



GOVERNMENT OF INDIA
MINISTRY OF POWER

Code Compliance for Energy Efficiency and Sustainability in Buildings

Guidebook

for

National Certification Examination
for Energy Auditors (Building)



Bureau of Energy Efficiency

FIRST EDITION, 2026

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PREFACE

The National Certification Examination for Energy Auditor (Building) aims to develop qualified professionals in the field of energy conservation in the building sector of India. To strengthen the Bureau of Energy Efficiency's (BEE) initiative for meeting the requirements of the National Certification Examination for Energy Auditor (Building), The Energy and Resources Institute (TERI) has developed two guidebooks in respect of the following examinations:

Guidebook	Examination paper	Topic
Book 5	Paper 5	Fundamentals of Energy Efficiency and Sustainability in Buildings
Book 6	Paper 6	Code Compliance for Energy Efficiency and Sustainability in Buildings

These books comprehensively cover the fundamentals and compliance requirements of the Energy Conservation and Sustainable Building Code (ECSBC) and Eco Niwas Samhita (ENS) 2024. Candidates preparing for the National Certification Examination for Energy Auditor (Building) may use these resources alongside the ECSBC, ENS 2024, and the Retrofit Manual for commercial and residential buildings to develop a thorough understanding of code provisions, compliance methodologies for new buildings, and energy efficiency strategies for existing buildings.

Beyond their primary purpose, these books are also expected to serve as valuable reference material for practicing building professionals and officials of Urban Local Bodies (ULBs), supporting them in strengthening their knowledge and effectively applying code compliance approaches and energy efficiency practices in the building sector.

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(Ministry of Power, Government of India)



JUNE 29, 2026

MESSAGE

The Guidebook for the National Certification Examination for Energy Auditor (Buildings) marks an important step in strengthening professional capacity for advancing sustainability and energy efficiency in India's building sector.

India's building stock is expanding rapidly, with total floor space projected to grow from estimated 20 billion m² in 2025 to roughly 34.3 billion m² by 2050. Residential buildings constitute the bulk of this stock, increasing from nearly 18.4 billion m² to about 30.2 billion m² over the same period, while commercial floor space is expected to rise from around 1.6 billion m² to approximately 4.1 billion m². This rapid anticipated growth in residential and commercial construction underscores the need for a qualified pool of professionals who can guide the transition towards sustained reductions in electricity demand, peak loads and building-related emissions.

Energy Conservation and Sustainable Building Code (ECSBC) and Eco Niwas Samhita (ENS) 2024 provide a unified framework for high-performance buildings, covering envelope efficiency, low-energy cooling, renewable integration and climate-sensitive design; with an expected 18% reduction in electricity consumption. By promoting efficient envelopes, better daylighting, appropriate glazing, and climate-responsive design, these codes help lower cooling loads and peak demand while improving thermal comfort for occupants. Together, ECSBC and ENS form a comprehensive framework that aligns building development with India's long-term pathway to net-zero emissions in the built environment.

This Guidebook has been developed as a key resource to support the implementation of ECSBC and ENS 2024. It provides a structured understanding of the principles, concepts, methodologies, and compliance approaches required for effective application of these codes on the ground. While intended as study material for candidates appearing in the National Certification Examination for Energy Auditor (Buildings), it also serves as a core technical reference for examination candidates and a practical handbook for architects, engineers and auditors. By helping create a pool of certified building energy auditors, this publication will contribute to transforming India's growing building stock into a driver of energy savings, emissions reductions, and improved environmental performance. I commend all the experts and institutions who have contributed to the preparation of this publication and wish all readers success in their professional endeavours.


(Krishna Chandra Panigrahy)

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of Self and Nation



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BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)



FOREWORD

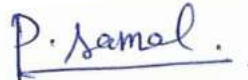
The Bureau of Energy Efficiency (BEE), under the Ministry of Power, has been leading efforts to promote energy conservation and efficiency through policy initiatives, standards, capacity-building programs, and market transformation measures. Over time, its focus has expanded to encompass broader sustainability goals for the built environment. This evolution is reflected in the Energy Conservation and Sustainable Building Code (ECSBC) and ENS 2024, which integrate energy efficiency with broader sustainability considerations such as renewable energy integration, water conservation, waste management, indoor environmental quality, and climate-responsive building design.

Recognizing the growing importance of building energy performance and sustainability in India's energy-efficiency ecosystem, and the need for specialized professional expertise in this sector, the Bureau of Energy Efficiency has launched the National Certification Examination for Energy Auditors (Building). The certification will support the effective implementation of ECSBC, ENS, and other national initiatives aimed at advancing sustainable and resource-efficient buildings.

This Guidebook for the National Certification Examination for Energy Auditors (Building) has been developed as a comprehensive learning resource for aspiring professionals and a valuable reference for practitioners. The publication presents the fundamental principles and compliance approaches for the implementation of ECSBC and ENS.

As India advances towards a low-carbon, resource-efficient, and climate-resilient future, the role of certified building energy auditors will become increasingly important. I am confident that this guidebook will equip professionals with the knowledge and skills necessary to contribute meaningfully to the transformation of India's building sector and to the broader national mission of sustainable development.

I extend my sincere appreciation to the advisors, reviewers, and contributors for their invaluable contributions to this collaborative effort. I am confident that this publication will serve as a valuable resource in strengthening professional capacity and accelerating the adoption of sustainable and energy-efficient building practices across the country.


(Pravatani Samal)
Director

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of self and Nation

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ABBREVIATIONS

ABE:	Advisory Board on Energy
ACR:	Air change rate
ACH:	Air changes per hour
ADB:	Asian Development Bank
AHU:	Air-handling unit
API:	Active pharmaceutical ingredients
ASTM:	American Society for Testing and Materials
BEP:	Best efficiency point
BEE:	Bureau of Energy Efficiency
BIS:	Bureau of Indian Standards
BMS:	Building management system
BoQ:	Bill of quantities
BU:	Billion Units
C&D:	Construction and demolition
CAG:	Comptroller and Auditor General
CEA:	Central Electricity Authority
CPHEEO:	Central Public Health and Environmental Engineering Organization
CCT:	Correlated colour temperature
CGWA:	Central Ground Water Authority
CMPD:	Central Mine Planning and Design Institute
CO:	Carbon monoxide
CO ₂ :	Carbon dioxide
COP:	Coefficient of performance
CPCB:	Central Pollution Control Board
CPWD:	Central Public Works Department
CRI:	Colour-rendering index
CT:	Current transformer
DBR:	Design basis report
DC:	Designated consumer
DCV:	Demand-controlled ventilation
DG:	Diesel generator

DPR: Detailed project report
DSM: Demand-side management
EER: Energy efficiency ratio
EC Act: Energy Conservation Act
ECBC: Energy Conservation Building Code
ECSBC: Energy Conservation and Sustainable Building Code
ECSBC+ / Super ECSBC: Enhanced/highest level ECSBC
EMC: Energy management centre
EMS: Energy management system
ENS: Eco Niwas Samhita
EPI: Energy performance index
EPF: Envelope performance factor
ESCert: Energy-saving certificate
ESCO: Energy service company
ESIC: Energy Survey of India Committee
ETC: Evacuated tube collector
FAT: Factory acceptance test
FEI: Fan efficiency index
FPC: Fuel Policy Committee
GW – Gigawatt
HVAC: Heating, ventilation, and air conditioning
IAQ: Indoor air quality
ICM: Integrative compliance method
ICAR: Indian Council of Agricultural Research
IE (2, 3, 4): International efficiency (classes)
IEER: Integrated energy efficiency ratio
ISEER: Indian Seasonal Energy Efficiency Ratio
IFE: Installed fan efficiency
IPLV: Integrated part load value
IREDA: Indian Renewable Energy Development Agency
IS: Indian Standard
JICA: Japan International Cooperation Agency

kVA: Kilovolt-ampere

kVARh: Kilovolt-ampere reactive hour

kW: Kilowatt

kWh: Kilowatt-hour

LED: Light-emitting diode

LPD: Lighting power density

MEP: Mechanical, electrical, plumbing

MEPI: Modelled energy performance intensity

MNRE: Ministry of New and Renewable Energy

MoHUA: Ministry of Housing and Urban Affairs

MoP: Ministry of Power

MoU: Memorandum of understanding

NAPCC: National Action Plan on Climate Change

NABL: National Accreditation Board for Laboratories

NBC: National Building Code

NECO: Nodal Energy Conservation Organisation

NoC: No objection certificate

NMEEE: National Mission for Enhanced Energy Efficiency

NPC: National Productivity Council

O&M: Operation and maintenance

OC: Occupancy certificate

PAT: Perform, Achieve, and Trade

PES: Percentage energy saving

PT: Potential transformer

PV: Photovoltaic

REGZ: Renewable energy generating zone

RWH: Rainwater harvesting

RO: Reverse osmosis

SAT: Site acceptance test

SC: Shading coefficient

SDA: State designated agency

SFC: Specific fuel consumption

SGWA: State Ground Water Authority
SHGC: Solar heat gain coefficient
SLD: Single-line diagram
SPCB: State Pollution Control Board
SRI: Solar reflectance index
SRR: Skylight-to-roof ratio
STP: Sewage treatment plant
tCO₂e: Metric tonne of carbon dioxide equivalent
THD: Total harmonic distortion
THDi: Total harmonic distortion (current)
THDv: Total harmonic distortion (voltage)
TR: Tonne of refrigeration
UDPFI: Urban Development Plans Formulation and Implementation
UDI: Useful daylight illuminance
U-factor: Rate of heat transfer coefficient
USAID: United States Agency for International Development
VFD: Variable frequency drive
VLT: Visible light transmittance
VOC: Volatile organic compound
VRF: Variable refrigerant flow
VRV: Variable refrigerant volume
VVVF: Variable voltage variable frequency
WFR: Window-to-floor ratio
WWR: Window-to-wall ratio



1. HISTORICAL BACKGROUND OF ENERGY EFFICIENCY POLICIES IN INDIA AND INDIAN ENERGY SCENARIO 2025

1.1. Historical background

The Indian Electricity Act, 1910, laid the foundational legal framework for electricity generation and supply in India. Following independence, the country introduced several new laws, policies, and development programmes aimed at nation-building and industrial growth. During this phase, ensuring the availability of electricity, oil, and coal to support economic expansion was the government's foremost concern. Energy conservation and efficiency did not receive policy priority during the first two decades after Independence, as the focus remained on increasing supply rather than managing demand.

The Electricity (Supply) Act, 1948, marked a significant institutional development by enabling coordinated growth of the power sector, which was seen as essential for post-war reconstruction and national development. One of its major outcomes was the establishment of the Central Electricity Authority (CEA) in 1950, tasked with formulating uniform policies for power development and coordinating electricity planning across the country.

Integrated energy planning gained recognition as early as the 1960s as an important component of India's development strategy. However, there was minimal emphasis on demand-side management (DSM) during this period. In 1963, the government constituted the Energy Survey of India Committee (ESIC) to assess patterns of energy demand and supply at national, regional, and sectoral levels. The Committee's findings were expected to guide energy planning, with considerable attention paid to rural energy needs.

By the late 1960s, it became clear that India required long-term forecasting of energy supply and demand. Consequently, the Fuel Policy Committee (FPC) was constituted in 1970 to formulate a national fuel policy.

A shift in policy thinking occurred during the 1970s in response to the global oil crisis triggered by the 1973 Yom Kippur War. The sharp increase in international oil prices exposed India's vulnerability to external energy shocks and catalyzed a national interest in energy conservation. Initially, conservation efforts focused on reducing consumption of petroleum products, but over time they expanded to encompass electricity use as well.

The oil crisis also influenced the deliberations of the FPC, which in its 1974 report recommended substitution of oil with coal and electricity, along with the promotion of energy conservation measures. The report emphasized supply-side planning but also introduced the idea of embedding conservation practices at the consumer level. Energy efficiency began to be viewed as an essential complement to energy expansion.

Energy policy assumed greater importance during the latter half of the 1970s. Under the Fifth Five-Year Plan, the government set up the Working Group on Energy Policy in 1977 to outline strategies for energy development over short-, medium-, and long-term horizons. In its 1979 report, the Group proposed measures aimed at optimizing energy use, including limiting dependence on imported oil, improving efficiency across sectors, reducing energy intensity in economic activity, and increasing the share of renewable resources, particularly hydropower.

The 1980s: Focus on Energy Productivity and Energy Management

In the early 1980s, energy efficiency emerged as a matter of institutional concern. The government constituted the Inter-Ministerial Working Group on Energy Conservation

(IMWG) in 1981 to develop strategies to achieve national energy savings targets. The Group's report, submitted in 1984, strongly advocated the creation of a central authority to coordinate, monitor, and guide energy conservation initiatives across sectors.

Following this recommendation, the Advisory Board on Energy (ABE) was established in 1983 to advise the government on technical, financial, and institutional reforms in the energy sector. One of the ABE's most important initiatives was commissioning the drafting of a comprehensive Energy Conservation Bill.

The proposed Bill recommended amendments to existing legislations, including the Motor Vehicles Act, 1939, the Bureau of Indian Standards Act, 1986, and the Essential Commodities Act, 1955. The draft legislation, completed in 1988, also proposed setting up a nodal energy conservation organisation (NECO), whose directives would be binding on all central and state authorities. However, the Bill did not progress to enactment, reportedly due to legal and administrative constraints.

During this period, the Department of Power (now the Ministry of Power) became the nodal agency for implementing national strategies on energy conservation. From 1985 onwards, it supported the expansion of energy conservation programmes through funding assistance and public outreach initiatives.

In 1989, the Energy Management Centre (EMC) was established as an autonomous organisation with support from the World Bank and the United Nations Development Programme (UNDP). The EMC

played a pioneering role in promoting energy audits, energy management systems, training programmes, and employment initiatives related to efficient energy use.

The 1990s: Liberalization and Legislative Reform

Until the early 1990s, India followed a largely inward-looking economic model characterized by state-led development, extensive regulation, and limited participation of the private sector. The economic crisis of 1991 compelled India to adopt wide-ranging reforms involving liberalization, privatization, and global integration. These reforms also reshaped the energy sector by introducing competition and private investment.

In the 1990s, India launched several initiatives to promote energy conservation. Oil Conservation Week began in 1991 and expanded into Oil Conservation Fortnight in 1997, focusing on awareness and sector-specific activities. The government also designated 14 December as National Energy Conservation Day and introduced National Energy Conservation Awards to recognize outstanding efforts across sectors.

The voluntary Ecomark Scheme was introduced in 1991 under Bureau of Indian Standards (BIS) to encourage environmentally responsible products through life-cycle-based labelling, including energy use. Despite its wide product coverage, uptake has remained limited due to low awareness. During this period, several international agencies such as United States Agency for International Development (USAID), Japan International Cooperation Agency (JICA), Asian Development Bank (ADB), World Bank, and United Nations Development Programme (UNDP) supported India's energy conservation programmes through technical and institutional assistance.

Despite multiple efforts in the preceding decades, energy conservation still lacked statutory backing, limiting the government's capacity to enforce efficiency measures. Recognizing this gap, the Ministry of Power constituted an inter-ministerial working group in 1994 to draft legislation on energy conservation. By 1997, the Cabinet approved the

proposal to enact a national energy efficiency law and to establish a dedicated institutional authority. A one-member review committee was also appointed to finalize the draft Bill.

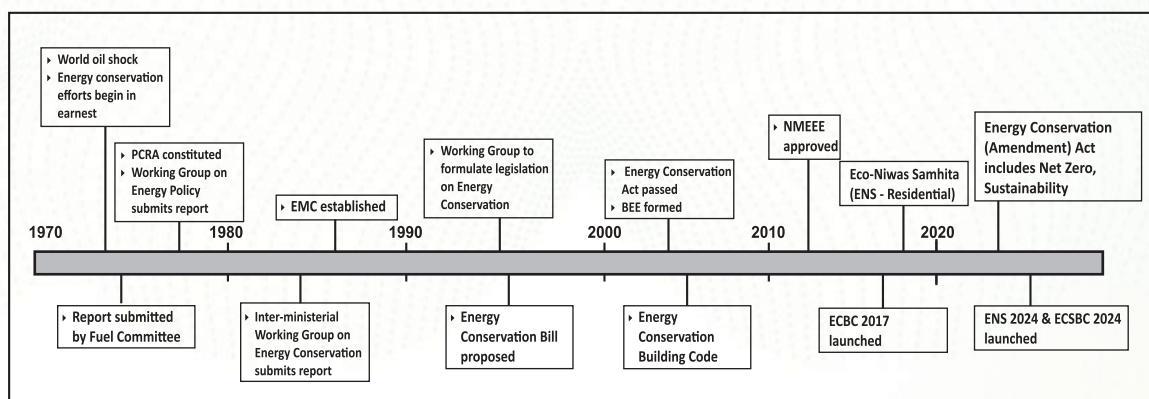


Figure 1 Chronology of Energy Efficiency policies

The Energy Conservation Bill was introduced in the Parliament in February 2000 and passed by both Houses, receiving Presidential assent in September 2001. The Energy Conservation Act, 2001 was notified in October 2001 and came into force on 1 March 2002, providing India with its first comprehensive legal framework for promoting energy efficiency.

