding to values in this table will supersede as and when the Indian standards/ BEE Standard & Labeling notification are published.

Table 7: Permissible Limit for Oil Type Transformers

Rating (kVA)	Impedance (%)	Max. Total Loss (W)					
		BEE 1 Star		BEE 3 Star		BEE 5 Star	
		50 % Load	100% Load	50 % Load	100% Load	50 % Load	100% Load
16	4.5	135	440	108	364	87	301
25	4.5	190	635	158	541	128	448
63	4.5	340	1,140	270	956	219	791
100	4.5	475	1,650	392	1,365	317	1,130
160	4.5	670	1,950	513	1,547	416	1,281
200	4.5	780	2,300	603	1,911	488	1,582
250	4.5	980	2,930	864	2,488	761	2,113
315	4.5	1,025	3,100	890	2,440	772	1,920
400	4.5	1,225	3,450	1,080	3,214	951	2,994
500	4.5	1,510	4,300	1,354	3,909	1,215	3,554
630	4.5	1,860	5,300	1,637	4,438	1,441	3,717
1,000	5.0	2,790	7,700	2,460	6,364	2,170	5,259
1,250	5.0	3,300	9,200	3,142	7,670	2,991	6,394
1,600	6.25	4,200	11,800	3,753	10,821	3,353	9,924
2,000	6.25	5,050	15,000	4,543	13,254	4,088	11,711
2,500	6.25	6,150	18,500	5,660	16,554	5,209	14,813

Total loss values given in above table are applicable for thermal classes E, B and F and have component of load loss at reference temperature according to Clause 17 of IS 1180 i.e., average winding temperature rise as given in Column 2 of Table 8.2 plus 300C. An increase of 7% on total for thermal class H is allowed.

Permissible total loss values shall not exceed:

* 5% of the maximum total loss values mentioned in IS 1180 for oil type transformers in voltage class above 11 kV but not more than 22 kV
* 7.5% of the maximum total loss values mentioned in above IS 1180 for oil type transformers in voltage class above 22 kV and up to and including 33 kV

5.5.2 All measurement of losses shall be carried out by using calibrated digital meters of class 0.5 or better accuracy and certified by the manufacturer. All transformers of capacity of 500 kVA and above would be equipped with additional metering class current transformers (CTs) and potential transformers (PTs) additional to requirements of Utilities so that periodic loss monitoring study may be carried out.

6.1 The Table 8 below gives the component wise distribution of points for each building component to achieve minimum ENS Score.

Table 8: Component wise Distribution of ENS Score

Components	Minimum Points	Additional Points	Maximum Points
Building Envelope			
Building Envelope	47	40	87
Building Services			
Common area & exterior lighting	3	6	9
Elevators	13	9	22
Pumps	6	8	14
Electrical Systems	1	5	6
Indoor Electrical End-Use			
Indoor Lighting		12	12
Comfort Systems		50	50
ENS Score	70	130	200

i. Minimum points: are the set of points which are compulsory to achieve for each component to show compliance for ENS

ii. Additional Points: are the set of points which are awarded for adopting additional or better energy efficiency measures in a respective component. These points are trade able with other components to achieve the total score mentioned in section 3.1.2 for ENS compliance.

iii. Maximum points are the total points available for each component.

6.2 The code also provides additional 20 points for renewable energy as mentioned in Table 9 which can be availed after fulfilling the minimum points criteria as per section 6.7.

Table 9: Score for Renewable Energy System Components

Renewable Energy Systems Components	Minimum Points	Additional Points	Maximum Points
Solar Hot Water Systems		10	10
Solar Photo Voltaic		10	10
Additional ENS Score		20	20

6.3 In order to demonstrate compliance with the code using Point System Method, the ENS building must obtain the applicable minimum points as specified under section 6.1 and get remaining points by:

a) meeting the requirements labelled as 'additional points' of building envelope under section 6.4; and/or

b) meeting the requirements labelled as 'additional' of 'Building Services' & Indoor Electric End-Use under section 6.5 & 6.6; and/or

c) meeting the requirements labelled as 'additional' of 'Renewable Energy Systems' under section 6.7.

6.4 Building Envelope (Maximum 87 Points)

6.4.1 Thermal transmittance of roof (U_{roof})

Maximum Score	7 Points

Score breakup for the thermal transmittance of roof is as mentioned in the Table 10

Table 10: Points for Thermal Transmittance of Roof (U_{roof})

Minimum, if opted: Thermal transmittance of roof shall comply with the maximum Uroof value of 1.2 W/m²·K.	Up to 3 Points
Additional: 1 Point for every reduction of 0.23 W/m²·K in thermal transmittance of roof from the Minimum requirement prescribed under §6.1(a).	Up to 4 Points

6.4.2 Residential Envelope Transmittance Value (RETV) for building envelope (except roof) for four climate zones, namely, composite climate, Hot-Dry climate, Warm-Humid climate, and Temperate climate[7]

Maximum Score	80 Points

Score breakup for the Residential envelope transmittance value for building envelope (except roof) is as mentioned in the Table 11. Residential Envelope Transmittance Value (RETV) for building envelope (except roof) for four climate zones, namely, composite climate, Hot-Dry climate, Warm-Humid climate, and Temperate climate shall be calculated as specified in ENS Part I.

Table 11: Points for Residential Envelope Transmittance Value (RETV) for building envelope (except roof) for four climate zones, namely, composite climate, Hot-Dry climate, Warm-Humid climate, and Temperate climate

The RETV for the building envelope (except roof) for four climate zones, namely, Composite Climate, Hot-Dry Climate, Warm-Humid Climate, and Temperate Climate, shall comply with the maximum RETV of 15 W/m².	44 Points
For RETV less than 15 and up to 12 W/m², score will be calculated by following equation: 74 – 2 x (RETV)	**Up to 50 Points**
Additional: For RETV less than 12 and up to 6 W/m², score will be calculated by following equation: 110 – 5 x (RETV)	**Up to 80 points**
Additional: For RETV less than 6 W/m²	80 Points

[7] The project shall meet the requirements of either section 6.4.2 or 6.4.3 depending on the climatic zone

- If a proposed building development comprises two or more residential building blocks having different RETV. The weighted average RETV of the total residential project shall be computed using following equation –

$$RETV_{Weighted\ average} = \sum (RETV_{bldg.} \times EA_{bldg.})/EA_{total}$$

$$= \frac{(RETV_{bldg1} \times EA_{bldg1}) + (RETV_{bldg2} \times EA_{bldg2})/ + (RETV_{bldg3} \times EA_{bldg3})}{(EA_{total})}$$

Where,

$RETV_{Weighted\ average}$: is the combined RETV of the overall residential development project

$RETV_{bldg\ i}$: is the individual RETV of each residential block

$EA_{bldg\ i}$: is the total envelope area of the individual building or the total residential project

EA_{total}: is the total envelope area of the individual building or the total residential project

6.4.3 Thermal transmittance of building envelope (except roof) for cold climate ($U_{ENVELOPE,\ COLD}$)[8]

Maximum Score	80 Points

Score breakup for the Thermal transmittance of building envelope (except roof) for cold climate ($U_{ENVELOPE,\ COLD}$) is as mentioned in the Table 12. Thermal transmittance of building envelope (except roof) for cold climate ($U_{ENVELOPE,\ COLD}$) shall be calculated as specified in ENS-I.

Table 12: Points for Thermal transmittance of building envelope (except roof) for cold climate ($U_{ENVELOPE,\ COLD}$)

For Cold Climate Zone, the thermal transmittance of the building envelope (except roof) for cold climate shall comply with the maximum of 1.8 W/m²·K.	44 Points
For thermal transmittance of building envelope between 1.8 W/m²·K and 1.32 W/m²·K following equation shall be used: 66.5 - 12.5 x (thermal transmittance of building envelope in W/m²·K)	Up to 50 Points
For thermal transmittance of building envelope between 1.32 W/m²·K and 0.36 W/m²·K following equation shall be used: 91.25 – 31.25 x (thermal transmittance of building envelope in W/m²·K)	Up to 80 Points
For thermal transmittance of building envelope less than 0.36 W/m²·K	80 Points

[8] The project shall meet the requirements of either section 6.4.2 or 6.4.3 depending on the climatic zone

6.5 Building Services

6.5.1 Common Area and exterior Lighting

i. The Lighting power density (LPD) and Luminous efficacy (LE) of permanently installed lighting fixtures in common area of the ENS building shall meet the requirements of either maximum LPD or minimum LE given in Table 13.

Table 13: Common Area Lighting

Common Areas	Maximum LPD (W/m^2)	Minimum luminous efficacy (lm/W)
Corridor lighting & Stilt Parking	3.0	All the permanently installed lighting fixtures shall use lamps with an efficacy of at least 85 lumens per Watt
Basement Lighting	1.0	All the permanently installed lighting fixtures shall use lamps with an efficacy of at least 85 lumens per Watt

ii. When the exterior lighting load is more than 100 W, the permanently installed lighting fixtures shall use lamps with an efficacy of at least 85 lumens per Watt or meet the maximum LPD requirements given in Table 14.

Table 14: Outdoor Lighting Requirement

Exterior Lighting Areas/ Zones	Maximum LPD (in W/m^2)
Driveways and parking (open/ external)	1.6
Pedestrian walkways	2.0
Stairways	10.0
Landscaping	0.5
Outdoor sales area	9.0

iii. Lamps for all exterior applications apart from emergency lighting shall be controlled by photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available, or the lighting is not required.

Maximum Score	9 Points

Score breakup for the Common Area and exterior Lighting is as mentioned in the Table 15

Table 15: Score breakup for the Common Area and exterior Lighting

Minimum: The Lighting power density (LPD) and Luminous efficacy (LE) of permanently installed lighting fixtures in common area of the ENS building shall meet the requirements of either maximum LPD or minimum luminous efficacy given in Table 13, Table 14 and as mentioned in section 6.5.1 (ii) and 6.5.1 (iii) for all the areas/ zones applicable for the building for which compliance is sought. If a particular area/ zone is not applicable to a building for which compliance is sought, the performance requirement of the respective zone/ area is not required.	3 Points
Additional: Installing all the permanently installed lighting fixtures with lamp luminous efficacy of 95 lm/W in areas mentioned below	**Up to 3 Points**

Area/ Zones	Points
Corridor lighting and stilt parking	1
Basement Lighting	1
Exterior Lighting Areas	1

Additional: Lamps for all exterior applications apart from emergency lighting shall be controlled by photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available, or the lighting is not required. Installing all the permanently installed lighting fixtures in all corridor lighting, stilt parking, basement lighting and exterior lighting with lamp luminous efficacy of 105 lm/W.	**Up to 6 Points**

Area/ Zones	Points
Corridor lighting and stilt parking	2
Basement Lighting	2
Exterior Lighting Areas	2

6.5.2 Elevators

Maximum Score	22 Points

Score breakup for the elevators is as mentioned in the Table 16

Table 16: Points for Elevators

Minimum: Elevators installed in the ENS building shall meet all the following requirements: i. Install high efficacy lamps for lift car lighting having minimum luminous efficacy of 85 lm/W ii. Install automatic switch-off controls for lighting and fan inside the lift car when are not occupied iii. Install minimum class IE 3 high efficiency motors iv. Group automatic operation of two or more elevators coordinated by supervisory control	13 Points
Additional: Additional points can be obtained by: i. Installing the variable voltage and variable frequency drives. (4 points) ii. Installing regenerative drives. (3 points) iii. Installing class IE4 motors. (2 points)	9 Points

6.5.3 Pumps

Maximum Score	14 Points

Score breakup for the thermal transmittance of roof is as mentioned in the Table 17

Table 17: Points for Pumps

Minimum: Either hydro-pneumatic pumps having minimum mechanical efficiency of 60% or BEE 4 star rated Pumps shall be installed in the ENS building.	6 Points
Additional: Additional points can be obtained by: Installation of BEE 5 star rated pumps (5 Points) Installation of hydro-pneumatic system for water pumping having minimum mechanical efficiency of 70% (3 Points)	8 Points

6.5.4 Electrical Systems

Maximum Score	6 Points

Score breakup for the electrical system is as mentioned in the Table 18

Table 18: Points for Electrical System

Minimum: i. Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. The permissible loss shall not exceed the values listed in Table 8 for dry type transformers and BEE 4-star rating in Table 9 for oil type transformers.	13 Points
Additional: Additional points can be obtained by providing all oil type transformers with BEE 5 star rating.	5 Points

6.6 Indoor Electrical End-Use

The points mentioned under section 6.6 are not mandatory to show overall compliance.

6.6.1 Indoor lighting

Maximum Score	12 Points

Score breakup for the electrical system is as mentioned in the Table 19

Table 19: Points for Indoor Lighting

Minimum, if opted: All the lighting fixtures shall have lamps with luminous efficacy of minimum 85 lm/W installed in all bedrooms, hall and kitchen.	4 Points
Additional: Additional points for indoor lighting by installing all lighting fixtures in all bedrooms, hall and kitchen shall have lamps luminous efficacy as per following: 95 lm/w (3 Points) 105 lm/W (8 Points)	Up to 8 Points

6.6.2 Comfort Systems

Maximum Score	50 Points

Score breakup for the comfort System for ceiling fans and Air Conditioners is as mentioned in the Table 20 and Table 21. If comfort system is applicable, in such case minimum marks for ceiling fans and air conditioners will be mandatory.

1. **Ceiling Fans:** Points for ceiling fans will be only applicable and could be achieved if all the bedrooms and hall in all the dwelling units are having ceiling fans and points could be gained, if installed as per Table 20.