Key Directives of EC Act 2001

- Minimum energy consumption standards for appliances and labelling of energy use
- Prohibit manufacture, sale, and import of equipment and appliances not conforming to standards
- Identification of energy-intensive industries and other establishments to be notified as designated consumers (DCs)
- Energy efficiency improvement in unorganized sectors such as domestic and agriculture sectors
- Energy audits by accredited energy auditors and implementing techno-economic viable recommendations
- Energy conservation building codes to suit local conditions
- Establishment of Central and State Energy Conservation Funds
- Energy-use inspection of DCs
- Enforcement of energy consumption norms



Salient features of Electricity Act, 2003

- The Electricity Act, 2003 was enacted to harmonize and rationalize provisions of existing laws and to reform legislation by 'promotion of efficient and environmentally benign policies'; the Act mandates efficiency in various forms in generation, transmission and distribution. Under the provisions of Section 3 (1) of the Act, the Central Government brought out the National Electricity Policy for the development of the country's power system based on optimal utilization of resources.
- The policy emphasizes higher efficiency levels of generating plants, stringent measures against electricity theft, energy conservation measures and boosting renewable and non-conventional energy sources.
- The DSM was accorded high priority, periodic energy audits were made compulsory for power-intensive industries, emphasis was placed on labelling of appliances and high-efficiency pumps in agriculture, load management and differential tariff was suggested, and energy service companies (ESCOs) were to be encouraged (the last three have been initiated by the BEE).
- Adoption of measures and practices which are conducive to increase fuel efficiency and training programmes in the transport sector.
- Modernization of boilers, furnaces, and other oil-operated equipment with efficient ones and promotion of fuel-efficient practices and equipment in the industrial sector.
- Standardization of fuel-efficient irrigation pump sets and rectification of existing pump sets to make them more energy efficient in the agricultural sector.
- Development and promotion of the use of fuel-efficient equipment and appliances like kerosene and liquefied petroleum gas (LPG) stoves in the household sector.

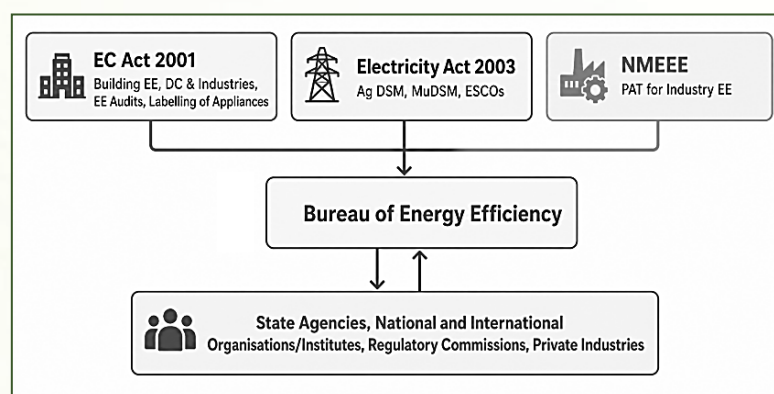


Figure 2 Regulatory environment for energy efficiency

Following the enactment of the Energy Conservation Act, a series of measures were introduced to mobilize both public and private stakeholders towards energy efficiency. The BEE emerged as the nodal agency for implementing large-scale programmes under National Mission for Enhanced Energy Efficiency (NMEEE) and for fostering partnerships among government bodies, industry, financial institutions and international agencies. This integrated policy and institutional framework consolidated Bureau of Energy Efficiency

BEE's role as the central authority for designing systems, standards, and processes to advance India's national energy-efficiency objectives.

1.2. Indian Energy Scenario 2025

India has made notable strides in strengthening its energy sector over recent years, steadily balancing the dual objectives of meeting growing electricity demand and advancing sustainability. The International Energy Agency (IEA) estimates that emerging and developing economies will account for 85% of the growth in global electricity demand

over the next three years. As one of the world's fastest-growing major economies, India occupies a pivotal position in the global energy transition. Its energy demand is projected to rise at the quickest pace among major economies, underpinned by sustained economic growth, resulting in India's share of global primary energy consumption doubling by 2035.

During the past decade, India's power sector has expanded significantly, supported by increasing demand, infrastructure augmentation, and strong policy backing for both conventional and renewable energy. Electricity generation has risen from 1,168 billion units (BU) in 2015–16 to an estimated 1,824 BU in 2024–25, while total installed capacity has grown from 305 gigawatts (GW) to a projected 475 GW over the same period.

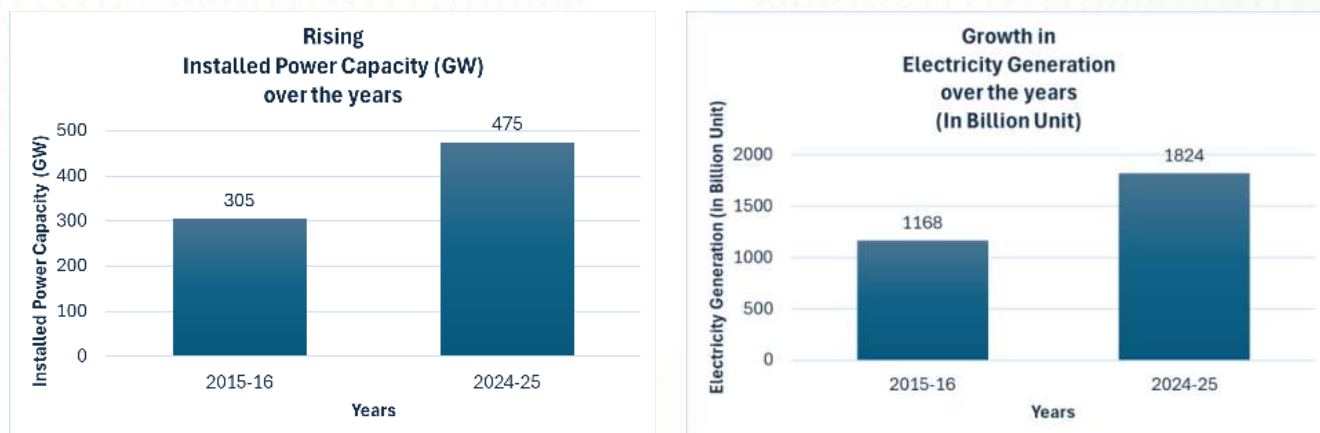


Figure 3 Installed power capacity energy generation of India during 2015–25

India's power sector ranks among the most diversified globally, drawing electricity from a wide mix of conventional sources—such as coal, gas, hydro, and nuclear—and renewable sources including solar, wind, biomass, and small hydro. In response to steadily increasing electricity demand, the country continues to scale up its energy capacity to sustain economic growth while advancing its sustainability objectives.

As of June 2025, India's total installed power capacity has reached a significant milestone with 476 GW, led by 240 GW of thermal, 110.9 GW of solar, and 51.3 GW of wind power, marking a strong shift towards renewable energy and energy security.

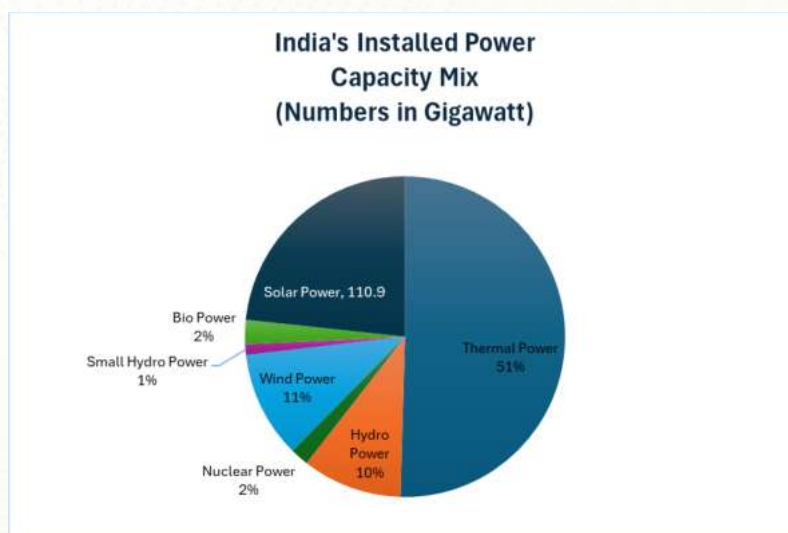


Figure 4 India's installed power capacity mix

In line with its COP26 commitment, the Ministry of New and Renewable Energy (MNRE) is actively pursuing the target of 500 GW of installed electricity capacity from non-fossil fuel sources by 2030. As of June 2025, India has already installed 235.7 GW of non-fossil fuel capacity, including 226.9 GW from renewable energy and 8.8 GW from nuclear power. Together, these sources account for 49% of the country's total installed power capacity of 476 GW. This progress represents a major milestone in India's decarbonisation pathway and reinforces its commitment to a sustainable energy future.

India's energy sector is heavily reliant on non-renewable thermal sources, which together account for the largest share of the country's electricity generation capacity. Thermal power alone accounts for 50.52% of India's total installed energy capacity, underscoring its central role in meeting the nation's electricity demands.

The oil and gas sector is one of India's eight core industries and plays a pivotal role in driving the country's economic engine. India is the third-largest consumer of oil in the world (as of 2023), making this sector crucial for the country's energy security and future growth.

India is not only expanding its energy capacity but also undertaking a comprehensive transformation of its energy system through policy support and addressing climate change while enhancing energy security and access.

India's climate commitments under the Paris Agreement, submitted through its Nationally Determined Contributions (NDCs) in 2015, laid a strong foundation for climate action. The country committed to reducing the emissions intensity of its GDP by 33–35% from 2005 levels and achieving 40% cumulative electric power installed capacity from non-fossil fuel sources by 2030. Both targets were achieved well ahead of schedule—approximately 11 years and 9 years early, respectively; demonstrating India's credible and action-oriented approach to climate governance. India's emissions intensity had already declined by 36% between 2005 and 2020.

Subsequently, India enhanced its target to a 47% reduction in emissions intensity by 2035, further strengthening its pathway toward a low-carbon and climate-resilient future. Buildings contribute to approximately 33% of the energy demand of India in 2024 and it is projected to increase to approximately 50% as per India Energy Security scenario 2047 if unabated. NITI Aayog has in its “Report Scenarios towards Viksit Bharat and Net Zero: Sectoral insights Buildings”, has recommended pathways to increase energy efficiency in order to meet the net zero goal for 2070.

Questions

Section A: Objective Questions (MCQs) – 10 Nos

1. **Which statutory body was established in 1950 to formulate uniform policies for power development and coordinate electricity planning across India?**
 - A) Bureau of Energy Efficiency (BEE)
 - B) Central Electricity Authority (CEA)
 - C) Energy Management Centre (EMC)
 - D) Fuel Policy Committee (FPC)
2. **What global event in the 1970s shifted Indian policy thinking and catalyzed a national interest in energy conservation?**
 - A) The Second World War
 - B) The Liberalization of the Indian Economy
 - C) The 1973 Yom Kippur War oil crisis
 - D) The establishment of the United Nations
3. **In its 1974 report, the Fuel Policy Committee (FPC) recommended substituting oil with which of the following?**
 - A) Natural Gas and Solar energy
 - B) Nuclear power and Wind energy
 - C) Coal and Electricity
 - D) Biomass and Hydropower
4. **The Energy Management Centre (EMC), which promoted energy audits and training, was established as an autonomous organisation in 1989 with support from which agencies?**
 - A) USAID and JICA
 - B) World Bank and UNDP
 - C) Asian Development Bank and UNESCO
 - D) Ministry of Power and NITI Aayog
5. **Which specific date is designated as National Energy Conservation Day in India?**
 - A) 15th August
 - B) 2nd October
 - C) 14th December
 - D) 1st January
6. **When did the Energy Conservation Act, 2001 officially come into force? A) September 2001**
 - A) 1st September 2001
 - B) 1st March 2002
 - C) 15th August 1947
 - D) 8th August 2022
7. **As of June 2025, what was India's total installed power capacity?**
 - A) 305 GW
 - B) 476 GW
 - C) 500 GW
 - D) 235.7 GW

8. **What is India's target for installed electricity capacity from non-fossil fuel sources by the year 2030?**
 - A) 476 GW
 - B) 235.7 GW
 - C) 500 GW
 - D) 1,000 GW
9. **Which energy source remains the largest contributor to India's total installed capacity as of June 2025, accounting for 50.52% of the mix?**
 - A) Solar Power
 - B) Nuclear Power
 - C) Thermal Power
 - D) Wind Power
10. **According to data from 2023, India holds what rank globally in terms of oil consumption?**
 - A) Largest consumer
 - B) Second-largest consumer
 - C) Third-largest consumer
 - D) Fifth-largest consumer

Section B: Short Answer Questions – 5 Nos

1. Write a short note on historical background of energy efficiency policies in India. Bureau of Energy Efficiency 11
2. Write a short note on Indian energy scenario and importance of building energy efficiency.
3. Write in short note on key directives of Energy Conservation Act.
4. Write a short note on regulatory environment for energy efficiency in India
5. Write a short note on formation of BEE its role in regulating energy efficiency in India.

Section C: Long Answer Questions – 2 Nos

1. Describe key energy efficiency policies in India.
2. What are the key directives of Energy Conservation Act.

Answer Key for MCQs

- | | |
|------|-------|
| 1. B | 6. B |
| 2. C | 7. B |
| 3. C | 8. C |
| 4. B | 9. C |
| 5. C | 10. C |

2. THE ENERGY CONSERVATION ACT, 2001 FRAMEWORK AND SALIENT ASPECTS OF 2022 AMENDMENT TO ENERGY CONSERVATION ACT, 2001

2.1. Background

The increasing pressure on energy resources due to rapid urbanization, climate change, and economic growth has necessitated the establishment of robust regulatory frameworks to promote efficient energy use and sustainable development. In India, the built environment is one of the largest consumers of electricity and resources, contributing substantially to both energy demand growth and greenhouse gas (GHG) emissions and environmental stresses. Buildings account for nearly one-third of India's total electricity consumption, driven by expanding commercial infrastructure, air conditioning demand, and rising living standards.

To institutionalize energy efficiency across sectors including buildings, industry, appliances, and transportation, the Government of India enacted the Energy Conservation Act, 2001 (EC Act, 2001). The Act provides a comprehensive statutory framework for promoting energy efficiency through regulatory mandates, institutional development, and market-based mechanisms.

For the buildings sector, the most significant outcome of the Act has been the introduction of the Energy Conservation Building Code (ECBC), which establishes minimum energy performance standards for commercial buildings.

The Act also laid the foundation for the creation of institutional mechanisms at both central and state levels, leading to uniform enforcement of energy efficiency codes. The Act empowers the Central and state governments to facilitate and enforce efficient use of energy and its conservation, notifying energy-intensive industries, establishment commercial and large residential buildings. It also defines designated consumers with mandatory obligations of achieving energy efficiency and issue directions for energy efficiency in different sectors. The Act was amended in 2010 and later in 2022.

The EC Act was amended in 2010, expanded the scope of energy conservation norms for buildings and better equip Bureau of Energy Efficiency (BEE) to manage the ever-evolving sphere of energy efficiency in the country. The main amendments introduced to the original act are given below:

- The Central Government may issue energy savings certificates to the designated consumer whose energy consumption is less than the prescribed norms and standards in accordance with the procedure as may be prescribed. Bureau of Energy Efficiency 13
- The designated consumer whose energy consumption is more than the prescribed norms and standards shall be entitled to purchase energy savings certificates to comply with the prescribed norms and standards.
- The amendment increased penalties for non-compliance and provided for establishment of appellate tribunal for energy conservation to hear appeals against the orders of the adjudicating officer or the Central Government or state government or any other authority under the EC Act.
- The Central Government may, in consultation with the Bureau, prescribe the value per metric tonne of oil equivalent of energy consumed.