Table 20: Points for Ceiling Fans

Minimum, if opted: All ceiling fans installed in all the bedrooms and hall in all the dwelling units shall have a service value as given below: For sweep size <1200 mm: equal or greater than 4 m3/minute·Watt For sweep size >1200 mm: equal or greater than 5 m3/minute·Watt BEE Standards and Labeling requirements for ceiling fans shall take precedence over the current minimum requirement, as and when it is notified as mandatory.	6 Points
Additional: Additional points for ceiling fans by installing in all the bedrooms and hall in all the dwelling units as per following: 4 Star 5 Star	**1 Point** **3 Points**

2. **Air Conditioners:** Points for air conditioners will be only applicable and could be achieved if all the bedrooms in all the dwelling units are having air conditioners (either unitary, split, VRF or centralized plant) and points could be gained, if installed as per Table 21. In case, air conditioners installed are of mixed type, in that case calculation of points will be based on following formula:

Table 21: Points for Air Conditioners

Minimum, if opted: Unitary Type: 5 Star Split AC: 3 Star VRF: 3.28 EER Chiller: Minimum ECBC Level values as mentioned in ECBC 2017	20 Points
Additional : Split AC: 4 Star VRF: Not Applicable as on date, however, whenever BEE Star labelling for VRF is launched, Star 4 will be applicable Chiller: Minimum ECBC+ Level values as mentioned in ECBC 2017	9 Points
Additional : Split AC: 5 Star VRF: Not Applicable as on date, however, whenever BEE Star labelling for VRF is launched, Star 5 will be applicable Chiller: Minimum SuperECBC Level values as mentioned in ECBC 2017	21 Points

6.7 Renewable Energy Systems

6.7.1 Solar Water Heating: Solar water heater shall meet the minimum efficiency level mentioned in IS 13129 Part (1&2) and for evacuated tube collector the storage tanks shall meet the IS 16542:2016, tubes shall meet IS 16543:2016 and IS 16544:2016 for the complete system.

Maximum Score	10 Points

Score breakup for the electrical system is as mentioned in the Table 22

Table 22: Points for Solar Water Heating

Minimum, if opted: The ENS compliant building shall provide a solar water heating system (SWH) of minimum BEE 3 Star label and is capable of meeting 100% of the annual hot water demand of top 4 floors of the residential building. or 100% of the annual hot water demand of top 4 floors of the residential building is met by the system using heat recovery	5 Points
Additional: Additional points can be obtained by installing SWH system as per as per following: 100% of the annual hot water demand of top 6 floors of the residential building (2 points) 100% of the annual hot water demand of top 8 floors of the residential building (5 points)	Up to 5 Points

6.7.2 Solar Photo-Voltaic

Maximum Score	10 Points

Score breakup for the electrical system is as mentioned in the Table 23.

Table 23: Points for Solar Photo Voltaic

Minimum, if opted: The ENS compliant building shall provide a dedicated Renewable Energy Generation Zone (REGZ) – Equivalent to a minimum of 2 kWh/m^2.year of electricity; or Equivalent to at least 20% of roof area. The REGZ shall be free of any obstructions within its boundaries and from shadows cast by objects adjacent to the zone.	5 Points
Additional: Additional points can be obtained by installing solar photo voltaic as per following: Equivalent to a minimum of 3 kWh/m^2.year of electricity or Equivalent to at least 30% of roof area (2 points) Equivalent to a minimum of 4 kWh/m^2.year of electricity or Equivalent to at least 40% of roof area (5 points)	Up to 5 Points

Terminology & Definitions

7

A

Above Grade area: It is the carpet area plus the thickness of outer walls and the area covered by balcony, expressed in meters, and subtracting the basement area.

Addition: An extension or increase in the carpet area or height of a building or structure.

Affordable Housing Projects: Affordable houses are Dwelling Units (DUs) with Carpet Area less than 60 sqm. It also includes Economically Weaker Section (EWS) category and Lower Income Group (LIG) category (LIG-A: 28-40 sq. m. and LIG-B 41- 60 Sq.m.). Projects using at least 60 percent of the FAR/ FSI for dwelling units of Carpet Area not more than 60 sqm. will be considered as Affordable housing projects. This definition could be changed time to time by Ministry of Housing & Urban Affairs and respective states and latest definition for the respective state shall be considered.

Affordable housing scheme: The Pradhan Mantri Awas Yojana (PMAY), also known as, Affordable housing scheme, including any notification of change in name of the aforesaid scheme, is an initiative provided by the Government of India which aims at providing affordable housing to the urban poor.

Alteration: A change from one type of occupancy to another or the removal of part of a building, or any change to the structure, such as the construction of, cutting into or removal of any wall, partition, column, beam, joist, floor or other support, or a change to or closing of any required means of ingress or egress or a change to the fixtures or equipment.

Authority Having Jurisdiction: The Authority which has been created by a statute and which, for the purpose of administering the Code, may authorize a committee or an official or an agency to act on its behalf.

B

Building services: Basic MEP services such as firefighting systems, elevators and escalators, HVAC systems, gas supply systems, building management systems, power backup, water supply, water recycling etc. that are provided for the comfort and available to all dwelling units/apartments of the building or building complex.

Built-up area: It is the carpet area plus the thickness of outer walls and the area covered by balcony, expressed in meters.

C

Common Area: Amenities such as corridors, hallways, lobby, staircases, lifts, pool, parking areas etc. provided for the comfort and available for use to all occupants, owners, tenants, or users of the building or building complex expressed in m^2.

D

Dwelling unit: An Independent housing unit with separate facilities for Living, Cooking and sanitary requirement.

E

ENS building: Any building in which all covered spaces comply with the requirements of §3 of the Eco- Niwas Samhita 2021

ENS Score: It is the algebraic sum of the points that are obtained by meeting the requirements of Eco- Niwas Samhita 2021

Energy Efficiency Ratio (EER): the ratio of net cooling capacity in kW to total rate of electric input in watts under design operating conditions

F

Floor area: the net enclosed area expressed in m^2 of a floor in the building including circulation spaces like lobby or corridors, service areas and semi-open spaces such as verandah or balcony.

H

High Rise Buildings: A building above 4 stories, and/or a building exceeding 15 meters or more in height (without stilt) and 17.5 meters (including stilt).

I

Integrated Energy Efficiency Ratio (IEER): is a single-number cooling part load efficiency figure of merit calculated as specified by the method described in ANSI/AHRI Standard 340/360/1230.

Indian Seasonal Energy Efficiency Ratio (ISEER): It is the ratio of the total annual amount of heat that the equipment can remove from the indoor air when operated for cooling in active mode to the total annual amount of energy consumed by the equipment during the same period.

L

Lighting Power Density (LPD): It is the total of the maximum power rating of the lamps (in Watts) in a space, other than those that are plugged into socket outlets for intermittent use such as floor standing lamps, desk lamps, divided by the area of the space (in meters).

Low Rise Buildings: A building equal or below 4 stories, and/or a building up to 15 meters in height (without stilt) and up to 17.5 meters (including stilt).

Low energy comfort systems: Space conditioning or ventilation systems that are less energy intensive then vapor compression-based systems.

Luminous Efficacy (LE): total luminous flux emitted from a luminaire upon input power, expressed in lumens per Watt.

M

Mechanical Efficiency: It is a dimensionless number that measures the effectiveness of a machine in transforming the power input to the device to power output.

Mixed land-use building projects: a single building or a group of buildings used for a combination of residential, commercial, business, educational, hospitality and assembly purposes

Mixed-mode ventilated: building in which natural ventilation is employed as the primary mode of ventilating the building, and air conditioning is deployed as and when required.

O

Openable area of dwelling unit: The total openable area expressed in m^2 of a dwelling unit is the sum of openable area of all windows and ventilators opening directly to the external ambience, open balcony, verandah, corridor and or shaft.

Exclusions: Doors opening into corridors and external doors on ground floor (for e.g. ground floor entrance doors or back-yard doors).

P

Plot Area: A parcel (piece) of land enclosed by definite boundaries expressed in m^2.

Projection Distance: It is the horizontal depth, expressed in meters, of the external shading projection

R

Renewable Energy Systems: Energy from renewable non-fossil energy sources, e.g. solar energy (thermal and photovoltaic), wind, hydropower, biomass, geothermal, wave, tidal, landfill gas, sewage treatment plant gas and biogases. A resource that is available naturally, harnessed, and can be replenished.

Residential Building(s): Residential building(s) (including affordable housing) include any building in which sleeping accommodation is provided for normal residential purposes with or without cooking or dining or both facilities. This includes:

i. One- or two-family private dwellings: These shall include any private dwelling, which is occupied by members of one or two families and has a total sleeping accommodation for not more than 20 persons.

ii. Apartment houses: These shall include any building or structure in which living quarters are provided for three or more families, living independently of each other and with independent cooking facilities. This also includes group housing.

However, following buildings are excluded for the purpose of this code.

- Lodging and rooming houses: these shall include any building or group of buildings under the same management in which separate sleeping accommodation on transient or permanent basis, with or without dining facilities but without cooking facilities for individuals, is provided. this includes inns, clubs, motels, and guest houses.

- Dormitories: these shall include any building in which group sleeping accommodation is provided, with or without dining facilities for persons who are not members of the same family, in one room or a series of closely associated rooms under joint occupancy and single management. For example, school and college dormitories, students, and other hostels and military barracks.

- Hotels: these shall include any building or group of buildings under single management, in which sleeping accommodation is provided, with or without dining facilities.

Retrofit: providing or adding something with a building component or feature not fitted when the building or building complex was first constructed.

R – Value: measurement of the thermal resistance of a material which is the effectiveness of the material to resist the flow of heat, i.e. the thermal resistance ($m^2 \cdot K/W$) of a component calculated by dividing its thickness by its thermal conductivity.

S

Service Value: The Service value is the ratio of air delivery to power input.

T

Thermal Insulation: A material used to reduce heat loss or gain through thermal envelope component.

Thermal Transmittance (U-Value): Also known as U-Factor, thermal transmittance (U-value) is the heat transmission in a unit of time through a unit of area of an envelope component or insulating material, induced by a unit of temperature difference between conditioned and

unconditioned spaces. The U-value for an envelope component indicates its ability to reduce heat transfer through conduction. U-value is expressed as $W/m^2 \cdot K$.

Rationale

Embodied energy in construction in India (especially in "formal' residential buildings of the sort that are covered by the ENS code) can sometimes be of the order of magnitude of many decades of operating energy use[9] and therefore is very significant to consider when such a code is being developed.

However, this was true for non-air-conditioned housing stock, and it seems likely that, like in the developed economies, increasing consumption of operating energy (e.g., for appliances, common area services, air-conditioning etc.) may cause the embodied energy to become less significant compared to operating energy. Still this is an important area to include in the code.

Embodied energy is also important because much of it is consumed in the form of primary energy (coal, oil, fuels) causing direct pollution and carbon emissions.

Embodied energy is the sum of all energy used in the construction process, i.e., in the product, transport and installation: from the extraction of raw materials, manufacture of materials and fabrication of products, to their transportation and installation in buildings. It is often measured in megajoules per square meter. But its units can also be kWh(th) (Thermal Kilowatt hours, with 1kWh(th) being equivalent of 3600 kJ) per sqm of built-up-area, making it more easily comparable with EPI of the ENS code.

Cement and steel are the major contributors of embodied energy in residential building construction in India. According to the study conducted by Jadavpur University[10], 98% of the embodied energy is attributed to the embodied energy of the materials used and 2% is the contribution of actual erection of the building. Unfortunately, embodied energy is often "hidden" in industry for the manufacture and transport of materials, and the transportation of workers.

Institutes of technological research need to be tasked with creating standards for embodied energy benchmarks based on average and best practice. If necessary this research needs to attract funds from the building industry and foundations.

Embodied Energy measured in kWh(th)/sqm and Operating Energy measured in kWh(th)/sqm.year can be combined. In order to combine the (capital) embodied energy with the operating energy, it is necessary to merge the two to units equivalent of kWh(th)/sqm.year so that a single number can represent the energy performance of a project.

In a recent piece of research for Technology Information Forecasting and Assessment Council of India[11], it was found that the best way to translate from kWh(th)/sqm (Embodied Energy) to

9 The Mud Village project, sponsored by HUDCO, entry by Studio Plus, 1987

10 Embodied Energy Analysis of Multi-storied Residential Buildings in Urban India, S Bardhan - WIT Transactions on Ecology and the Environment, 2011

11 Technology Vision 2035, Technology Information Forecasting and Assessment Council (TIFAC) 2014

kWh(th)/sqm.year (equivalent Operating Energy) would be to set up a notional or actual discount/ replacement rate of construction taking its nominal life, say, as:

- 50 years life leading to a 2% replacement rate of stock for mainstream buildings
- 20 years life leading to a 5% replacement rate of stock for temporary industrial materials (steel) buildings.
- And so, on

According to a study by HUDCO[12], affordable housing uses 4257 MJ/sqm of embodied energy and so at a rated life of 50 years (or 2% replacement rate), this is equivalent of 85 MJ/sqm.year or 23.6 kWh(th)/sqm.year which is substantial for a building without air-conditioning but low for a building with various mechanical systems using up substantial operating energy.

This can be codified along with other benchmarks in the ENS code after suitable characterisation, study, analysis of best practices, and benchmarking.

Notes

Embodied energy is given less importance in the affluent regions of the world since their operating energy is high. There are two methods to evaluate this energy: by process or by input-output. Researchers in the Indian Institute of Science[13] identified process analysis as appropriate for embodied energy assessment in the Indian context.

One of the earliest researchers using process-based analysis of embodied energy, Dr. Mohan Rai, carried out studies at CBRI Roorkee in the early 1960s and made the first listing of embodied energy, sorted in descending order, as follows:

Materials	Unit	kWh(th)	MJ
Sheet Glass	sqm	74.199	267.1
Linoleum	sqm	46.287	166.6
Aluminium	kg	39.891	143.6
PVC	kg	32.273	116.2
Sanitaryware	kg	9.071	32.7
Mild Steel	kg	7.327	26.4
L.D. Polyethylene	kg	6.048	21.8
Stoneware Pipes	kg	5.896	21.2
Cement	kg	2.245	8.1
Quick Lime	kg	1.756	6.3
Bloated Clay Aggregate	kg	1.477	5.3
Burnt Clay Roofing Tiles	each	1.233	4.4
Burnt Clay Bricks	each	1.187	4.3
Wood Particle Board	kg	0.861	3.1
Sand Lime Bricks	each	0.773	2.8
Clay Fly-Ash Bricks	each	0.643	2.3
Gypsum (Calcined)	kg	0.420	1.5
Brick Dust (Surkhi)	kg	0.384	1.4
Crushed Aggregate	kg	0.060	0.216

12 Accessed in December 2019 at https://www.slideshare.net/sslele456/embodied-energy-in-residential-cost-effective-units

13 K.I. Praseeda, B.V. Venkatarama Reddy, Monto Mani, 2015. Embodied energy assessment of building materials in India using process and input–output analysis, *Energy and Buildings*, 86 (677-686), ISSN 0378-7788

The table above shows (as is well-known) that the embodied energy of processed industrial materials like aluminium, steel and cement is much higher than relatively unprocessed and mined materials extracted from nature (like crushed aggregates). Natural and renewable materials such as timber may be deemed to have zero renewable energy. Therefore, all other things being equal, a concrete framed structure with cement and steel is worse than a load bearing structure with hardly any cement and steel and masonry (preferably non-fired) and funicular forms holding up the roof.