- Commercial buildings which are having a connected load of 100 kilowatt (kW) or contract demand of 120 kilovolt-ampere (kVA) and above are brought under the purview of ECBC under the EC Act.

With continuous developments taking place in the Indian energy scenario, including but not limited to (i) need to facilitate the achievement of India's international commitments including those announced at COP 26; (ii) introduce concepts such as carbon trading, and (iii) encourage use of non-fossil sources, there was a need to amend the EC Act 2001 further.

In this background, on 8 August 2022, Lok Sabha passed the Energy Conservation (Amendment) Bill, 2022 to amend the EC Act 2001 and received Presidential assent on 15 December 2022.

With the amendment of the Act in 2022, sustainability aspects and residential building were introduced in the Act.

Next section elaborates the objectives, institutional structure, and key provisions of the EC Act, 2001, with focus on salient aspects of 2022 amendment.

The amendments to the act are given below:

2.2. Key Amendments to Energy Conservation Act, 2001

In 2022 amendment was done to the EC Act ,2001, The following table compares the provision of the original text of sections of the Energy Conservation Act 2001, prior to 2022 amendment , these details only cover the aspects that are linked to building sector.

Table 1 Amendments of Energy Conservation Act, 2001

Section	Provision	Original text (pre-2022)	Excerpts from Energy Conservation Act, 2001 after Amendment
2	(c)	'Building' means any structure or erection or part of structure or erection after the rules relating to energy conservation building codes have been notified under Clause (p) of Section 14 and Clause (a) of Section 15 and includes any existing structure or erection or part of structure or erection, which is having a connected load of 100 kilowatt (kW) or contract demand of 120 kilovolt-ampere (kVA) and above and is used or intended to be used for commercial purposes.	'Building' means any structure or erection or part of structure or erection— - Constructed after the rules relating to energy conservation and sustainable building codes have been notified by the Central Government under Clause (p) of Section 14 and by the state government under Clause (a) of Section 15. - Which has a minimum connected load of 100 kW or contract demand of 120 (kVA); and - Which is used or intended to be used for commercial purpose or as an office building or for residential purpose. Provided that the state government may specify a lower connected load or contract demand than the load or demand specified above.

	(h)	'Energy' means any form of energy derived from fossil fuels, nuclear substances or materials, hydro-electricity and includes electrical energy or electricity generated from renewable sources of energy or bio-mass connected to the grid.	'Energy' means any form of energy derived from fossil fuels or non-fossil sources or renewable sources.
	(ia)	Not present	'Energy auditor' means any individual possessing the qualifications prescribed under Clause (m) of Section 14;
	(j)	'Energy conservation building codes' means the norms and standards of energy consumption expressed in terms of per square metre of the area wherein energy used and includes the location of the building.	'Energy conservation and sustainable building code' means the code which provides norms and standards for energy efficiency and its conservation, use of renewable energy and other green building requirements for a building
13	(a)	Recommend to the Central Government the norms for processes and energy consumption standards required to be notified under Clause (a) of Section 14.	Recommend to the Central Government the norms for processes and energy consumption standards required to be notified under Clause (a) of Section 14 and other standards required to be prescribed under other provisions of this act.
	(d)	Take suitable steps to prescribe guidelines for energy conservation building codes under Clause (p) of Section 14.	Take suitable steps to prescribe guidelines for energy conservation and sustainable building codes under Clause (p) of Section 14;
	(h)	Promote research and development in the field of energy conservation.	Promote or undertake research and development in the field of energy conservation;
14	(a)	Specify the norms for processes and energy consumption standards for any equipment, appliance which consumes, generates, transmits, or supplies energy.	Specify the norms for processes and energy consumption standards for any equipment, appliance, vehicle, vessel, industrial unit, building or establishment which consumes, generates, transmits or supplies energy.

	(b)	Specify equipment or appliance or class of equipment or appliances, as the case may be, for the purposes of this act.	Specify equipment or appliance or vehicle, vessel, industrial unit, building or establishment or class of equipment or appliances, as the case may be, for the purposes of this act.
	(c)	Prohibit manufacture or sale or purchase or import of equipment or appliance specified under Clause (b), unless such equipment or appliance conforms to energy consumption standards: Provided that no notification prohibiting manufacture or sale or purchase or import of equipment or appliance shall be issued within a period of six months from the date of notification issued under Clause (a) of this section: Provided further that the Central Government may, having regard to the market share and the technological development having impact on equipment or appliance, and for reasons to be recorded in writing, extend the said period of six months referred to in the first proviso by a further period not exceeding six months.	Prohibit manufacture or import of any equipment or appliance or vehicle or vessel specified under Clause (b), unless it conforms to energy consumption standards specified under Clause (a): Provided that an industrial unit specified under Clause (b) shall close its operations unless it conforms to the norms for processes or energy consumption standards specified under Clause (a): Provided further that from the date of notification of norms for processes and energy consumption standards under Clause (a), no notification prohibiting such manufacture or import shall be issued— - I within a period of six months in the case of equipment or appliance or vehicle or vessel. and - ii within a period of two years for closure of industrial unit. Provided also that the Central Government may, having regard to the market share and the technological development having impact on equipment or appliance or vehicle or vessel, and for reasons to be recorded in writing, extend the said period of six months referred to above, by a further period not exceeding six month.
	(f)	After the list of energy-intensive industries specified in the schedule.	Alter the list of energy-intensive industries and other establishments specified in the schedule.

	(p)(q)(r)	(p) Prescribe energy conservation building codes for efficient use of energy and its conservation in the building or building complex. (q) Amend the energy conservation building codes to suit the regional and local climatic conditions. (r) Direct every owner or occupier of the building or building complex, being a designated consumer to comply with the provisions of energy conservation building codes for efficient use of energy and its conservation.	(p) Prescribe energy conservation and sustainable building codes for efficient use of energy and its conservation in the building or building complex. (q) Amend the energy conservation and sustainable building codes to suit the regional and local climatic conditions. (r) Direct every owner or occupier of the building or building complex, being a designated consumer to comply with the provisions of energy conservation and sustainable building codes for efficient use of energy and its conservation.
52		52. Power to obtain information every designated consumer or manufacturer of equipment or appliance specified under Clause (b) of Section 14 shall supply the Bureau with such information, and with such samples of any material or substance used in relation to any equipment or appliance, as the Bureau may require.	52. Power to obtain information: Every designated consumer or manufacturer of equipment or appliance or any other person or entity covered under this act shall furnish to the Bureau such information, documents or records relating to energy consumption, and such samples of any material or substance used in relation to any equipment or appliance, as the Bureau may require.
56	(2) (1)	The energy conservation building codes under Clause (p) of Section 14.	

57	2	(2) In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters: (a) Energy conservation building codes under Clause (a) of Section 15. (b) The form, the manner and the period within which information with regard to energy consumption shall be furnished under Clause (h) of Section 15.	(2) In particular, and without prejudice to the generality of the foregoing, power, such rules may provide for all or any of the following matters: (a) Energy conservation and sustainable building codes under Clause (a) of Section 15. (b) The form, the manner and the period within which information with regard to energy consumption shall be furnished under Clause (h) of Section 15. b (a): The fee to be levied for the services rendered by the designated agency for promoting efficient use of energy and its conservation under clause (ha) of Section 15. b (b): The form in which and the time at which, the budget of the designated agency shall be prepared under Section 15A.
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Salient Aspects

- 1 **Energy conservation and sustainable building code:** The Energy Conservation (Amendment) Act, 2022 introduces the statutory framework for the Energy Conservation and Sustainable Building Code (ECSBC), thereby expanding the scope of the Act beyond energy efficiency to include broader sustainability considerations in the building sector. The term 'Energy Conservation and Sustainable Building Code' is defined under Section 2(j) (as substituted by the 2022 Amendment) to mean a code that prescribes "norms and standards for energy efficiency and conservation, the use of renewable energy, and other green building requirements applicable to buildings." Further to ensure the efficient use of energy in buildings, under Section 14(p) and 14(q) of the Act, the Central Government is empowered to prescribe and amend the ECSBC respectively. This provision authorises the Central Government to notify codes applicable to different categories of buildings, taking into account factors such as building type, climatic conditions, and energy use intensity. The introduction of the ECSBC represents a significant evolution of the earlier Energy Conservation Building Code (ECBC) framework by formally integrating renewable energy adoption and sustainability parameters within a statutory code.
- 2 **Applicability to residential buildings:** The Energy Conservation (Amendment) Act, 2022 significantly expands the scope of the energy conservation regime by extending its applicability to large residential buildings, in addition to commercial and office buildings. Prior to the amendment, compliance with energy conservation requirements under the

Energy Conservation Act, 2001 was largely limited to commercial buildings. The Amendment revises the definition of 'building' under Section 2(c) of the Act to include buildings that meet the following criteria:

- Buildings constructed after the energy conservation and sustainable building codes are notified by the Central Government under Section 14(p) and by the State Governments under Section 15(a).
- Buildings having a minimum connected load of 100 kilowatt (kW) or a contract demand of 120 kilovolt-ampere (kVA).
- Buildings that are used or intended to be used for commercial purposes, as office buildings, or for residential purposes.

By explicitly including residential buildings meeting the prescribed energy thresholds within the statutory definition, the Amendment brings large housing developments and group residential projects under the ambit of the energy conservation framework. This enables the application of the ECSBC- residential (ENS) to such buildings, thereby promoting energy efficiency, renewable energy integration, and sustainable construction practices across the residential sector.

3. **Standards for appliance, vehicle, vessel, industrial unit, building or establishment:**

Under the Energy Conservation Act, 2001, the Central Government was originally empowered to prescribe energy consumption standards for equipment and appliances that consume, generate, transmit, or supply energy. The Energy Conservation (Amendment) Act, 2022 significantly expands the scope of this provision by expressly extending the applicability of energy consumption and fuel efficiency standards to vehicles, vessels industrial units' buildings or establishments and enables the establishment of Star rating, Shunya labeling or any other building labeling scheme.

For further study of the Energy Conservation Act, 2001 original text from government sources can be referred.

Questions

Section A: Objective Questions (MCQs) – 10 Nos

1. **According to the 2022 Amendment to the Energy Conservation Act, 2001, which of the following criteria must a structure meet to be defined as a "Building".**
 - A) It must be used exclusively for industrial manufacturing with a connected load of at least 500 kW.
 - B) It must be a structure constructed after the notification of codes, having a minimum connected load of 100 kW (or contract demand of 120 kVA), and used for commercial, office, or residential purposes.
 - C) It must be a private residence accommodating no more than two families with a maximum load of 50 kW.
 - D) It must be an existing structure used for agricultural purposes regardless of its connected load.
2. **Which market-based mechanism was introduced through the 2010 amendment to the Act?**
 - A) Carbon Credits
 - B) Energy Savings Certificates (ESCert) Bureau of Energy Efficiency 21
 - C) Renewable Energy Certificates (REC)
 - D) Net Metering
3. **What was a primary motivation for the 2022 amendment to the Energy Conservation Act?**
 - A) To reduce the number of designated consumers
 - B) To facilitate the achievement of India's international commitments.
 - C) To strengthen the Bureau of Energy Efficiency (BEE)
 - D) To focus exclusively on the agricultural sector
4. **Under the 2022 amendment, the "Energy Conservation Building Code" (ECBC) was renamed to what?**
 - A) National Building Energy Code (NBEC)
 - B) Energy Conservation and Sustainable Building Code (ECSBC)
 - C) Eco Niwas Samhita (ENS) 2024
 - D) Sustainable Development Building Code (SDBC)
5. **According to the salient aspects of the Energy Conservation (Amendment) Act, 2022, how has the statutory framework for the building sector been impacted?**
 - A) Scope of the Act was expanded beyond energy efficiency to include broader sustainability considerations and officially extended applicability to large residential buildings
 - B) Addition of residential buildings in the act
 - C) Diversification of definition of energy to include fossil fuels and Renewable energy sources
 - D) All of the above.
6. **What is the minimum connected load or contract demand specified in the Act for a building to fall under its purview?**
 - B) 50 kW or 60 kVA
 - B) 100 kW or 120 kVA
 - C) 200 kW or 240 kVA
 - D) 500 kW or 600 kVA

7. **According to the amended Section 2(h), 'Energy' now explicitly includes power derived from which of the following?**
 - A) Only fossil fuels
 - B) Only nuclear substances
 - C) Fossil fuels, non-fossil sources, or renewable sources
 - D) Only biomass connected to the grid
8. **The 2022 amendment empowers the Central Government to specify energy consumption and fuel efficiency standards for which additional categories?**
 - A) Only household appliances
 - B) Vehicles and vessels
 - C) Only agricultural pump sets
 - D) Non-motorized transport
- 9) **According to the Energy Conservation (Amendment) Act, 2022, , what are the specific load or demand thresholds a residential building must meet to fall under the statutory definition of a "Building" and thus be subject to the code?**
 - A) A minimum residential plot size of 500m².
 - B) A minimum connected load of 100 kW or a contract demand of 120 kVA.
 - C) A minimum connected load of 50 kW or a contract demand of 60 kVA.
 - D) A minimum connected load of 500 kW or a contract demand of 600 kVA.
10. **What new concept was introduced by the 2022 amendment to encourage decarbonisation across the Indian economy?**
 - A) Mandatory solar for all homes
 - B) Carbon trading
 - C) Free electricity for energy-efficient industries
 - D) Abolition of thermal power plants

Section B: Short Answer Questions – 5 Nos

1. Provide short note on 3 salient features of EC Amendment 2022 relevant for building sector.
2. Provide short note on salient features of EC Amendment 2010.
3. Write a short note on changes of the definition of buildings in EC act amended 2022, and its relevance for building sector.
4. write a short note on changes of the definition of energy in EC act amended 2022, and its relevance for building sector.
5. Write a short note on inclusion of sustainability in the ECSBC

Section C: Long Answer Questions – 2 Nos

6. Describe salient aspects of 2022 amendment to EC Act for building sector
7. Describe the importance of inclusion of residential buildings in the EC act.

Answer Key for MCQs

1. B	6. B
2. B	7. C
3. B	8. B
4. B	9. B
5. D	10. B

3. BUREAU OF ENERGY EFFICIENCY AND STATE-DESIGNATED AGENCIES

3.1. Bureau of Energy Efficiency

The Bureau of Energy Efficiency (BEE) is a statutory body constituted by the Central Government under Section 3 of the Energy Conservation Act, 2001. The Central Government, by notification in the Official Gazette, established the Bureau for the purpose of administering and implementing the provisions of the Act. The mission of the BEE is to develop policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 (EC Act). The primary objective is to aim for reducing the energy intensity of the Indian economy. This would be achieved with active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all potential sectors of the Indian economy.

The Bureau functions under the administrative control of the Central Government through the Ministry of Power, and consists of members appointed by the Central Government.

II. Statutory Roles and Functions of BEE related to building sector

The functions of BEE are primarily derived from Section 13 of the Energy Conservation Act, 2001, supplemented by statutory powers conferred elsewhere in the Act and policy responsibilities assigned under the National Mission for Enhanced Energy Efficiency (NMEEE).

1. Advisory to Central Government

To advise the Central Government on matters relating to energy conservation and recommend policy measures and regulatory frameworks for effective implementation of the Act.

2. Appliance and Equipment Standards and Labelling

To specify and monitor energy efficiency standards and energy consumption norms for equipment and appliances, and to implement energy labelling programmes.

3. Energy Conservation and Sustainable Building Code (ECSBC)

To develop and recommend the ECSBC -Commercial and ECSBC- Residential also known as Eco Niwas Samhita (ENS) 2024 and assist state governments in its adoption and enforcement.

4. Designation and Regulation of Energy-Intensive Consumers

To recommend notified users and industries as designated consumers and prescribe procedures for monitoring and compliance with energy consumption norms.

5. Accreditation of Energy Auditors and Managers, and Energy Auditor (Buildings)

To specify qualifications, conduct examinations, grant certificates and accredit energy auditors and energy managers.

6. Data Collection and Reporting

To specify formats and procedures for submission of energy consumption data and to require submission of reports from designated consumers.

7. Promotional and Awareness Role

To promote awareness and training in energy efficiency and conservation and

disseminate information to stakeholders.

8. Coordination with state governments and institutions

To assist state governments, regulatory commissions, financial institutions, and other agencies in promoting energy-efficiency measures.

3.2. Schemes of BEE

Building Energy Efficiency Program

a) Energy Conservation and Sustainable Building Code (ECSBC) and Eco Niwas Samhita (ENS) -2024

In India, the Energy Conservation Act, 2001 provides the basic framework for regulating all initiatives relating to the efficient use of energy and this includes Energy Conservation and Sustainable Building Code (ECSBC). Building Codes have been adopted as a regulatory measure for ushering energy efficiency in the building sector.