Annex B-Best Construction Practice

B

Energy can be consumed in bad practices that may be observed on building sites. This needs to be stopped but is currently outside the scope of the ENS code. Typical practices include excessive requirement of movement of fluids (like mixed concrete) or solids (like steel) on site due to bad layout, improper sizing of pipes to save initial costs but causing greater pumping power due to friction losses, an over- or under-reliance on assisted manual labour (which may be seen as a form of renewable energy), and industry having got used to fuel-based services or energy-on-tap (firm energy) and so unable to convert to renewable energy such as solar photovoltaic systems (due to their being infirm, not available on-tap). Often machinery is also often designed so as to have very high starting surge loads, thereby making it impractical to invest in capital-intensive technologies (renewable) instead of fuel-based technologies, causing emissions and/or pollution. These areas need to be improved and then can be codified.

Although according to the study conducted by Jadavpur University[14] 98% of the embodied energy is attributed to the embodied energy of the materials used and 2% is the contribution of actual erection of the building, it is important to look at this seemingly trivial 2% for the main reason that there can be a lot of energy wasted and emissions and pollution created by bad site practices, and also because better site practices lead to better buildings and saves cost for the builder, thereby (ultimately) resulting in more affordable construction.

To achieve this:

- Layout planning of sites should be made a course in civil engineering and project managers need to, by mandate, graduate in at least a one-semester course in this subject.
- Civil engineers need to be able to engage with concepts of renewable energy through manual labour and solar and wind energy systems and they, along with project managers, need to, by mandate, graduate in at least a one-semester course in this subject.
- Total energy losses due to waste and friction on site (per unit area of building being made) need to be analysed, benchmarked, and codified.
- All these point to research directions that need to be undertaken (again by Civil Engineering departments in our Engineering Institutes).
- Best industry standards for ratios of running energy: starting surge, need to be analysed, benchmarked, and codified, so that infirm energy sources such as solar photovoltaics may be able to be considered to meet the demand of energy on site. It may be noted that infirm energy sources such as solar photovoltaics could be seen to be a form of production of energy, and if managed well and with sufficient open area, with a good rental market created for solar photovoltaics or wind turbines, sites can in the future become energy-neutral for construction of buildings.

Since research in this area is nascent, it has been kept out of the ENS code for now.

14 Embodied Energy Analysis of Multi-storied Residential Buildings in Urban India, S Bardhan - WIT Transactions on Ecology and the Environment, 2011

Annex C- Retrofitting of Residential Buildings

C

Retrofitting consists of additions and alterations to existing (and, in the context of the ENS code, residential) building stock and typically this is set into motion by building owners.

For reasons of poor research and difficult practice, this code is currently silent on retrofit provisions and this appendix is created because given the right conditions this situation may change. This code does not mention provisions for retrofit cases because of the principle that laws (and codes) should preferably not be applied retroactively (so we cannot declare a building not meeting standards before the standard was even made), but in doing so we lose out a large potential of building stock (say over 50% of the residential building stock in 2030 if we read the McKenzie report[15] that "nearly 70% of building stock that will be there in 2030 is yet to be built in India" and geometrically extrapolate it from 2010 when it was written to 2019 today).

The following market innovations need to be encouraged to cover a large part of India's existing residential building stock even when they are not being added to or being altered:

- For apartment dwellers, before enforcing this code, there need to be financial (low-interest loan) instruments available or created whereby collective retrofitting may take place through collective action, for example changing of window or wall specifications through RWA action to comply with provisions of the ENS so that capital cost of such retrofits may be kept low per month.
- For individual house owners, there need to be encouragement of vendors who can audit and retrofit because until that is done the implementation of ENS code shall be resisted or "loopholed" by homeowners.
- For rental stock, these audit and retrofit companies can undertake audit and retrofit to meet the ENS code provisions either through RWA or through apartment owners' associations (this is more difficult but can be eased by easy upgrade costs accompanied by strict compliance demands).

It would help a lot if the improvements effected by RWAs or contractors can be documented in a standardized way and the improvements in performance recorded numerically on a plaque or certificate for the owners to take pride in retrofitting their homes. This can be designed like the BEE star labels for various appliances.

It is anticipated that since the primary means of enforcing the ENS code is at the time of municipal approval and completion, this code could be immediately applied (subject to state-by-state acceptance into law) at the time of application for addition and alterations of buildings.

This would automatically exempt minor addition and alterations (such as raising internal walls, painting, etc.) For reference, these "minor" retrofits in existing buildings that do not need any permission according to Delhi Development Authority (DDA), similar to changes in buildings all over the country, are provided below:

[15] India's Urban Awakening: Building inclusive cities, sustaining economic growth (McKinsey Global Institute, April 2010)

Excerpt from DDA[16]

1. To convert existing barsati into room provided the wall is made of only 115 mm thick.
2. Grills and glazing in verandah with proper fixing arrangement.
3. Raising height of front and rear courtyard wall upto 7' height by putting up jali/ fencing.
4. Providing door in courtyard wherever not provided.
5. Providing sunshades on doors and windows wherever not provided with proper fixing arrangements.
6. Closing the door.
7. If the bathroom or WC are not having roof, these may be treated as open urinals and allowed.
8. Raising the wall of balcony/terrace parapet with grill or glazing upto 5' height.
9. Construction of open staircase (cat ladder) where no staircase has been provided for approach to the terrace.
10. To put provide additional PVC water tank at ground floor area without disturbing the common passage.
11. To provide an additional PVC water tank in the scooter/car garage at the surface level.
12.. To provide loft /shelf in the rooms without chase in the walls.
13. To change the flooring with water proofing treatment.
14. To remove half (41/2) brick wall.
15. To make a ramp at front gate without disturbing the common passage /storm water drain.
16. To provide sunshades or the outer windows upto 2'wide projection.
17. To provide false ceiling in rooms.
18. To make an opening of maximum size of 2'6" x1'9" for exhaust fan or air-conditioner in existing walls.
19. Fixing of door in back and front courtyard.
20. Converting of window into Almirah subject to availability of light and ventilation as per building byelaws provided that no structural elements are disturbed and there is no projection extending beyond the external wall.
21. Shifting of water storage tank/raising of parapet wall upto 5' height and putting additional water storage tank. Wherever the existing water storage tank capacity is less than 500 ltrs in a flat, a 500 ltrs tank can either replace the existing water storage tank or if possible the additional tank can be added so as to make the total storage capacity upto 550 ltrs. However, such replacement/provision of additional tank will be done only on the locations specified for such tanks and the supporting beams will be required to be strengthened suitably. Parapet wall around terrace can be increased to a height of 5'.
22. To shift the front glazing, rooms/windows upto existing chajja.

16 http://www.dda.org.in/housing/pending_cases/permissible_alteration_housing.htm, accessed December 2019.

Not implementing retrofit cases for, say, 5 years, it can then be suggested that the ENS code could be made applicable to all Addition and Alterations cases that come for approval to ULBs. This will cover at least some 5% of existing building stock (say 10% of 50%) and simultaneously measures (1) through (3) in the last page need to be actively pursued in the market to make alterations proactively possible for existing building stock, even when not undertaking additions and alterations.

Generally, alterations in themselves do not require municipal approval. The key changes that require getting municipal approval is increase of height / FAR / Ground Coverage, all of these are related to increasing the size of the home.

Studying codes from other countries[17], it can be seen that whenever a project comes up for municipal sanction, the codes require the renovated project to comply with the code provisions. This should be recommended in India also.

This will leave out only that part of the existing building stock that has a completion certificate from the ULB and remains unchanged. In time it shall be added to (requiring ULB approval) or demolished and rebuilt (requiring ULB approval). Therefore, by the later part of this century definitely the entire residential building stock shall become ENS compliant, even if market forces do not already make it so.

17 There are many references. See for instance, the Residential Compliance Manual for the 2019 Building Energy Efficiency Standards, California, at https://ww2.energy.ca.gov/2018publications/CEC-400-2018-017/CEC-400-2018-017-CMF.pdf, or https://www.buildwaikato.co.nz/building-projects/additions-alterations/ from the Waikato Building Consent Group (WBCG) in New Zealand, both accessed in December 2019.

Annex D- Improved Air Cooling

D

Residential buildings sector accounts for 24% of the electricity consumption and is the second largest consumer after industries. Within the building sector, the residential electricity consumption amounts to 259 TWh. Within this sector, with increasing affluence in the Indian middle class, there is a tendency (in warm humid, hot dry, composite and even moderate climates which always have some hot days) to create comfort by installing an air-conditioner or two. Capital costs of air conditioning is low compared to capital costs of building (today, cheap – and inefficient – air-conditioning can be as low as 5% of the building cost). EMI-based loans make it easy for even a lower middle-class family to install split air-conditioners at less than the monthly energy costs of running the same.

Use of air-conditioning therefore is a major hurdle in creating energy efficient residential stock in India, since it cannot be denied that it creates superior comfort in all sorts of conditions: warm humid, hot dry, composite, and moderate.

Often the rationale for a lower middle-class family, who realize that the energy bills are not easy to manage, is that they will use it minimally, only in the night and only in extreme weather, or by setting the thermostat up to higher temperatures. However, air-conditioning, with its superior performance in terms of managing humidity, is addictive, and there is a tendency for its use to increase to the limit of the users' paying capacity, and even beyond it.

It is worse that in this economic class, the tendency is to procure cheap, lower rated inefficient equipment, and install it in poorly insulated houses, which uses even more electricity than it could.

This causes residential air-conditioning to become a major barrier in energy efficiency (USAID, 2014)[18]. This issue is a major guzzler of energy in houses and needs to be mitigated by codification. However, since the research on this is ongoing, this has not yet been included in the ENS code.

On November 15, 2019, the Rocky Mountain Institute (RMI) in collaboration with the Ministry of Housing and Urban Affairs (MoHUA) of the Government of India (GoI) announced the results of a Global Cooling Prize competition, for Incentivizing the development of a residential cooling solution that will have at least five times less climate impact than standard residential/room air conditioners (RAC) units in the market today. This technology could prevent up to 100 gigatons (GT) of CO2-equivalent emissions by 2050, and put the world on a pathway to mitigate up to 0.5°C of global warming by 2100, all while enhancing living standards for people in developing countries around the globe[19].

Therefore, the following are urgently required to be researched and implemented for Indian residences to become comfortable while remaining energy efficient, at capital costs that are affordable or can be made affordable by fiscal incentives or financial instruments:

- Air-conditioning systems that can be used at higher set-point temperatures (say, up to 28 °C) in combination with ceiling fans. These require higher cfm of air to be pushed through (rather than the industry standard of 400 cfm per Ton) and a balance between refrigerant temperature, air flow, and set point since currently air-conditioning industry

18 HVAC Market Assessment and Transformation Approach for India, PACE-D Technical Assistance Program, USAID, August 2014

19 https://globalcoolingprize.org/ accessed in December 2019

has optimised all systems for 22°C - 24°C. As the set point temperature is increased, the other parameters need to change. This kind of device will be ideal for bill-conscious lower middle classes even if they can progressively afford air-conditioning capex.

- Fiscal incentives or financial instruments to lower capex for improving house thermal performance to ENS code levels so that optimum (not too much) air-conditioning is installed. Unfortunately, at this point, the ENS code has been developed assuming that the cooling system is some form of air-conditioning.
- Rapid development and deployment of effective an acceptable intermediate technologies including adiabatic technologies, such as passive hybrid and active evaporative coolers, better natural ventilation, indirect evaporative coolers, or chilled coil indirect evaporative coolers, combined with fiscal incentives or financial instruments to lower capex for improving houses to a level so that sufficient passive cooling is managed and the number of days of usage of cooling or conditioning can be brought down.
- Alternative desiccant and evaporative systems for cooling (which are not yet well-developed). This may require fundamental research and cannot be expected to be rapidly deployed.

Promotion of all these above alternatives through some cultural or social incentives (such as the BEE star rating system or TV promotions) so that they are not perceived as inferior to "complete" air-conditioning. This requires a major social change in attitude from progress seen as consumption only to progress seen as sufficiency, but is probably the most effective instrument for meeting and even bettering the EPI targets of the ENS code.

Natural and SENS Score Ventilation

If buildings can achieve comfort by natural or sENS Score ventilation, this would entirely avoid the use of energy for mechanical cooling, and needs to be highly encouraged.

Natural ventilation fulfils two primary needs: first, it gives fresh air for satisfactory indoor quality; and, second when the outdoor temperature are comfortable (during night and transition seasons), it expels heat from inside the structure and facilitates cooling.

Natural ventilation is of course not useful for cooling when the outdoor air is at a temperature higher than the set-point or desired indoor temperatures. This leads us to another very important concept of ventilation, **sENS Score ventilation**, opening the building very much to the outdoor air whenever the temperature outside is more comfortable than the inside, namely summer nights and winter days.

The National Building Code 2016 (Part 8; 1; 5. Ventilation) or ASHRAE 62.1–2016 provide standard ventilation rates for acceptable indoor quality.

To aid cooling a larger volume of airflow is required than the standard ventilation rates.

The rate of ventilation by natural means through windows or other openings depends on,

a) direction and velocity of wind outside and sizes and disposition of openings (wind action); and

b) convection effects arising from temperature of vapour pressure difference (or both) between inside and outside the room and the difference of height between the outlet and inlet openings (stack effect).

One of the parameters to quantify the adequacy of natural ventilation is hourly air change rate (ACH), which is a proportion of how frequently the air volume inside a room is supplanted by

outside air in 60 minutes. The larger the number, the better is the cooling potential through common ventilation. As a rule, 5 to 20 ACH gives good natural ventilation.

NBC 2016 discusses the design guidelines for natural ventilation in the 5.4.3 of Part 8: Building Services of the code.

Once the promotion of naturally ventilated buildings can be successfully undertaken, it should be possible to eliminate the use of air-conditioning or at least drastically reduce its use in all but the most affluent residences.

Ventilation in residential buildings can be provided by one of the following methods:

a) Natural supply and natural exhaust of air (natural ventilation)
b) Natural supply and mechanical exhaust of air (mechanical ventilation, see below)
c) Mechanical supply and natural exhaust of air (mechanical ventilation, see below)
d) Mechanical supply and mechanical exhaust of air (mechanical ventilation, see below).