In view of the amendment made to Energy Conservation Act, 2001 in 2022, Energy Conservation and Building Code (ECBC) has been upgraded to Energy Conservation and Sustainable Building Code (ECSBC) to include sustainable features for both commercial and residential building sectors. ECSBC has been launched in September 2024, for Commercial buildings and Eco-Niwas Samhita (ENS) for Residential buildings.

b) Star Rating of the commercial Buildings and Shunya Labeling for Net Zero and Net Positive Energy Buildings.

The Building Star Labelling Programme of BEE is a performance-based initiative designed to promote energy efficiency in the building sector by providing a simple and transparent framework to rate buildings based on their actual energy consumption. The program can be applied to appliance, vehicle, vessel, industrial unit, building or establishment, including Net zero labeling. These labels define the energy efficiency on a 1-5 star scale or any other parameter like energy consumption, carbon emission etc.

c) Energy Efficient Retrofit Manual for Existing Buildings.

While considerable progress has been made in designing energy-efficient new buildings, the potential for retrofitting existing structures remains largely untapped. Retrofitting offers a cost-effective and scalable solution to reduce energy consumption and greenhouse gas emissions, aligning with national sustainability goals. In recognition of this potential, BEE has developed comprehensive manuals to guide the assessment, planning and implementation of energy-efficient retrofits in both commercial and residential buildings.

Perform Achieve and Trade

Perform Achieve and Trade (PAT) is a regulatory instrument to reduce Specific Energy Consumption in energy intensive industries, with an associated market-based mechanism to enhance the cost effectiveness through certification of excess energy saving which can be traded under the National Mission for Enhanced Energy Efficiency (NMEEE).

PAT mechanism is designed to achieve the targeted specific energy consumption norms and standards through energy efficiency measures in energy intensive industries and establishment. Energy consumption norms and standards are set by BEE. Such energy intensive industries and establishments are identified as Designated Consumers (Dcs),

who are required to designate an energy manager and file energy consumption return every year and conduct mandatory energy audits regularly.

The Specific Energy Consumption (SEC) is calculated on a Gate-to-Gate concept. The DC's achievements is based on the difference between the specific energy consumption in the baseline year and specific energy consumption in the target year covering different forms of net energy going into the boundary of the designated consumer's plant and the products leaving it over the relevant cycle.

The Perform, Achieve and Trade (PAT) scheme of BEE has steadily evolved from a foundational energy-efficiency initiative in PAT Cycle I—focused on a limited set of energy-intensive sectors and establishing the Energy Saving Certificate (ESCert) trading mechanism—into a mature, multi-sectoral market instrument

PAT Cycles II to VIII, expanded coverage, stricter specific energy consumption (SEC) targets, and improved monitoring, reporting, and verification systems. Over successive cycles, the scheme has incorporated diverse sectors such as railways, DISCOMs, petrochemicals, and commercial buildings, while refining methodologies for normalization and compliance, thereby increasing both ambition and credibility.

Under PAT-IV, PAT-V and PAT-VI under commercial buildings hotels were added. Total 132 Hotels as Designated Consumers (DCs) were added in PAT-IV. 37 DCs Hotels in PAT-IV, 31 DCs Hotels in PAT-V and 64 DCs in PAT-VI.

By the time of PAT Cycle VIII (2023–26), PAT has not only scaled in size and impact but also begun aligning with India's broader climate goals under the Carbon Credit Trading Scheme, signaling a transition from a pure energy-efficiency framework to an integrated market-based mechanism supporting decarbonization, and continuing to transform as a key pillar of the country's sustainable energy policy landscape.

Establishment of Excellence Center (UTPRERAK)

UTPRERAK (Unnat Takniki Pradarshan Kendra) also known as AITDC (Advance Industrial Technology Development Centre) has been set up at NPTI Badarpur wherein 13 technologies across 5 sectors namely Cement Chlor-Alkali, Iron & Steel, Pulp & Paper and Textile has been demonstrated through their models in order to promote energy conservation and sustainable development in India. The centre was inaugurated in June 2023. Eight capacity building programs have been conducted at the Centre in FY2024-25 for representatives from the Cement, Textile, Thermal Power Plant and Pulp & Paper industries. Additional training programs for other sectors, State Designated Agencies (SDAs), and Accredited Energy Auditors (AEAs) are currently underway.

DEEP (Demonstration of energy efficiency project)

Demonstration of Energy Efficiency Project (DEEP) is entrusted to EESL regarding demonstration of 8 nos. of energy efficiency technologies in about 27 Designated Consumer units.. MOAs have been signed between EESL and 16 PAT Designated Consumers (DCs) under DEEP where energy efficient technologies would be demonstrated at the DC's premises.

Financial Energy Efficiency Program

India's pathway to the low-carbon economy and enhanced energy security requires strong investment flows into energy efficiency (EE) interventions. The investment potential for energy efficiency in industries and commercial establishments in India is estimated to be in the range of USD 10-15 billion, particularly in sectors such as MSMEs, large industries, commercial buildings, and municipalities. However, access to timely and affordable finance, along with risk perceptions among lenders, continues to be a major barrier to

scaling up EE project.

a) Energy Efficiency Financing Program (EEFP)

A strategic platform by BEE to engage financial institutions, project developers, and stakeholders for accelerating financing of energy efficiency projects across sectors. The primary objective is to enable demand-side financing by leveraging future energy savings, building capacity among financial institutions and ESCOs, and raising awareness on BEE'S EE financing schemes.

b) Framework for Energy Efficient Economic Development

An initiative to develop and implement fiscal instruments that support financial institutions in funding energy efficiency projects at scale. Its main aim is to catalyze market development for energy efficiency by easing access to finance through innovative mechanisms and fiscal tools.

BEE initiative also include other complementing activities like Derisking instruments for energy efficiency projects.

Assistance in Deploying Energy Efficient Technology in Industrial Establishments (ADEETIE) Scheme

The scheme envisages to provide interest subvention of 5% for Micro and Small Enterprises, and 3% of Medium Enterprises on loans, ensuring accessibility and affordability for MSMEs seeking financial aid for energy efficiency (EE) projects. The scheme assist MSMEs for conducting investment Grade Energy Audit (IGEA), preparation of Detailed Project Reports (DPRs), and Post-implementation Monitoring and Verification (M&V).

ADEETIE Aimed to Implement a Cluster-Based Approach

The initiative emphasizes technology adoption, financial accessibility, and transparent implementation through a dedicated scheme portal. ADEETIE represents a major step in bridging the gap between energy efficiency potential and its implementation, fostering competitiveness and sustainability in the Indian MSME sector."

Standards and Labeling Scheme

The Standards and Labeling (S&L) Program, implemented by BEE, aims to empower consumers with informed choices regarding the energy consumption and cost-saving potential of various energy-consuming appliances. As of July 2025, the S&L program encompasses following appliances.

List of Mandatory Appliances

- 1 Frost Free Refrigerators
- 2 Stationary Storage Type Electric Water Heater
- 3 Colour Television
- 4 Washing Machine (Semi/Top Load/Front Load)
- 5 Room Air Conditioner (Variable Speed)
- 6 TFL
- 7 LED LAMPS
- 8 Chillers
- 9 Light Commercial Air Conditioners
- 10 Deep Freezers

- 11 Ultra-High Definition (UHD) Televisions
- 12 Room Air Conditioner (Fixed Speed)
- 13 RAC (Cassette, Floor Standing Tower, Ceiling, Corner AC)
- 14 Induction Hob(w.e.f-1 July,2026)
- 15 Grid Connected Solar Inverter
- 16 Distribution Transformer
- 17 Direct Cool Refrigerators
- 18 Ceiling Fan
- 19 Domestic Liquefied Petroleum Gas Stove

List of Voluntary Appliances

- 1 General Purpose Industrial Motor
- 2 Submersible Pump Set
- 3 Computer
- 4 Ballast
- 5 Office Automation Products
- 6 Diesel Engine Driven Mono set Pumps for Agricultural Purposes
- 7 Solid State Inverter
- 8 Diesel Generator Set
- 9 Microwave Oven
- 10 Solar Water Heater
- 11 Air Compressors
- 12 High Energy Li-Battery
- 13 Tyres/Tires
- 14 Side by Side/Multi Door Refrigerator
- 15 Pedestal Fan
- 16 Table/Wall Fan
- 17 Induction Hob
- 18 Solar Photovoltaic
- 19 Packaged Boiler
- 20 Commercial Beverage Coolers
- 21 Refrigerant Compressors
- 22 Evaporative Air Coolers
- 23 EV Charger

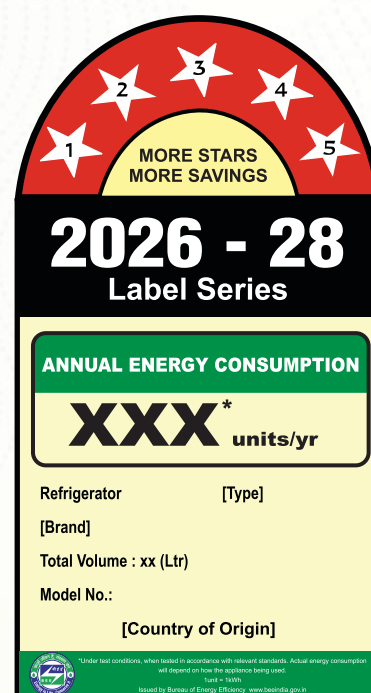


Figure 5 Sample of BEE Star Labeling for Frost Free Refrigerators

The scheme is in a continuous evolution with new appliances being included in list of appliances in the mandatory and voluntary regime and upgradation/revision of energy performance standards of appliances already included in the list.

Demand Side Management (DSM)

Demand side management interventions by BEE for Municipal and Agricultural demand is done for reducing the burden of utilities during the peak hours and enable them to contain financial losses, improving efficiencies and reducing subsidy burden on state utilities. There are several capacity building programs done by BEE and activities such as replacement of inefficient transformers.

Energy Efficiency in Transport sector

The initiatives taken to improve energy efficiency of automobiles including cars, medium & heavy commercial vehicles are as follows:

- (i) Passenger Cars : Corporate Average Fuel Efficiency (CAFE) norms were first implemented by the Government in 2017, under the Energy Conservation Act, 2001 to lower fuel consumption per km travelled by passenger cars.
- (ii) Commercial Vehicles: Fuel Economy Norms for Heavy-Duty Vehicles (HDVs) and Light & Medium Commercial Vehicles (LMCVs)
- (iii) Star Rating Programme for Tyres

E-Mobility

Electric Vehicles (EVs) are a crucial part of India's sustainable mobility transition, offering zero tailpipe emissions and reduced dependence on fossil fuels. With the transport sector contributing nearly 13% of the country's total carbon emissions and road transport alone responsible for 90% of passenger movement, EV adoption has accelerated through targeted policies as follows:

- (i) FAME-I and FAME-II
- (ii) Production-Linked Incentive (PLI) for Advanced Chemistry Cell (ACC) batteries
- (iii) PM E-DRIVE Scheme
- (iv) Scheme to Promote Manufacturing of Electric Passenger Cars in India (SPMEPCI)
- (v) State-level incentives under State EV Policies

Carbon Credit Trading Scheme (CCTS) and Indian Carbon Market:

Globally, carbon pricing instruments are essential tools in the fight against climate change. These instruments can be categorized into two main types: compliance mechanisms and voluntary

mechanisms. Compliance mechanisms, such as CCTS, are typically implemented and managed by governments. They set a cap on emissions and allow entities to trade emission allowances to meet their targets. Voluntary mechanisms, on the other hand, are often managed by independent standards or non-governmental organizations and enable entities to voluntarily offset their emissions by purchasing carbon credits from projects that reduce or remove GHG emissions.

In the past, Indian industries are familiar with the implementation of both compliance markets (PAT-ESCs and RECs) and voluntary (offset) projects such as CDM (Clean Development Mechanism) and similar other instruments. Indian agencies have registered 2nd largest number of CDM projects globally. Under the PAT scheme, Indian units have been able to save more than 106 million tonnes of CO₂ emissions since 2015 till June 2024.

To facilitate the achievement of India's enhanced NDC targets, a robust National Framework for Indian Carbon Market (ICM) through a reliable national carbon credit electronic platform is being developed. This framework aims to complement and support various entities by pricing their additional actions towards Green House Gas (GHG) emission reduction, who are undertaking projects to decarbonize the Indian economy.

The Indian Carbon Market Framework has two key mechanism – Compliance mechanism which aims to address the emissions from its energy use and industrial sectors and offset mechanism to incentivize the voluntary actions from entities (not covered under compliance) for GHG reduction, thus providing a comprehensive approach to decarbonization of the economy.

National Certification Examination for Energy Managers and Energy Auditors, and Energy Auditor (Buildings)

As per the Energy Conservation Act 2001, it is mandatory for all the designated energy consumers to get energy audit conducted by an Accredited Energy Auditor and to designate or appoint an Energy Manager.

BEE has regularly conducted the National Certification Examination, nation-wide, for Energy Managers and Energy Auditors since May 2004 and has created a cadre of professionally qualified energy managers and auditors with expertise in energy management, project management, financing and implementation of energy efficiency projects.

In august 2025 regulation for certification of energy auditors , energy auditors building and energy manager was notified. This will help implementation of ECSBC and ENS 2024.



India Cooling Action Plan

The India Cooling Action Plan (ICAP), launched in 2019 by the Ministry of Environment, Forest and Climate Change (MoEF&CC), is a comprehensive national strategy aimed at addressing the rapidly growing demand for cooling in India. With rising temperatures, urbanization, and increasing access to air-conditioning, cooling demand is expected to grow significantly, leading to higher energy consumption, peak electricity loads, and environmental impacts due to refrigerant use. ICAP provides a long-term (2019–2037) roadmap to ensure sustainable cooling while minimizing energy use and environmental damage. It is one of the first such national cooling plans globally and integrates energy efficiency, climate action, and thermal comfort considerations.

The primary objective of ICAP is to provide sustainable cooling for all while reducing its environmental footprint. The plan sets ambitious targets, including reducing overall cooling demand by 20–25%, lowering refrigerant demand by 25–30%, and decreasing cooling energy requirements by 25–40% by 2037. It also emphasizes enhancing thermal comfort for vulnerable populations and promoting skill development in the refrigeration and air-conditioning sector. These goals are aligned with India's international commitments under the Paris Agreement and the Kigali Amendment to the Montreal Protocol, which mandates the phasedown of high global warming potential refrigerants.

The building sector plays a central role in achieving the objectives of ICAP, as it is expected to drive a large share of future cooling demand. The plan promotes a hierarchy of cooling strategies that prioritize passive design measures before relying on mechanical systems. These include climate-responsive building design, improved building envelopes, appropriate orientation, shading devices, natural ventilation, and the use of cool roofs and reflective materials. Such strategies significantly reduce the need for active cooling and are aligned with provisions in the ECSBC and the National Building Code (NBC) 2016.

In addition to passive strategies, ICAP emphasizes the adoption of energy-efficient cooling technologies. This includes the use of high-efficiency air-conditioning systems, such as those compliant with Bureau of Energy Efficiency (BEE) star labeling, and advanced HVAC solutions like Variable Refrigerant Flow (VRF) systems. The plan also supports the transition to low-global warming potential refrigerants in line with international commitments. Further, it promotes innovative solutions such as district cooling systems and integration of renewable energy to meet cooling demands in a sustainable manner.

ICAP is closely linked with several existing policies and regulatory frameworks in India. It reinforces the role of ECSBC in setting minimum energy performance standards for buildings and strengthens the implementation of NBC provisions related to thermal comfort and ventilation. It also complements initiatives such as the BEE star labeling program, state-level energy codes, and urban missions like the Smart Cities Mission, which promote sustainable infrastructure. Effective implementation of ICAP depends on coordination between central, state, and local authorities, particularly in enforcing building codes and promoting energy-efficient practices.

Promotional Role of BEE

The promotional role of BEE primarily includes:

- Creating awareness and disseminating information on energy efficiency and conservation.
- Arranging and organizing training of personnel and specialists in techniques for efficient use of energy.
- Strengthening consultancy services in the field of energy efficiency. • Promoting research and development.
- Developing testing and certification procedures and promoting testing facilities.
- Formulating and facilitating the implementation of pilot and demonstration projects.
- Promoting the use of energy-efficient processes, equipment, devices, and systems. • Encouraging preferential treatment for use of energy-efficient equipment and appliances.
- Promoting innovative financing of energy efficiency projects.
- Providing financial assistance to institutions for promoting the efficient use of energy and its conservation.
- Implementing international cooperation programmes relating to the efficient use of energy and its conservation.

Those sectors that have received multi-lateral, bilateral, and private sector support are empowered by BEE initiatives. State nodal agencies are enabled to drive energy conservation measures. State energy regulatory commissions, distribution companies (DisComs) and utilities are entrusted with regulatory conservation measures and promotion of energy-efficiency programmes.

Other activities

- National energy conservation awards and painting competition
- International bilateral and multilateral programmes

3.3. State-Designated Agency

As per the Energy Conservation (EC) Act 2001, state government has been empowered to designate agencies (state- designated agencies, i.e. SDA) in consultation with BEE. Designated agencies will have the responsibility to implement the act within the state.

Responsibilities

- Spread awareness on EC Act
- Undertake voluntary initiatives to promote energy conservation
- Liaison and coordinate with BEE, state government departments dealing with energy, industry, planning, regulators, consumer affairs, municipal bodies, etc.
- Capacity building of staff employed
- Launch and maintain state specific website addressing the voluntary and mandatory

provision of the EC Act

- Undertake energy conservation awareness program for consumers, industrial, commercial and residential sector, school children, farmers, etc.
- Arrange interactive meetings between energy managers, energy auditors, designated consumers, and other experts.

Duties

- Prepare a list of designated consumers.
- Compile information received from designated consumers through annual statements on energy consumption, energy audit reports, and action taken on the report of energy audit.
- Prepare a state and sectoral energy database and provide feedback to designated consumers.
- Take all measures necessary to create awareness and disseminate information for efficient use of energy and its conservation.
- Arrange and organize training of professionals and specialists in the technique for efficient use of energy and its conservation.
- Take steps to encourage preferential treatment for use of energy-efficient equipment of appliance.
- Appoint or designate inspecting officer with specified powers as necessary for the purposes of ensuring compliance with energy consumption standards.
- Assist state government in the preparation of rules under Section 57 of the Energy Conservation Act.
- Establish Energy Conservation Fund for the purposes of promotion of efficiency use of energy and its conservation within the state.

Questions

Section A: Objective Questions (MCQs) – 10 Nos

1. **Under which section of the Energy Conservation Act, 2001, was the Bureau of Energy Efficiency (BEE) established as a statutory body?**
 - A) Section 2
 - B) Section 3
 - C) Section 13
 - D) Section 14
2. **What is the primary objective of the Bureau of Energy Efficiency (BEE)?**
 - A) To maximize the export of petroleum products
 - B) To reduce the energy intensity of the Indian economy
 - C) To manage the distribution of energy in urban areas
 - D) To build new thermal power plants
3. **Which scheme of BEE is specifically designed to reduce Specific Energy Consumption in energy-intensive industries through a market-based mechanism for trading energy savings?**
 - A) Standards and Labeling (S&L)
 - B) Demand Side Management (DSM)
 - C) Perform, Achieve and Trade (PAT)
 - D) E-Mobility
4. **The 'UTPRERAK' center, also known as the Advance Industrial Technology Development Centre, was established to promote energy conservation in which of the following sectors?**
 - A) Solar and Wind energy
 - B) Cement, Iron & Steel, and Textile industries
 - C) Information Technology and Telecom
 - D) Agriculture and Fisheries
5. **What is the primary aim of the Standards and Labeling (S&L) Program implemented by the Bureau of Energy Efficiency (BEE)?**
 - A) To assist MSMEs in deploying energy-efficient technologies
 - B) To empower consumers with informed choices regarding the energy consumption and cost-saving potential of various energy-consuming appliances
 - C) To formulate uniform policies for power systems
 - D) To mandate the use of renewable energy
6. **According to the India Cooling Action Plan (ICAP) what is the primary role of the building sector in achieving sustainable cooling?**
 - A) To prioritize the use of high-capacity mechanical air-conditioning systems.
 - B) To promote a hierarchy of cooling strategies that prioritizes passive design measures—such as improved building envelopes, shading, and natural ventilation—before relying on mechanical systems.
 - C) promote district cooling.
 - D) To focus exclusively on the transition to high-global warming potential (GWP) refrigerants.

7. **The Indian Carbon Market (ICM) Framework consists of which two key mechanisms?**
 - A) Direct Tax and Indirect Subsidy
 - B) Compliance and Offset mechanisms
 - C) Import and Export mechanisms
 - D) Generation and Distribution mechanisms
8. **Since when has BEE been conducting the National Certification Examination for Energy Managers and Energy Auditors?**
 - A) September 2001
 - B) March 2002
 - C) May 2004
 - D) August 2025
9. **Who has the authority to designate a State-Designated Agency (SDA) for the purpose of implementing the Energy Conservation Act within a state?**
 - A) The Ministry of Power alone
 - B) The State Government, in consultation with BEE
 - C) The NITI Aayog
 - D) The Supreme Court of India
10. **Which of the following is a primary duty of a State-Designated Agency (SDA) as per the Act?**
 - A) To develop standards for energy efficiency of appliances in the state
 - B) To prepare a list of designated consumers within the state
 - C) To regulate international fuel prices
 - D) To issue carbon credit certificates for the transport sector

Section B: Short Answer Questions – 5 Nos

1. What is the significance of the Energy Conservation and Sustainable Building Code (ECSBC) and Eco Niwas Samhita (ENS) 2024 in the Building Energy Efficiency Program?
2. What are the key statutory roles of the Bureau of Energy Efficiency (BEE) that specifically relate to the building sector?
3. How does Star Labelling Programme promote energy efficiency?
4. write short note on schemes of BEE for Building sector?
5. What are the primary duties and responsibilities of State-Designated Agencies (SDAs) in implementing building energy policies?

Section C: Long Answer Questions – 2 Nos

1. What are the Statutory Roles and Functions of BEE related to building sector
2. What is the role of State designated agency for promoting energy efficiency in building sector.

Answer Key for MCQs

1. B	6. B
2. B	7. B
3. C	8. C
4. B	9. B
5. B	10. B

4. ECSBC FOR COMMERCIAL AND RESIDENTIAL BUILDINGS

4.1. Background

The Energy Conservation and Sustainable Building Code (ECSBC) 2024 provides India's national framework for energy-efficient and sustainable commercial buildings, notified by the Central Government under Section 14 (p) and 14 (q) and Section 56(2)(I) to prescribe Energy Conservation and Sustainable Building Codes. The code is defined vide Section 2(j) of the Act as the norms and standards for energy efficiency and its conservation, use of renewable energy and other green building requirements for a building. It replaces the earlier ECBC 2017 by combining energy efficiency with sustainability, covering energy, water, waste, materials, indoor environment, and site planning.

In line with the global launch of the Hon'ble Prime Minister's LiFE (Lifestyle for Environment) movement, the scope of the ECBC has been progressively expanded beyond energy efficiency to incorporate renewable energy integration and sustainability principles. This evolution reflects India's commitment to climate action, resource efficiency, and sustainable development in the built environment.

4.2. Energy Efficiency in Commercial Buildings

Pursuant to the Energy Conservation (Amendment) Act, 2022, the earlier energy codes were comprehensively revised and notified as the ECSBC for commercial buildings in 2024. The ECSBC builds upon the foundations of ECBC by integrating broader sustainability dimensions alongside energy efficiency.

In addition to prescribing minimum energy performance standards, ECSBC introduces enhanced priorities such as energy efficiency, renewable energy, and other green building. The code incorporates passive building design strategies, sustainable site planning, water conservation, waste management, and improved indoor environmental quality, thereby promoting a holistic approach to sustainable building design.

The ECSBC framework provides incremental performance levels, namely ECSBC, ECSBC Plus, and Super ECSBC, enabling projects to progressively exceed baseline requirements. The code applies to commercial buildings with a connected load of 100 kilowatt (kW) or more or a contract demand of 120 kilovolt-ampere (kVA) or more. These codes can be amended by states by provision of EC act 2001 under sec 15 (a) to suit the local and regional climatic condition of the states.

4.3. Energy efficiency in residential buildings

India has witnessed rapid growth in its residential building stock, accompanied by increasing electricity consumption, particularly for space cooling. Projections by NITI Aayog indicate that electricity consumption in the residential sector could increase six to thirteen times by 2047. Studies of urban middle-income housing reveal that 30–60% of annual electricity consumption is attributed to achieving thermal comfort. Ensuring thermal comfort is especially critical in residential buildings, including affordable housing, as it directly affects the health, well-being, and productivity of occupants.

Recognizing this challenge, BEE introduced residential building energy codes in 2018, Eco Niwas Samhita (ENS) Part I – Building Envelope. This code part prescribes minimum envelope performance standards to limit heat gains in cooling-dominated climates and heat losses in heating-dominated climates, while ensuring adequate natural ventilation and daylighting. The ENS applies to residential buildings with a connected load of 100 kW

or more or a contract demand of 120 kVA or more.

Subsequently, Eco Niwas Samhita Part II, covering code compliance approaches, electro-mechanical systems, indoor electrical loads, and renewable energy systems, was notified in 2021. Following the Energy Conservation (Amendment) Act, 2022, residential buildings were formally brought within the energy conservation regime. In response, a comprehensive and integrated code—Eco Niwas Samhita 2024—was introduced, combining energy efficiency requirements with sustainability aspects related to site planning, water efficiency, waste management, and indoor environmental quality.

4.4. Implementation and Enabling Measures

To facilitate effective implementation of ECSBC and ENS across the country, BEE has undertaken several enabling measures. These include the establishment of building cells in states and union territories, development of technical reference documents, compliance check tools, and standardized training modules for key stakeholders. The BEE has also supported the development of ECSBC demonstration projects in various states to showcase best practices.

While BEE is responsible for notifying the codes, the implementation and enforcement of ECSBC and ENS rest with the state and union territory governments. States adapt the codes and associated rules to local conditions and integrate them into existing building approval and permitting processes, thereby enabling systematic enforcement and compliance within their respective jurisdictions.



Questions

Section A: Objective Questions (MCQs) – 10 Nos

1. **Which overarching legislation provides the legal framework for regulating the efficient use and conservation of energy in India's building sector?**
 - A) The National Building Code 2016
 - B) The Electricity Act, 2003
 - C) The Energy Conservation Act, 2001
 - D) The Environment (Protection) Act, 1986
2. **The scope of the building codes was expanded beyond energy efficiency to include renewable energy and sustainability principles in line with which global movement?**
 - A) The Paris Agreement
 - B) The LiFE (Lifestyle for Environment) movement
 - C) The Net Zero 2070 pledge
 - D) The Montreal Protocol
3. **Beyond prescribing minimum energy performance standards, how does the Energy Conservation and Sustainable Building Code (ECSBC) promote a holistic approach to sustainable building design?**
 - A) By introducing enhanced priorities such as renewable energy integration and other green building requirements
 - B) By incorporating passive building design strategies and sustainable site planning
 - C) By including provisions for water conservation, waste management, and improved indoor environmental quality
 - D) All of the above
4. **Which of the following is NOT one of the three progressive performance levels defined under the ECSBC framework?**
 - A) ECSBC
 - B) ECSBC Plus
 - C) Ultra ECSBC
 - D) Super ECSBC
5. **While the Bureau of Energy Efficiency (BEE) is responsible for notifying the codes, which entities are responsible for their actual implementation and enforcement?**
 - A) Central Electricity Authority (CEA)
 - B) State and Union Territory governments
 - C) Ministry of Environment, Forest and Climate Change (MoEF&CC)
 - D) State Designated Agencies
6. **Which specific organizational initiative has the Bureau of Energy Efficiency (BEE) undertaken in states and union territories to facilitate the effective rollout of the building energy codes?**
 - A) Establishing local "Building Cells" to support technical capacity and code adoption.
 - B) Creating a national task force for the direct manufacturing of energy-efficient windows.
 - C) Launching a mandatory insurance program for all energy-efficient construction projects.
 - D) Implementing a centralized water distribution network for all commercial complexes.
7. **In which year was Eco Niwas Samhita (ENS) Part II, covering code compliance approaches, electro-mechanical systems, indoor electrical loads, and renewable energy systems, notified?**
 - A) 2017
 - B) 2018
 - C) 2021
 - D) 2022

8. In which year was the first part of the residential building energy code, Eco Niwas Samhita (ENS) Part I – Building Envelope, introduced?

- A) 2007
- B) 2017
- C) 2018
- D) 2024

9. Under which section of the Energy Conservation Act, 2001, are state governments empowered to amend the building codes to suit regional and local climatic conditions?

- A) Section 2(j)
- B) Section 13(d)
- C) Section 14(p)
- D) Section 15(a)

10. What was the major outcome of the 2022 Amendment regarding the Energy Conservation Building Code (ECBC)?

- A) It was abolished and replaced by a voluntary scheme.
- B) It was renamed to the Energy Conservation and Sustainable Building Code (ECSBC) to include sustainable features.
- C) It was limited only to government-owned buildings.
- D) It removed the requirement for residential building compliance.

Section B: Short Answer Questions – 5 Nos

1. What was the primary reason for evolving the Energy Conservation Building Code (ECBC) into the Energy Conservation and Sustainable Building Code (ECSBC)?
2. What are the implementation and enabling measures BEE has undertaken for promoting ECSBC, and ENS in states.
3. What are the statutory load and demand thresholds for a building to fall under the purview of these codes?
4. Write a short note on energy efficiency in residential buildings.
5. Write a short note on energy efficiency in commercial buildings.

Section C: Long Answer Questions – 2 Nos

1. Explain the transition from the original Energy Conservation Building Code (ECBC) to the 2024 Energy Conservation and Sustainable Building Code (ECSBC). Discuss the primary drivers for this evolution, the expanded scope of the code, and the specific performance levels defined under the new statutory framework.
2. Addressing Residential Sector through Eco Niwas Samhita (ENS) Discuss the critical challenges facing India's residential building sector regarding energy consumption and sustainability

Answer Key for MCQs

1. C	6. A
2. B	7. C
3. D	8. C
4. C	9. D
5. B	10. B

5. CODE COMPLIANCE FOR COMMERCIAL BUILDINGS (ECSBC)

The ECBC Rules 2018 provides India's national framework for energy-efficient and sustainable commercial buildings, notified by the Central Government under Section 14 (p) and 14 (q) and Section 56(2)(I) to prescribe Energy Conservation Building Codes (ECBC). The code is defined vide Section 2(j) of the Act as the norms and standards for energy efficiency and its conservation, use of renewable energy and other green building requirements for a building. It replaces the earlier ECBC 2017 by combining energy efficiency with sustainability, covering energy, water, waste, materials, indoor environment, and site planning. The Code applies to commercial/office buildings ≥ 100 kilowatt (kW) connected load or ≥ 120 kilovolt-ampere (kVA) contract demand.

The state government under Section 15 (a) of the Act, may amend the energy conservation and sustainable building codes to suit the regional and local climatic conditions and may be rules made by it specify and notify energy conservation and building codes with respect to use of energy in the buildings and implement the same through building bye-laws of the state. Further, the state government is also empowered to coordinate, regulate, and enforce provisions of the Act within the state under Section 15 (d) of the Act through designated agency known as State Designated Agency (SDA).

The key objectives of ECSBC are to set a long-term vision for building energy efficiency and sustainability, and include new types of buildings, focus on strategies for reducing energy use, establish a baseline of energy performance and promote sustainability in buildings under the Act.

While the ECSBC is developed at Central level by the Central Government in consultation with the Bureau, its implementation has to be carried out through building bye-laws of the state under Clause (a) of Section 15 of the EC Act 2001. The ECSBC Rules can be included by updating the generic building bye-laws of authorities having jurisdiction of every state for compliance.

The BEE provides support to states by establishing the ECSBC Cells, formerly ECBC cells. The major role of ECSBC Cells is to support amendment of ECSBC for respective states, amendments in existing bye-laws, preparation of notification documents, energy efficient design templates for public buildings, assisting public work departments (PWDs) in design and construction of public buildings, building up technical capacities for code compliance and documentation for compliance.

The Code opens with Chapter 1, which states its purpose and articulates the statutory basis under the Energy Conservation Act, 2001. This chapter explains that the ECSBC seeks to set minimum mandatory requirements for energy-efficient design, renewable integration, and sustainable management of water, waste, materials, and indoor environmental quality. It also introduces the concept of tiered performance levels—ECSBC Compliant, ECSBC+, and Super ECSBC—each representing progressively stringent benchmarks in building performance.