Mechanical Ventilation

There are a range of circumstances in which natural ventilation may not be possible or sufficient to attain thermal comfort:

- The building is too deep to ventilate from the perimeter.
- Local air quality is poor, for example if a building is next to a busy road.
- Local noise levels mean that windows cannot be opened.
- The local urban structure is very dense and shelters the building from the wind.
- Privacy or security requirements prevent windows from being opened.
- Internal partitions block air paths.
- The density of occupation, equipment, lighting and so on creates very high heat loads or high levels of contaminants.

Some of these issues can be avoided or mitigated by careful design, and mixed mode or assisted ventilation might be possible, where natural ventilation is supplemented by mechanical systems. Naturally it is not desirable to go with mechanical ventilation where natural ventilation could achieve the similar results.

Where mechanical ventilation is necessary it can be:

- A circulation system such as a ceiling fan, which creates internal air movement, but does not introduce fresh air.
- A pressure system, in which fresh outside air is blown into the building by inlet fans, creating a higher internal pressure than the outside air.
- A vacuum system, in which stale internal air is extracted from the building by an exhaust fan, creating lower pressure inside the building than the outside air.
- A balanced system that uses both inlet and extract fans, maintaining the internal air pressure at a similar level to the outside air and so reducing air infiltration and draughts.
- A local exhaust system that extracts local sources of heat or contaminants at their source, such as cooker hoods, fume cupboards and so on.

Kitchen Ventilation

Kitchen is always the hottest space in a flat on account of the huge amount of heat produced due to cooking. The arrangement of a decent ventilation framework that can proficiently separate hot air

from the kitchen before it blends with the encompassing air can help lessen the heat in the kitchen and adjoining spaces.

For powerful natural ventilation of the kitchen, notwithstanding the window, an extra louvre opening ought to be given to further aid the movement of air.

If the kitchen is ventilated utilizing a fume hood, the distance of the hood from the gas fire and the fume flow rate should be appropriately chosen for best ventilation of the kitchen.

Evaporative Cooling

Evaporative cooling is a process that uses the effect of evaporation of water as a natural heat sink. The amount of sensible heat absorbed depends on the amount of water that can be evaporated. Currently this is the most promising area of reducing energy for cooling, except that it is largely ineffective in warm and humid seasons or climates. Sensible heat from the air is absorbed to be used as latent heat necessary to evaporate water.

- **Direct Evaporative cooling (DEC):** In this system, commonly used in the form of a 'desert' cooler, the outdoor air is brought into direct contact with water, cooling the air by converting sensible heat to latent heat. DEC systems could be divided into: Active DECs which are electrically powered to operate and Passive DECs that are naturally operated systems with zero power consumption. In DEC, the water content of the cooled air increases because air is in contact with the evaporated water. This strategy is useful in dry and hot climates.
- **Indirect Evaporative Cooling:** Indirect evaporative coolers operate by decreasing air sensible heat without changing its humidity, which is a distinct advantage over DEC systems (the final temperature approached can be dew point instead of wet bulb temperatures). In indirect evaporative cooling, evaporation occurs inside a heat exchanger and the absolute humidity of the cooled air remains unchanged. This strategy is even more effective in hot and dry climates that DEC and fairly effective for warm and humid climates, too.

EPI for Evaporative Cooler

The efficiency of the evaporative coolers is measured based on the evaporative efficiency which depends on the outside dry bulb temperature and relative humidity of the airstream.

The EPI shall be estimated for Evaporative Coolers as shown below:

EPI = [Total Wattage of fan(s) + Total wattage of pump(s)] * Hours of operation/ (1000 * Built-up area)

Rationale for EPI calculation for evaporative cooler

Parameters influencing EPI for evaporative cooler are:

Design Parameters	Technology Parameter
● Location (Climate) ● Air delivery rate ● Pump water circulation rate ● Fan and Pump efficiencies	● Direct evaporative cooling ● Fan and pump motor types
Controls	
Dew point based shut-off controller	

The EPI ranges from

User inputs in calculating the EPI shall include:

Power rating of the fan motor (From nameplate) in watts

Power rating of the pump motor (From nameplate) in watts

If a residence uses DEC or IEC or any of the natural, ENS Score, or mechanical ventilation strategies for cooling and avoids Carnot cycle based air-conditioning altogether, then it is proposed that it should automatically be able to meet the ENS code without undergoing the rigorous process of showing complete EPI calculation processes. This part has not been codified but remains in this appendix as a proposal that may be considered.

District Cooling

District cooling systems, which typically require about 15% less capacity than conventional distributed cooling systems for the same cooling loads due to load diversity and flexibility in capacity design and installation. District cooling helps in greatly reducing the peak demands and provide new generation capacity to meet cooling demand. District cooling systems are appropriate for densely populated urban areas having mixed uses of buildings with high cooling requirement. It provides enhanced level of reliability and flexibility, as individual building's cooling demand can increase or decrease without the need to change the main plant's capacity.

District cooling indicates central manufacturing and distribution of cooling energy. Chilled water is generated at main plant and then by means of an underground insulated pipeline is provided to the buildings to cool down the interior within a neighbourhood/zone. Specifically, designed devices (HX & pumps, AHUs etc.) in each building utilize this chilled water to decrease the temperature level of air going through the building's cooling system.

Thermal Energy Storage

Thermal storage may be used for limiting maximum demand, by controlling peak electricity load through reduction of chiller capacity, and by taking advantage of high system efficiency during low ambient conditions. Thermal storage would also help in reducing operating cost by using differential time-of-the day power tariff, where applicable.

The storage media can be ice or water. Water need stratified storage tanks and is mostly viable with large storage capacity and has an advantage of plant operation at higher efficiencies but requires larger storage volumes. In case of central plant, designed with thermal energy storage, its location shall be decided in consultation with the air conditioning engineer. For roof top installations, structural provision shall take into account load coming on the building/structure due to the same. For open area surface installation, horizontal or vertical system options shall be considered and approach ladders for manholes provided. Buried installation shall take into account loads due to movement of vehicles above the area.

Annex E-Smart Home

E

The concept of smart home is in existence for many decades; however, it has gained further importance in present scenario due to increase in demand for comfort and convenience (with growth of disposal income), increased dependence on appliances, increase in per capita electricity consumption and availability of rooftop solar PV and EV for potential onsite generation and storage respectively.

Alongside these drivers at consumer end; technology advancement in the form of availability of high speed computing devices (smart phones) and affordable internet data, reduction in size of IoT devices / sensors and by shifting sophisticated computing functions to cloud and development of complex algorithms to control systems as per user requirement and preference (using Artificial Intelligence) has provided fresh push to demand of smart home product and services.

The need of utility-based demand response program to match the variable consumer demand (due to use of diverse appliances) with dynamic electricity supply (due to penetration of renewable energy in grid) is gradually making the smart home solutions a must have product/service in every home, to make it demand response ready.