Chapter 2 defines the scope and classification of buildings covered under the Code. It establishes that ECSBC 2024 applies to commercial and office buildings with a connected load of 100 kW or more or a contract demand of 120 kVA or more. It further describes the types of occupancies included, such as business, assembly, hospitality, health care, educational, shopping complexes, and mixed-use buildings with significant commercial components. The chapter also clarifies the systems and subsystems regulated under the Code, including the building envelope, comfort systems, lighting, electrical systems, water management, waste management, and site planning. It establishes the hierarchy of standards, noting that where a conflict exists, the more stringent provisions—such as National Building Codes, environmental

norms, or statutory safety requirements—will prevail.

Chapter 3 details the approach to compliance by defining the methodologies available for demonstrating conformity with the Code. It presents two primary pathways: the integrative compliance method (ICM), a whole-building performance-based approach using simulation, and the standardized compliance method (SCM), which adopts prescriptive component-level requirements. The chapter explains that certain mandatory provisions apply regardless of the compliance path. It also outlines the compliance requirements for new buildings, additions, and alterations, and specifies the documentation, tools, and forms required for compliance submissions and verifications.

In the ECSBC 2024 technical sections are structured differently for sustainability aspects introduced in 2024 version and aspect, such as sustainable sites, water management, waste management, and indoor air quality. These sections detail out the mandatory requirement to be met for complying to ECSBC in Sub-section 2 while Sub-section 3 details out the requirement for ECSBC plus and Super ECSBC. The other sections linked to energy efficiency which were also part of the earlier version of ECBC, such as building envelope, comfort systems and controls, lighting and controls, electrical and renewable energy mentions the mandatory and prescriptive requirements in its subsections. In case of building envelope there is a building envelope tradeoff method. The Building Envelope Trade-off Method is a performance-based compliance pathway that allows a building to meet energy code requirements even if some individual envelope components do not meet the prescriptive limits, as long as the overall envelope performance is equal to or better than the code baseline.

5.1. Compliance Levels under ECSBC 2024

The ECSBC 2024 defines three progressive levels of compliance: ECSBC, ECSBC+, and Super ECSBC. Each level builds upon mandatory requirements and allows designers to demonstrate higher performance of compliance across the various sustainability chapters of the Code.

The building is assessed for compliance through any of the following two methods

1. Integrative compliance method (ICM) (simulation method)

To comply with the ECSBC through ICM, modelled energy performance intensity (MEPI) value shall be calculated using simulation as specified in Section 12 of the ECSBC with respect to the mandatory and prescriptive requirements of Sections 5 to 8 of the ECSBC along with the compliance of all the mandatory requirements of Sections 4.2, 9.2, 10.2, 11.2.

For meeting the compliance of ECSBC plus and Super ECSBC, along with MEPI and percentage energy saving (PES) respective requirements of Sections 4.3, 9.3, 10.3, and 11.3 shall be met.

MEPI can be determined using the formula:

Here, the net built-up area (m²) is the total built-up area (m²) excluding the following areas:

$$\text{MEPI} = \frac{\text{(Total Annual Energy Consumption(kwh/year))}}{\text{Net built - up Area (m}^2\text{)}}$$

- (a) Unconditioned basement area (m²)
- (b) Unconditioned refuge area (m²)
- (c) Stilt Parking Area (m²)

Sections required to be followed for ECSBC, ECSBC +, and Super ECSBC compliance with ICM

TABLE 2 SECTIONS REQUIRED FOR COMPLIANCE WITH ICM

Mandatory requirements for ECSBC, ECSBC +, and Super ECSBC	Additional mandatory Requirements for ECSBC +, and Super ECSBC	Simulation requirements for ECSBC, ECSBC +, and Super ECSBC
Section 4.2	Section 4.3	Section 12.1 to 12.5
Section 5.2		
Section 6.2		
Section 7.2		
Section 8.2		
Section 9.2	Section 9.3	
Section 10.2	Section10.3	
Section 11.2	Section 11.3	

For meeting this approach, the ECSBC document provides compliance forms for providing required information for each section's mandatory, additional mandatory requirements and simulation requirement along with calculation of MEPI and PES to be provided through whole building performance Section 12.1–12.5.

2. Standardized compliance method (SCM) (Prescriptive Approach)

To comply with the ECSBC with SCM building shall meet the standardized requirement mentioned in the Section 5.3 through 8.3, in addition to meeting all the mandatory requirements. The ECSBC buildings that demonstrate compliance through SCM shall be deemed to have PES as defined in Section 12.5.3 of ECSBC.

For meeting the compliance of ECSBC Plus, and Super ECSBC, the building shall meet the standardized requirements mentioned in the Section 5.3 through 8.3 and the additional mandatory requirements mentioned in Section 4.3 through 11.3, in addition to meeting all the mandatory requirements

Sections required to be followed for ECSBC, ECSBC +, and Super ECSBC compliance with standardized compliance method (SCM)

TABLE 3 SECTIONS REQUIRED FOR STANDARDIZED COMPLIANCE METHOD (SCM)

Mandatory requirements for ECSBC, ECSBC +, and Super ECSBC	Additional mandatory Requirements for ECSBC+, and Super ECSBC	Standardized requirements for ECSBC, ECSBC +, and Super ECSBC
Section 4.2	Section 4.3	
Section 5.2		Section 5.3
Section 6.2		Section 6.3
Section 7.2		Section 7.3
Section 8.2		Section 8.3
Section 9.2	Section 9.3	
Section 10.2	Section 10.3	
Section 11.2	Section 11.3	

For meeting this approach, the ECSBC document provides compliance forms for providing required information for each section's mandatory, additional mandatory and prescriptive requirements of Section 4 to Section 11.

The ECSBC 2024 establishes distinct compliance requirements for new buildings, existing buildings, and buildings undergoing additions, alterations, or change of use. The objective is to ensure that all buildings progressively transition towards higher efficiency and sustainability, while also recognizing practical constraints in retrofitting existing structures.

All new buildings falling within the applicability criteria of ECSBC 2024—specifically those having a connected load of 100 kW or more or a contract demand of 120 kVA or more—are required to comply fully with the provisions of the Code. New buildings must demonstrate compliance either through the standardized compliance method or the integrative compliance method, in addition to meeting all mandatory requirements specified across Chapters 4 to 11.

For new construction, compliance applies to all building systems covered under the Code, including the building envelope, comfort systems, lighting, electrical systems, water and waste management systems, and indoor environmental quality provisions.

During the building approval process, project proponents must submit all required compliance forms, energy performance calculations, drawings, and supporting documentation. The reviewing authority evaluates whether the design meets ECSBC provisions at the planning stage, and later verifies as-built compliance prior to occupancy. Since new buildings provide ample opportunities for integrating high-efficiency design strategies and modern technologies, the Code expects full adoption of prescriptive or performance-based requirements without exceptions.

If any existing building after additions or alterations changes its connected load to 100 kilowatt (kW) or above or a contract demand of 120 kilovolt-ampere (kVA) or above shall comply with the provisions of Chapter 4 through 11. Compliance may be demonstrated in either of the following ways:

- (a) The addition shall comply with the applicable requirements, or
- (b) The addition, together with the entire existing building, shall comply with the requirements of this code that shall apply to the entire building, as if it were a new building.

Following sections provide the detailed compliance documents required to be submitted by the Building owners and also details out the evaluation process to be followed for each section of the compliance forms in great detail. These compliance forms are taken from ECSBC Appendix 9 which needs to be filled and submitted by owner or its representation to the authority having jurisdiction. These sections are organized as per the chapters of ECSBC for compliances.

Chapter 4 details the compliance requirements of sustainable sites and planning. It describes how responsible site selection and planning decisions influence sustainability. The chapter highlights provisions on topsoil conservation, preservation of existing trees, universal accessibility, mitigation of urban heat island effects, and site development practices that enhance climate resilience. It further establishes expectations for access to public transport, on-site transit facilities, and brownfield redevelopment, and explains how sustainability considerations are embedded in site design across the three performance levels of the code.



Table 4 Sustainable sites and planning – compliance form

Sustainable sites and planning – compliance form			
Section	Component	Information required (documents submissions)	Compliance verification methodology
Mandatory requirements (Section 4.2)			
4.2.1	Topsoil preservation	Submit fertility test report of topsoil from the site conducted by an Indian Council of Agricultural Research (ICAR)-accredited laboratory, indicating fertility of the topsoil.	Compliance documents: 1) Submit a fertility test report of topsoil from an ICAR-accredited laboratory indicating soil fertility. 2) Submit a site plan in .dwg format highlighting areas of excavation and topsoil preservation. 3) Submit calculations indicating the total quantity of topsoil preserved and reused in landscape activity. 4) Submit date-stamped photographs documenting topsoil stripping, storage, protection, and reuse measures. Pre-construction (design stage) Compliance shall be verified through desk review of submitted documents. The following shall be verified: • The fertility test report has been issued by an ICAR-accredited laboratory and includes key soil parameters including soil pH, electrical conductivity, organic carbon content, and available macro-nutrients (nitrogen, phosphorus, and potassium), confirming topsoil fertility. • The site plan submitted in .dwg format clearly demarcates areas of excavation and designated areas for topsoil preservation. • Calculations for topsoil quantity are logical, complete, and traceable to site area and excavation extents shown in the drawings. During construction Compliance shall be verified through site inspections and validation of photographic evidence. The following shall be verified: • Topsoil is stripped prior to excavation, stored separately from other excavated material and protected from erosion, contamination and compaction. • The on-site preservation locations correspond to those indicated in the approved site plan. • Date-stamped photographs accurately reflect on-ground implementation of topsoil preservation measures, including stockpiling and protection practices.
		Submit calculations indicating the total quantity of topsoil pre-served and used in landscape activity post construction.	
		Upload date -stamped photographs with description of the measures implemented.	

			Post-construction Compliance shall be verified through desk review and cross-verification with as-built conditions. The following shall be verified: • Calculations demonstrating the total quantity of topsoil preserved and reused are consistent with the preserved quantities recorded during construction. • Preserved topsoil has been reused in landscape areas, as evidenced by photographs and alignment with final landscape or site development works. • Photographic documentation confirms permanent application of preserved topsoil in landscaped areas post construction.
4.2.2	Tree preservation and planting	Provide a site survey plan and a landscape plan that include clear indications of existing trees that have been transplanted, cut, or pre-served/protected, as well as the locations of new plantations.	Compliance documents 1) Submit site survey plan and landscape plan clearly indicating existing trees proposed for preservation, transplantation, and removal, along with locations of new plantations. 2) Submit official permission letter from the competent local authority approving tree cutting on site. 3) Submit detailed calculations specifying the number of existing trees preserved and the number of new trees planted, in compliance with ECSBC requirements. 4) Submit purchase orders reflecting the quantities of plantation materials procured. 5) Submit date-stamped photographs documenting protection of existing trees, transplantation or cutting activities (where permitted), and on-site plantation of new trees. Pre-construction (design stage) Compliance shall be verified through desk review of submitted drawings and statutory documents. The following shall be verified: • The site survey plan and landscape plan clearly identify all existing trees within the site boundary, with unambiguous differentiation between trees proposed for preservation, transplantation and removal. • Locations and species of new plantations are clearly indicated and correspond to landscape design intent. • An official tree-cutting permission letter has been issued by the competent local authority and corresponds exactly to the number and location of trees proposed for removal. • Calculations demonstrating the number of existing trees preserved and new trees proposed are complete, consistent and compliant with ECSBC requirements.
		Submit an official letter from the local governing authority granting permission for tree cutting on-site.	
		Provide purchase orders that clearly reflect the full quantities of new plantation materials procured.	
		Submit detailed calculations specifying the number of new trees planted and the existing trees preserved, ensuring adherence to the code's requirements.	

			During construction Compliance shall be verified through site inspections and validation of photographic evidence. The following shall be verified: - Existing trees identified for preservation are physically protected on site (barricading, no-dig zones, root protection), in accordance with the approved plans. - Transplantation and tree-cutting activities, where permitted, are carried out strictly as per statutory approvals. - New trees are planted at the approved locations and in the quantities indicated in the submitted calculations. - Purchase orders for plantation materials correspond to on-site plantation activities and quantities. Post-construction Compliance shall be verified through desk review and on-site validation. The following shall be verified: - Final plantation quantities match the submitted calculations and purchase records. - Preserved and newly planted trees are physically present, established, and identifiable on site. - As-built landscape conditions are consistent with the approved landscape plan and tree inventory. - Photographic documentation confirms survival and integration of plantations within the completed site development.
4.2.3	Selection of site	Indicate the compliance of the site plan with the local bye-laws and UDPFI guidelines and regulations	Compliance documents 1) Submit approved / sanctioned site plan demonstrating compliance with applicable local building bye-laws, development control regulations, and Urban Development Plans Formulation and Implementation (UDPFI) guidelines. 2) Submit statutory approval documents indicating permissible land use, plot size, access, setbacks, road width, and development parameters as per the applicable master plan/development plan. 3) Submit copies of any specific conditions imposed by the competent local authority and their incorporation in site planning submissions. 4) Submit as-built site layout drawings reflecting development in accordance with the approved site plan. 5) Submit completion certificate or equivalent statutory approval issued by the competent authority confirming compliance with local bye-laws and planning regulations.

			Pre-construction (design stage) Compliance shall be verified through desk review of statutory and planning documents. The following shall be verified: • The submitted site plan is approved or sanctioned by the competent authority and demonstrates compliance with applicable local building bye-laws, development control regulations and UDPFI guidelines. • Land use, plot size, access, setbacks, road width and permissible development parameters shown on the site plan are consistent with the applicable master plan/development plan provisions. • Any specific conditions imposed by the local authority (if applicable) are clearly reflected in the site planning submissions. During construction Compliance shall be verified through site inspections and document cross-checks. The following shall be verified: • Construction activities are carried out strictly within the sanctioned site boundary and conform to the approved site plan. • No deviation in land use, access, or site extent has occurred during construction without revised statutory approval. • Temporary site arrangements do not violate local bye-laws or planning regulations. Post-construction Compliance shall be verified through desk review of completion records and as-built drawings. The following shall be verified: • As-built site layout drawings are consistent with the approved site plan and statutory permissions. • A completion certificate or equivalent statutory approval has been issued by the competent authority, confirming development in accordance with local bye-laws and planning regulations. • No unauthorized site-level modifications exist at the time of occupancy.
4.2.4	Design for differently abled	Indicated that the ramps, entrance gate, elevator, and washroom are designed as per requirements indicated in code for differently abled people or as defined by the local byelaw.	Compliance documents 1) Submit architectural drawings clearly indicating ramps, entrance gates, elevators, and washrooms designed for differently abled persons. 2) Submit accessibility drawings and details demonstrating compliance with the applicable code for differently abled persons and/or local bye-laws, including dimensions, slopes, clearances, handrails, signage, and turning radii. 3) Submit as-built drawings reflecting the implemented accessibility provisions.

			4) Submit date-stamped photographs confirming the construction, continuity, and usability of ramps, accessible entrances, elevators, and washrooms. Pre-construction (design stage) Compliance shall be verified through desk review of architectural and accessibility drawings. The following shall be verified: • The submitted architectural drawings clearly indicate ramps, entrance gates, elevators and washrooms designed for use by differently abled persons. • Dimensions, slopes, clearances, handrails, signage, and turning radii shown in the drawings are in accordance with the applicable code for differently abled persons and/or local bye-laws. • Accessibility provisions are integrated at all primary access points and common-use areas and not limited to isolated locations. During construction Compliance shall be verified through site inspections and physical measurements, supported by photographic evidence. The following shall be verified: • Ramps, entrances, elevators, and washrooms are constructed as per the approved drawings, including compliance with slopes, widths, levels, and safety features. • Accessibility elements are continuous, unobstructed, and usable and are not compromised by construction-stage modifications. • Temporary or permanent deviations from approved accessibility provisions are not introduced without revised approvals. Post-construction Compliance shall be verified through as-built review and functional validation. The following shall be verified: • As-built drawings reflect the implemented accessibility features accurately. • Accessibility elements are fully functional and safely usable by differently abled persons at the time of occupancy. • Photographic documentation confirms the presence and continuity of ramps, accessible entrances, elevators, and washrooms.
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4.2.5	Heat island reduction: non - roof areas	Provide photographic indication of paved, unpaved area, uncovered parking area and pathways of the site, building footprint area and their percentage coverage of total site area.	Compliance documents 1) Submit site plan and area statement clearly identifying paved areas, unpaved areas, uncovered parking areas, pathways, and building footprint 2) Submit calculations indicating percentage coverage of each non-roof surface type with respect to total site area 3) Submit date-stamped photographs depicting paved areas, unpaved areas, uncovered parking areas, pathways, and building footprint as implemented on site Pre-construction (design stage) Compliance shall be verified through desk review of site planning documents and area calculations. The following shall be verified: • The site plan and area statements clearly identify paved areas, unpaved areas, uncovered parking areas, pathways and the building footprint. • Percentage coverage of each surface type is clearly calculated and referenced to the total site area. • Design intent for non-roof heat island mitigation (use of unpaved areas, shaded surfaces, or other mitigation strategies) is evident in the submitted site planning documents. During construction Compliance shall be verified through site inspections and photographic documentation. The following shall be verified: • Site development is progressing in accordance with the approved surface area distribution shown in the design-stage submissions. • Paved, unpaved, parking, and pathway areas are being executed at the approved locations and extents. • Construction practices do not result in an increase in hard paved surfaces beyond those approved in the site plan. Post-construction Compliance shall be verified through final desk review and on-site validation. The following shall be verified: • Date-stamped photographs clearly and accurately depict all non-roof surface types within the site, including paved areas, unpaved areas, uncovered parking areas, pathways, and building footprint. • Final percentage calculations of surface coverage are reconciled with as-built site conditions. • Implemented site surfaces align with the approved design intent for heat island reduction.
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4.2.6	Brownfield remediation	Indicates brownfield remediation techniques following local building bylaws.	Compliance documents 1) Submit documentation identifying the site as a brownfield, including details of previous land use and contamination status (where applicable). 2) Submit description of proposed brownfield remediation techniques demonstrating compliance with local building bye-laws, environmental regulations, and planning requirements. 3) Submit approval/no-objection certificate issued by the competent local statutory authority permitting the intended use of the remediated site. 4) Submit records demonstrating implementation of approved remediation measures on site. 5) Submit completion certificate or statutory clearance confirming that remediation works have been completed and the site is fit for the intended use. 6) Submit as-built site layout or documentation confirming consistency with the approved remediation and development plan. Pre-construction (design stage) Compliance shall be verified through desk review of remediation and statutory documentation. The following shall be verified: • The submitted documentation clearly identifies the site as a brownfield, along with the nature, and extent of contamination or previous land use (if applicable). • The proposed brownfield remediation techniques are described and demonstrate compliance with local building bye-laws, environmental regulations, and planning requirements. • An approval/no-objection certificate has been issued by the competent local statutory authority permitting the intended use of the remediated site. • Any conditions imposed by the statutory authority are clearly reflected in the remediation approach. During construction Compliance shall be verified through site inspections and document cross-checks. The following shall be verified: • Approved remediation measures are implemented on site in accordance with the submitted remediation plan. • Construction activities are restricted to areas cleared for development and do not compromise the approved remediation measures • Any remediation-related monitoring or mitigation actions required by statutory authorities are being undertaken during construction.
		Approval of local statutory body for its intended use.	

			Post-construction Compliance shall be verified through desk review of completion documentation and statutory clearances. The following shall be verified: • Remediation works have been completed as approved and no unresolved contamination risks remain. • Final approvals/completion certificates from the competent authority confirm that the site is fit for the intended use. • As-built site conditions are consistent with the approved remediation and development plan.
Additional mandatory requirements (Section 4.3)			
4.3.1	Top soil preservation	The tender document (relevant portion only) specifying the measures to be undertaken by the contractor to prevent soil pollution during the construction phase. This must include provisions for the construction of soil erosion channels and sedimentation tanks as a part of the compliance demonstration. A detailed site management plan in .dwg format, highlighting the on-site strategies implemented to mitigate air and soil pollution during construction. This plan must also depict the layout of soil erosion channels connected to sedimentation tanks to demonstrate compliance. Date-stamped photographs, with descriptions, showcasing the implemented strategies to minimize soil pollution, as well as the construction of soil erosion channels and sedimentation tanks, during the construction phase for compliance verification. A section drawing of the sedimentation tank in .dwg format, illustrating its design, with a minimum depth of 1 metre to accommodate stormwater runoff, as required for compliance	Compliance documents 1) Submit relevant portion of the tender document specifying measures to prevent soil pollution during construction, including provisions for soil erosion channels and sedimentation tanks. 2) Submit detailed site management plan in .dwg format indicating on-site strategies for mitigation of air and soil pollution and layout of soil erosion channels connected to sedimentation tanks. 3) Submit section drawing of the sedimentation tank in .dwg format indicating a minimum depth of 1.0 metre. 4) Submit date-stamped photographs documenting implementation of soil pollution prevention measures, including construction and functioning of soil erosion channels and sedimentation tanks Pre-construction (design/tender stage) Compliance shall be verified through desk review of tender and planning documents. The following shall be verified: • The tender document (relevant portion) explicitly includes provisions requiring the contractor to prevent soil pollution during construction. • Clauses clearly mandate the construction of soil erosion channels and sedimentation tanks, including responsibilities, scope, and compliance obligations. • The site management plan (.dwg format) clearly illustrates on-site strategies for mitigating air and soil pollution, including the layout and connectivity of erosion channels to sedimentation tanks. • The section drawing of the sedimentation tank demonstrates a minimum depth of 1.0 metre and is technically adequate to manage stormwater runoff.

			During construction Compliance shall be verified through site inspections, physical measurements, and photographic validation. The following shall be verified: • Soil erosion channels and sedimentation tanks are constructed on site as per approved drawings, including compliance with minimum depth and layout. • Erosion control measures are functional and appropriately located to intercept and manage runoff from construction areas. • Date-stamped photographs accurately document the implementation of soil pollution control strategies and reflect actual site conditions. • Construction practices prevent mixing of topsoil with debris or contaminated runoff. Post-construction Compliance shall be verified through desk review and final site validation. The following shall be verified: • Construction-phase soil pollution control measures were implemented and maintained throughout the construction period. • Photographic and inspection records demonstrate effective control of soil erosion and sedimentation during construction. • No unresolved soil degradation or pollution issues attributable to construction activities remain at the time of completion.
4.3.2	Dedicated parking for differently abled	Indicates the parking facility are available as per NBC 2016 – Part 3, Annexure B-3.5	Compliance documents 1) Submit parking layout and architectural drawings indicating dedicated parking spaces for differently abled persons in accordance with NBC 2016 – Part 3, Annexure B-3.5. 2) Submit as-built parking drawings reflecting the implemented accessible parking provisions. 3) Submit date-stamped photographs confirming location, marking, signage, and usability of dedicated parking spaces for differently abled persons. Pre-construction (design stage) Compliance shall be verified through desk review of parking layout and architectural drawings. The following shall be verified: • The submitted parking plans clearly identify dedicated parking spaces for differently abled persons. • Number, location, dimensions, access aisles, gradients, and signage of accessible parking spaces comply with NBC 2016 – Part 3, Annexure B-3.5. • Dedicated parking spaces are located in close proximity to accessible building entrances, as required by NBC provisions.

			During construction Compliance shall be verified through site inspections and photographic documentation. The following shall be verified: • Dedicated accessible parking spaces are constructed at the approved locations and in accordance with the approved drawings. • Dimensions, gradients, access aisles, curb ramps, and surface finishes meet NBC requirements. • Temporary or permanent obstructions do not compromise the usability of accessible parking spaces during construction. Post-construction Compliance shall be verified through as-built review and on-site validation. The following shall be verified: • As-built parking drawings accurately reflect the implemented accessible parking provisions. • Accessible parking spaces are clearly marked, signposted, and unobstructed at the time of occupancy. • Photographic evidence confirms functional usability and compliance with NBC 2016 requirements.
4.3.3	Access for differently abled	Indicate the design of the entrance as per NBC 2016 – Part 3, Annexure B-3.5 for differently abled people	Compliance documents 1) Submit architectural entrance and access drawings demonstrating compliance with NBC 2016 – Part 3, Annexure B-3.5 for differently abled persons. 2) Submit detailed drawings indicating clear widths, level differences, ramp slopes, handrails, tactile indicators, and signage at building entrances. 3) Submit as-built drawings reflecting the implemented accessible entrance provisions. 4) Submit date-stamped photographs confirming continuity, unobstructed access, and usability of accessible entrance routes. Pre-construction (design stage) Compliance shall be verified through desk review of architectural entrance and access drawings. The following shall be verified: • The submitted drawings clearly indicate accessible building entrances designed for use by differently abled persons. • Entrance design parameters, including clear width, level differences, ramp slopes, handrails, tactile indicators and signage, comply with NBC 2016 – Part 3, Annexure B-3.5. • Accessible entrances provide a continuous and barrier-free route from designated accessible parking and site access points.

			During construction Compliance shall be verified through site inspections, dimensional checks, and photographic documentation. The following shall be verified: - Entrance access provisions are constructed in accordance with approved drawings, including slopes, widths, landings, and safety features. - No temporary or permanent obstructions compromise accessibility during construction. - Any modifications made during construction do not reduce compliance with NBC accessibility requirements. Post-construction Compliance shall be verified through as-built review and functional validation. The following shall be verified: - As-built drawings accurately reflect the implemented entrance access provisions. - Accessible entrances are fully functional, unobstructed and safely usable by differently abled persons at the time of occupancy. - Photographic documentation confirms continuity and usability of accessible entrance routes.
4.3.4	Access to amenities	Google Map images highlighting the walking distances from the main entrance of the project to each basic amenity. The images must be accompanied by date-stamped photographs of the services/amenities as marked in the Google Map images for verification of compliance. Calculations detailing the average distance travelled to reach basic amenities from the project site to demonstrate compliance. Geo-tagged photographs	Compliance documents - Submit Google Map images indicating walking routes and distances from the main project entrance to each basic amenity. - Submit calculations detailing the average walking distance from the project site to the identified basic amenities. - Submit date-stamped and geo-tagged photographs of the amenities marked in the Google Map images confirming their existence and accessibility Pre-construction (design stage) Compliance shall be verified through desk review of proximity analysis and mapping submissions. The following shall be verified: - Google Map images clearly indicate the walking routes from the main project entrance to each identified basic amenity. - All amenities claimed for compliance are clearly labelled, legible, and located within the prescribed distance limits, as applicable under ECSBC. - Distance calculations are methodologically consistent, indicating the route followed and the basis for measuring walking distance. - The set of amenities considered is appropriate, complete and relevant to the project context.

			During construction • Compliance during construction shall be verified through document cross-checks, where applicable. The following shall be verified: • No construction-related access restrictions permanently alter or eliminate the pedestrian routes relied upon for amenity access. • Any temporary disruptions do not invalidate the long-term accessibility assumptions made at the design stage. Post-construction Compliance shall be verified through final desk review and on-site validation. The following shall be verified: • Date-stamped and geo-tagged photographs accurately depict the amenities identified in the Google Map images and confirm their existence and operational status. • Final average distance calculations are consistent with actual on-ground walking routes available from the completed project. • Access routes remain unobstructed and publicly accessible at the time of occupancy.
4.3.5	Access to public transportation	Google Map images highlighting public transport by road/rail/ater as per mentioned in section from project exit gate.	Compliance documents 1) Submit Google Map images indicating the location of public transportation facilities accessible by road, rail, and/or water from the project exit gate. 2) Submit Google Map distance markings showing walking distances from the project exit gate to the nearest public transport access points. 3) Submit identification of the project exit gate used as the reference point for distance measurement. 4) Submit date-stamped or geo-referenced photographs confirming the physical presence and operational status of the identified public transportation facilities. Pre-construction (design stage) Compliance shall be verified through desk review of location mapping and distance analysis. The following shall be verified: • Google Map images clearly indicate the location of public transportation facilities accessible by road, rail and/or water, as applicable. • The project exit gate used for distance measurement is clearly identified and consistent across all submissions. • Walking distances from the project exit gate to the nearest public transport access points are clearly measured and fall within the prescribed ECSBC limits, where applicable. • The selected public transport facilities are functional, permanent and publicly accessible.

			During construction Compliance during construction shall be verified through document cross-checks and site review, where required. The following shall be verified: • Construction activities do not permanently obstruct or eliminate the access routes relied upon for public transportation connectivity. • Any temporary access changes do not affect the long-term availability of public transport access assumed at the design stage. Post-construction Compliance shall be verified through final desk review and on-site validation. The following shall be verified: • Geo-referenced or date-stamped photographs confirm the physical presence and operational status of the identified public transportation facilities. • Final access routes from the project exit gate to public transport facilities are clear, unobstructed and usable at the time of occupancy. • The verified on-ground conditions align with the distances and routes shown in the submitted Google Map images
4.3.6	In-situ transit	Indicate bicycle lane network and bicycle parking area distance from building entrance on site plane.	Compliance documents 1) Submit site plan indicating the bicycle lane network within the project site, including entry/exit points and internal circulation. 2) Submit site plan marking the locations of bicycle parking areas with distances measured from the main building entrance(s). 3) Submit as-built site drawings reflecting the implemented bicycle lane network and bicycle parking locations. 4) Submit date-stamped photographs confirming the presence, continuity, and usability of bicycle lanes and bicycle parking areas. Pre-construction (design stage) Compliance shall be verified through desk review of site planning and circulation drawings. The following shall be verified: • The site plan clearly indicates a continuous bicycle lane network within the project site, including entry/exit points and internal circulation. • Locations of bicycle parking areas are clearly marked on the site plan, with distances measured from the main building entrance(s). • Bicycle lanes and parking provisions are logically integrated with pedestrian movement and do not conflict with vehicular circulation. • The design intent demonstrates safe, convenient and accessible non-motorized transport infrastructure within the site. During construction Compliance shall be verified through site inspections and photographic documentation. The following shall be verified:

			- Bicycle lanes are constructed at the approved locations, with continuity and adequate width as indicated in the drawings. - Bicycle parking facilities are installed at the designated locations and within the distances committed at the design stage. - Construction activities do not eliminate or reduce the effectiveness of the approved bicycle circulation network. Post-construction Compliance shall be verified through as-built review and on-site validation. The following shall be verified: - As-built site drawings accurately reflect the implemented bicycle lane network and parking locations. - Bicycle lanes and parking facilities are physically present, clearly identifiable, and usable at the time of occupancy. - Photographic documentation confirms continuity of bicycle lanes and functional accessibility of bicycle parking areas from building entrances. Final compliance under this criterion shall be confirmed only after verification of physical implementation and usability of in-situ bicycle transit facilities.
4.3.7	Heat island reduction – roof areas	Net exposed roof area and area covered by vegetated roof/cool roof. Cool roof paint properties (SRI) and purchase order.	Compliance documents - Submit roof plans indicating total exposed roof area and area covered by vegetated roof and/or cool roof systems - Submit area calculations for exposed roof area and treated roof area referenced to architectural roof drawings - Submit technical specifications of cool roof materials indicating Solar Reflectance Index (SRI) values - Submit purchase orders for cool roof materials corresponding to the treated roof area - Submit date-stamped photographs confirming application or installation of vegetated roof and/or cool roof systems on site Pre-construction (design stage) Compliance shall be verified through desk review of roof plans, area calculations, and material specifications. The following shall be verified: - Roof drawings and calculations clearly identify the total exposed roof area and the portion proposed to be treated with vegetated roofing and/or cool roof systems. - Area calculations are accurate, traceable, and referenced to the approved architectural roof plans. - Specifications for cool roof materials clearly state the solar reflectance index (SRI) values and demonstrate compliance with ECSBC requirements. - Design intent for roof-level heat island mitigation is clearly incorporated prior to commencement of construction.

			During construction - Compliance shall be verified through site inspections and document cross-checks. The following shall be verified: - Cool roof coatings and/or vegetated roof systems are applied or installed at the approved roof locations. - Materials used on site correspond to the specified products and SRI values submitted at the design stage. - Installation practices do not reduce the effective treated roof area committed for compliance. Post-construction Compliance shall be verified through final desk review and on-site validation. The following shall be verified: - Purchase orders and material invoices correspond to the roof treatment area implemented on site. - Photographic documentation confirms complete and permanent application of vegetated or cool roof systems. - Final roof area calculations are reconciled with as-built roof conditions.
4.3.8	Heat island reduction – non- roof areas	Submit photographs showing the paved areas, unpaved areas, uncovered parking areas, pathways and the building footprint area, along with their corresponding percentage coverage of the total site area. Separate indication of non-roof coverage, which is structural shading with a cool roof. Documentation of the cool roof paint properties (SRI) and a purchase order for the materials used.	Compliance documents - Submit site planning drawings and area statements identifying paved areas, unpaved areas, uncovered parking areas, pathways, and building footprint. - Submit calculations indicating percentage coverage of each non-roof surface type with respect to total site area. - Submit separate identification of non-roof areas treated through structural shading with a cool roof. - Submit technical documentation of cool roof materials indicating solar reflectance index (SRI) values. - Submit purchase orders for cool roof materials used for non-roof heat island reduction measures. - Submit date-stamped photographs depicting paved areas, unpaved areas, uncovered parking areas, pathways, and building footprint as implemented on site. Pre-construction (design stage) Compliance shall be verified through desk review of site planning drawings and area calculations. The following shall be verified: - Site plans and area statements clearly identify paved areas, unpaved areas, uncovered parking areas, pathways and building footprint. - Percentage coverage of each non-roof surface type is clearly calculated and referenced to the total site area.