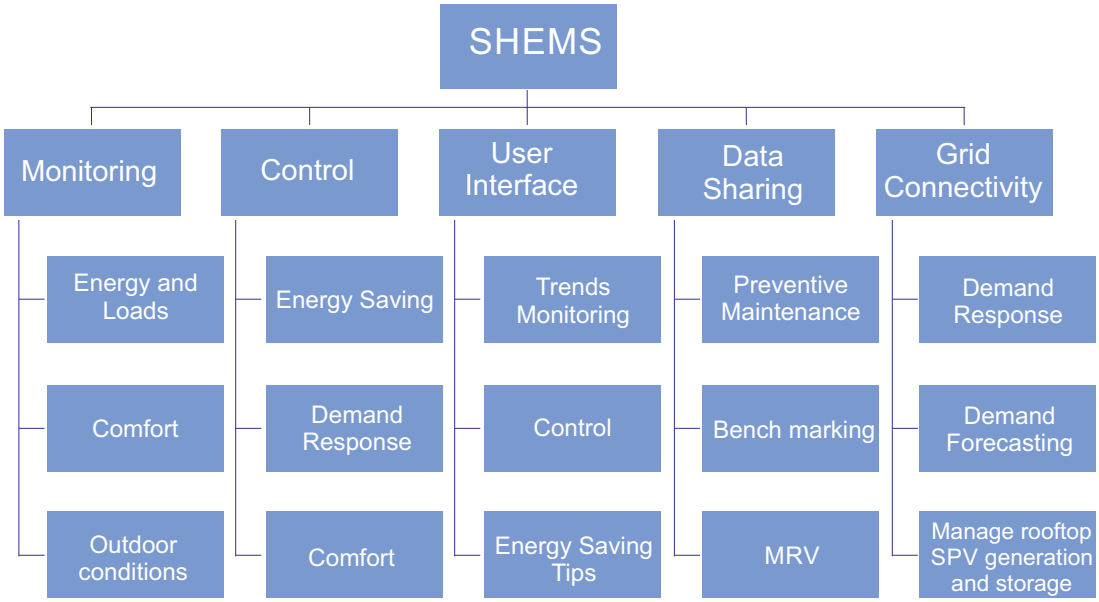
To manage the energy use in a home in order to make optimum use of these opportunities and for minimizing the demand supply gap, there is need of Smart Home Energy Management System (SHEMS). SHEMS can be defined[20] as the combination of a service and devices that are designed to work together to deliver occupancy-based optimization of energy use. SHEMS[21] consist of hardware and software, which are linked and integrated to, monitor energy usage, provide feedback on energy consumption, enhance control and provide remote access and automation provisions over appliances and devices that use energy in the home. SHEMS can deliver a range of services and benefits to households, which includes:

- Energy management (energy efficiency)
- Demand response (contribute to regulating energy demand)
- Electricity generation, storage and delivery to the grid
- Comfort and convenience

The functionality of SHEMS can be broadly categorized in five areas that include monitoring, control, user interface, data sharing and grid connectivity. Schematics indicating the functionality of SHEMS and purpose of each functionality is given below:

20 Source: ENERGY STAR® Program Requirements, Product Specification for Smart Home Energy Management Systems, https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20SHEMS%20Version%201.0%20Program%20Requirements_0.pdf

21 Source: Sustainable Now, https://sustainable-now.eu/guide-to-home-energy-management-systems/



The above-mentioned functionalities of SHEMS[22] can be operationalized with the support of:

- Physical sensors and devices
- Communication network for data transfer across smart devices, computation and data storage systems
- Data processing, decision making and relay commands as per defined logic or preference
- Smart appliances, devices and actuators to align the physical parameters to required level
- User interface to enable user to monitor, interact with smart home components and convey preferences
- Smart meter to monitor, record the energy consumption, load variation and to facilitate implementation of demand response program

In smart home, energy and cost savings is achieved by:

- Preventing idle running of energy consuming system
- Optimization of adjustable building envelope elements to minimize energy demand
- Optimization of operating parameters to match user preference
- Shifting the operation of non-essential energy consuming systems to off peak time
- Making use of renewable energy generation source, whenever available to meet the energy demand
- Optimization of charging and discharging of storage for cost saving

Smart home have significant potential for saving energy, however, the net energy savings depends on a range of factors, which include:

[22] Source: Based on the analysis conducted as part of BEE-GIZ study on Smart Home: Technology Assessment Study and Pilot Design through technical support of Deloitte Touche Tohmatsu India LLP and Prof. Vishal Garg (IIIT Hyderabad, India)

- The rationale behind automation (comfort or energy saving)
- Level and type of automation used (i.e. occupancy based on/off control or fine tuning of operating parameters based on user preference and weather conditions)
- User behaviour (whether the user just looks at energy monitoring information or uses this information to change settings or change behaviour)
- Power consumption by monitoring and control devices
- Additional power consumption by appliances in standby mode due to inclusion of smart communication features.

Several studies have been undertaken at international level by various public and private agencies, including manufacturer associations, to estimate the energy savings from smart home solutions (product and services). Based on one of them, conducted by the Connected Device Alliance (CDA)[23], energy savings potential in a dwelling enabled with smart home devices and services could be in the range of 20-30% of the present household energy use, subject to the factors mentioned above.

As technologies are optimised, developed and linked with the implementation of further energy efficiency opportunities in homes, the energy savings potential may increase. Smart Home requirement can be added to code along with other benchmarks in the ENS code after suitable characterisation, study, analysis of best practices, and benchmarking.

Notes

Minimum functionality requirement for smart home

To ensure availability of minimum capabilities (regarding monitoring, control, user-interface, data sharing and grid connectivity) and to successfully deliver basic smart home experience to user, a minimum set of smart home devices should to be installed in a home. Table indicating the minimum device/capability requirement for each functionality of SHEMS is provided below:

23 A case study of barriers and solutions – Smart Home by Connected Device Alliance (CDA), which is a network of more than 350 government and industry participants that have come together to work on the energy efficiency opportunities provided by networked devices. Further information on the CDA is available at: https://cda.iea-4e.org

Functionality	Smart home device and/or solution
Monitoring	Home level phase-wise energy and load monitoring Two 15A outlets for energy use monitoring of two appliances One temperature and humidity sensor One occupancy sensor
Control*	One AC Controller to control set point, mode of operations, ON/OFF with provision of receiving control signals One Geyser Controller for ON/OFF, with provision of receiving control signals One Controllable light with provision of receiving control signal
User interface	Common user interface (app, voice or gesture based), to connect smart home devices over single software package for energy use monitoring and control
Grid connectivity	Able to participate in utility demand response program
Data sharing	Typical daily indoor conditions, and device-wise energy consumption, and hours of usage to be reported once a month in anonymous way

*All controllable devices to be able take control signals from hub/cloud

Data privacy, cyber security, interoperability, safety and energy efficiency - minimum requirement for smart home devices and components

- All components, devices or elements of smart home that connects "directly or indirectly" to the internet must be equipped with "reasonable" security features, designed to prevent unauthorized access, modification, or information disclosure.
- All components, devices or elements of smart home should follow common standards (for hardware and software), as prescribed by the concerned department for connected devices, enabling them to discover and communicate with one another, regardless of manufacturer, operating system, chipset or physical transport.
- All components, devices or elements of smart home should have adequate level of fire, electricity and other user health related safety features to avoid potential accidents, hazards and discomfort.
- All components, devices or elements of smart home should be energy efficient and should meet the minimum energy efficiency criteria set by concerned government department.

Bureau of Energy Efficiency
Ministry of Power, Government of India
4th Floor, SEWA Bhavan, R. K. Puram,
New Delhi - 110066 (INDIA)
www.beeindia.gov.in