			During construction Compliance shall be verified through site inspections and photographic validation. The following shall be verified: • Development of paved, unpaved, parking, and pathway areas is carried out in accordance with approved site plans and area distributions. • Surface treatments and materials are implemented at the approved locations and extents. • Construction activities do not introduce additional hard-paved surfaces beyond those committed at the design stage. Post-construction Compliance shall be verified through final desk review and on-site validation. The following shall be verified: • Date-stamped photographs clearly depict all non-roof surface categories and accurately represent on-ground conditions. • Final percentage coverage of non-roof areas is reconciled with as-built site conditions. • Implemented site surfaces align with the approved heat island reduction intent and calculations.
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Chapter 5 details the compliance requirement of the building envelope, including its thermal performance and daylighting characteristics. This chapter elaborates on requirements for walls, roofs, fenestration systems, shading strategies, air sealing, and daylight-admitting designs. It explains the prescriptive thermal transmittance and solar heat gain limits applicable across various climatic zones, and clarifies how buildings may alternatively demonstrate compliance through envelope performance trade-off calculations. The aim is to ensure buildings minimize heat gains and losses while maximizing daylight availability without compromising visual or thermal comfort.

Table 5 Building envelope - compliance form

Building envelope - compliance form	
Vertical fenestration area calculation	1. Submit the photographs, building floor plans with highlighted vertical fenestration and schedule of openings (.dwg format). 2. Provide the window to wall ratio (WWR) with the total vertical fenestration area, gross exterior wall area
Skylight area calculation	1. Submit the photographs, building floor plans with highlighted horizontal fenestration and schedule of openings (.dwg format). 2. Provide the skylight to roof ratio (SRR) with the total horizontal fenestration area, gross exterior roof Area

Code section	Component	Information required	Notes
5.2.1 5.2.1-(a)	Fenestration U-factor	Specify reference standard	1. Submit the photographs of the materials tested for U-factor. Submit U-factors test report for the overall fenestration product (including the sash and frame) in accordance with ISO-15099 by an accredited independent laboratory labelled by the manufacturer. Or In case of unrated products, provide the relevant value as per ECSBC 2024 Appendix A of Chapter 14. Design stage evaluation: Fenestration U value: Verify that proposed fenestration U-factor values are specified at design stage, reference standards are identified (ISO-15099 or ECSBC Appendix A), and compliance intent is demonstrated through rated or default values as permitted under ECSBC Clause 5.2.1(a). Construction stage evaluation: Verify that installed fenestration products match approved specifications through manufacturer labels, test reports, invoices, and site photographs confirming U-factor compliance. Occupancy stage evaluation: Verify submission of final fenestration documentation confirming installed U-factors are consistent with approved design values prior to OC.
5.2.1 - (b)	SHGC	Specify reference standard	Submit the photographs of the materials tested for solar heat gain coefficient (SHGC). 2. Submit SHGC test report for the overall single or multi-glazed fenestration product (including the sash and frame) in accordance with ISO-15099 by an accredited independent laboratory labelled by the manufacturer [exceptions to Section 5.2.1-(b)] Design stage evaluation: Verify that SHGC values and reference standards are specified at design stage, using rated values or permitted defaults, in compliance with ECSBC Clause 5.2.1(b).
5.2.1- (c)	VLT	Specify reference standard	Submit the photographs of the materials tested for visible light transmittance (VLT). 2. Submit VLT test report for the overall fenestration product in accordance with ISO-15099 by an accredited independent laboratory labelled by the manufacturer. Or In case of unrated products, provide the VLT of the glass alone shall be derated by 10% with the specification sheet.

			Design stage evaluation: Verify that VLT values are specified at design stage, including reference standards and derating methodology where unrated products are proposed, in accordance with ECSBC Clause 5.2.1©. Construction stage evaluation: Verify installed fenestration VLT through manufacturer documentation, test reports, and site photographs. Occupancy stage evaluation: Verify final VLT compliance confirmation aligned with approved fenestration schedules prior to OC.
5.2.2	Opaque construction		
5.2.2 - (a)	(a) U-factor	Specify reference standard	Submit the photographs of the materials tested for U-factor. 2. Submit U-factors test report for the opaque construction in accordance with ISO-6946 by an approved ISO baseline for respective insulation type by an accredited independent laboratory. OR In case of unrated products, provide the relevant value as per ECSBC 2024 Appendix A of Chapter 14. Design stage evaluation: Opaque construction –U factor: verify that opaque envelope assemblies and corresponding U-factor values are defined at design stage using ISO-6946 or ECSBC Appendix A defaults, demonstrating compliance with ECSBC Clause 5.2.2(a). Construction stage evaluation: Verify installed opaque construction materials through invoices, test reports, and site inspection confirming U-factor compliance. Occupancy stage evaluation: Verify submission of as-built envelope documentation confirming U-factor compliance at occupancy stage.
5.2.2-(b)	Solar reflectance	Specify reference standard	Submit solar reflectance test report for external opaque roof construction material shall be determined in accordance with ASTM E903-96 by an accredited independent laboratory and labelled by the manufacturer. Design stage evaluation: Opaque roof-solar reflectance: verify that roof solar reflectance and emittance values, along with reference standards (ASTM E903-96), are specified at design stage in accordance with ECSBC Clause 5.2.2(b) and (c). Construction stage evaluation: Verify installation of roof materials through test reports, manufacturer labels, and site photographs confirming specified reflectance and emittance values. Occupancy stage evaluation: Verify final roof material compliance documentation as part of envelope closure prior to OC.

Code section	Component	Information required	Notes
5.2.2-(c)	Emittance	Emittance Specify reference standard	submit the photographs of the materials tested for emittance. 2. Submit emittance test report for the external opaque roof construction shall be determined in accordance with ASTM E408- 71 (RA 2008) by an accredited independent laboratory, and labelled by the manufacturer Design stage evaluation: Opaque roof –Emittance: verify that roof emittance values, along with reference standards (ASTM E408-71(RA 2008)), are specified at design stage in accordance with ECSBC Clause 5.2.2(b) and (c). Construction stage evaluation: Verify installation of roof materials through test reports, manufacturer labels, and site photographs confirming specified reflectance and emittance values. Occupancy stage evaluation: Verify final roof material compliance documentation as part of envelope closure prior to OC.
5.2.3	Daylighting and visual comfort	Specify simulation approach or manual approach	Provide the compliance approach as per simulation or manual approach as provided in ECSBC.
5.2.3 - (b)	-(b) UDI simulation method	- Brief description of the project with location, number of stories, space types, hours of operation and software used. - Summary describing the results of the analysis and output file from simulation tool outlining point-wise compliance for the analysis grid and compliance in percentage. - Explanation of any significant modelling assumptions made. - Explanation of any error messages noted in the simulation program output. - Building floor plans, building elevations and sections, and site plan with surrounding building details (if modelled). Material reflectance, analysis grid size, total number of grid size/resolution, total number of grid points.	Submit a narrative of the project with the location, number of stories, space types, hours of operation, software used along with the results of the analysis outlining point-wise compliance for the analysis grid and compliance (in percentage). - Submit the building photographs, floor plans, building elevations and sections, and site plan (.dwg format) with surrounding building heights and photographs (if modelled). - Submit the input and output files of the simulation along with any significant modelling assumptions made. - Provide a narrative, in case of any error messages noted in the simulation program output. Design stage evaluation: Daylighting and visual comfort –simulation: verify that the selected compliance approach (UDI simulation or manual method) is clearly defined at design stage, with methodology, assumptions, and required drawings identified as per ECSBC Clause 5.2.3.

			Construction stage evaluation: Verify consistency of daylighting implementation with approved drawings and simulation/manual assumptions through site inspection and documentation. Occupancy stage evaluation: Verify submission of final daylighting compliance outputs (simulation results) confirming compliance prior to occupancy.
5.2.3 -(c)	Daylight compliance manual method	1. A separate architectural plan shall be prepared with all-daylit areas marked on the floor plans. A summary shall be provided showing compliance as per Table 5.1.	1. Submit a narrative of the project with the location, number of stories, space types, hours of operation. 2. Submit the building photographs, floor plans, building elevations and sections, and site plan (.dwg format). 3. Provide the daylight area making drawing as a separate architectural plan with all daylit areas marked on the all relevant floor plans. Design stage evaluation: Daylighting and visual comfort –manual approach: verify that the selected compliance approach (manual method) is clearly defined at design stage, with methodology, assumptions, and required drawings identified as per ECSBC Clause 5.2.3. Construction stage evaluation: Verify consistency of daylighting implementation with approved drawings and simulation/manual assumptions through site inspection and documentation. Occupancy stage evaluation: Verify submission of final daylighting compliance outputs (marked drawings) confirming compliance prior to occupancy
5.2.4	Building envelope sealing	Indicate sealing, caulking, gasketing, and weather stripping	Provide a narrative on the building envelope sealing and the relevant measures taken (such as sealing, caulking, gasketing, and weather stripping). 2. Provide the specification sheets of the materials purchased for sealing, caulking, gasketing, and weather stripping. 3. Provide photographs of the measures undertaken for the building envelope sealing. Design stage evaluation: Building envelope sealing: verify that envelope sealing measures (caulking, gasketing, weather stripping) are specified at design stage, including materials and locations, in compliance with ECSBC Clause 5.2.4. Construction stage evaluation: Verify implementation of sealing measures through site inspection, material specifications, and photographic evidence. Occupancy stage evaluation: Verify final confirmation of envelope sealing measures as part of occupancy stage compliance documentation

5.3.1	Roof	Specify implemented U-factor	Provide the specification sheets highlighting the roof U-factor and photographs of the roof materials. Design stage evaluation: Verify that roof U-factors are specified at design stage with supporting calculations or specifications in line with ECSBC Clause 5.3. Construction stage evaluation: Verify installed roof through site inspection, invoices, and material specifications confirming U-factor compliance. Occupancy stage evaluation: Verify submission of final as-built envelope documentation confirming roof U-factor compliance.
5.3.1-(a)	Vegetative cool roof	Specify the solar reflectance, emittance, and reference standards.	1. Provide a narrative on the measures undertaken for the vegetative cool roof. 2. Provide the specification sheets highlighting the solar reflectance, emittance, and reference standards. Design stage evaluation: Verify that roof solar reflectance, emittance, and reference standards comply with ECSBC Clause 5.3.1 (a). Construction stage evaluation: Verify installed roof through site inspection, invoices, and material specifications confirming solar reflectance, emittance, and reference standards compliance. Occupancy stage evaluation: Verify submission of final as-built envelope documentation confirming roof solar reflectance, emittance, and reference standards.
5.3.2	Opaque external wall	Specify implemented U-factor	Provide the specification sheets/ calculation highlighting the opaque external wall U- factor and photographs of the roof materials. Design stage evaluation: Opaque external wall: verify that external wall U-factors are specified at design stage with supporting calculations or specifications in line with ECSBC Clause 5.3.2 Construction stage evaluation: Verify installed wall assemblies through site inspection, invoices, and material specifications confirming U-factor compliance. Occupancy stage evaluation: Verify submission of final as-built envelope documentation confirming External Wall U-factor compliance.

5.3.3	Vertical fenestration	(1) Indicate U-factors on fenestration schedule. Indicate if values are rated or default. If values are default, then specify frame type, glazing layers, gap width, low-e. (2) Indicate SHGC or SC on fenestration schedule. Indicate if values are rated or default. (3) Indicate VLT of fenestration schedule. Indicate if values are rated or default. (4) Indicate if overhangs or side fins or box-frame projection are used for compliance purposes. If so, provide projection factor calculation and equivalent SHGC calculation.	Submit the building floor plans and indicate the U-factors, frame type, glazing layers, gap width, glazing type (such as low-e) on fenestration schedule. 2. Submit and mention the SHGC or SC on fenestration schedule and indicate if values are rated or default. 3. Submit and mention the VLT on fenestration schedule and indicate if values are rated or default. 4. Submit the shading device details (such as overhangs or side fins or box-frame projection) and provide projection factor calculation and equivalent SHGC calculation. Design stage evaluation: Vertical fenestration and shading devices: verify that fenestration schedules include U-factor, SHGC/SC, VLT, rated/default status, and shading device calculations (projection factor, equivalent SHGC) at design stage, as required under ECSBC Clause 5.3.3. Construction stage evaluation: Verify installed fenestration and shading devices through site inspection, drawings, and calculation records confirming compliance with approved design. Occupancy stage evaluation: Verify final fenestration and shading compliance documentation prior to OC.
5.3.3	Fenestration U-factor exemption	(2) Specify if applicable, specify unconditioned space percentage, and specify incorporated specifications.	In case of exemption, specify unconditioned space percentage, and specify incorporated exceptions if any.
5.3.4	Skylights	(1) Indicate U-factors on fenestration schedule. Indicate if values are rated or default. If values are default, then specify frame type, glazing layers, gap width, low-e. (3) Indicate SHGC or SC on fenestration schedule. Indicate if values are rated or default.	Submit the Building floor plans and indicate the U-factors, frame type, glazing layers, gap width, glazing type (such as low-e) on horizontal fenestration schedule. 2. Submit and mention the SHGC or SC on fenestration schedule and indicate if values are rated or default. 3. Submit and mention the VLT on fenestration schedule and indicate if values are rated or default. Design stage evaluation: Skylights: verify that skylight U-factor and SHGC values are specified at design stage using rated or default values, in compliance with ECSBC Clause 5.3.4. Construction stage evaluation: Verify installed skylights through site inspection, test reports, and manufacturer documentation. Occupancy stage evaluation: Verify final skylight compliance confirmation at occupancy stage.

5.3.5	Envelope performance factor (EPF)	(2) Provide calculations as required in section.	Submit the narrative for compliance with tradeoff method. 1. Submit the narrative for compliance with tradeoff method. 2. the compliance for thermal properties of the building envelope. 3. Submit the compliance with WWR. 4. Submit the EPF of the standard building and the proposed building. Design stage evaluation: EPF: verifies that EPF calculations, baseline, and proposed envelope parameters, and WWR compliance are demonstrated at design stage in accordance with ECSBC Clause 5.3.5. Construction stage evaluation: Verify that constructed envelope parameters match those used in EPF calculations through drawings, site inspection, and documentation. Occupancy stage evaluation: Verify submission of final EPF compliance report confirming envelope performance prior to OC issuance. t constructed envelope parameters match those used in EPF calculations through drawings, site inspection, and documentation. Occupancy stage evaluation: Verify submission of final EPF compliance report confirming envelope performance prior to OC issuance.
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Chapter 6 details the compliance requirement of comfort systems and controls, principally focusing on heating, ventilation, and air conditioning (HVAC) systems. It outlines the mandatory efficiency standards for air-conditioning and ventilation equipment, requirements for ventilation rates, and provisions related to system controls, such as thermostats, variable frequency drives, economizers, and energy management systems. The chapter also includes detailed requirements for duct and pipe insulation, placement of condensers, performance of fans, pumps, chillers, and cooling towers, and the integration of low-energy comfort systems, ensuring that mechanical systems operate at optimal efficiency.

Table 6 Comfort systems and controls – compliance form

Code section	Component	Information required	Comfort systems and controls – compliance form
6.2.1	Ventilation	Indicate all habitable spaces are ventilated with outdoor air in accordance with Section 6.2.1 and guidelines specified in NBC	1) Submit a detailed design narrative describing the natural and/or mechanical ventilation strategies adopted in the project, demonstrating compliance with the minimum air change rate (ACR) requirements prescribed in the National Building Code (NBC) and the ventilation provisions of ECSBC 2024. 2) Submit approved architectural and MEP CAD drawings, clearly highlighting the ventilation systems and methodologies adopted, including the location of air inlets, outlets, exhaust points, ducts, shafts, fans, and associated equipment, in accordance with ECSBC 2024 requirements.

			3) Submit on-site photographs confirming the installation of natural and/or mechanical ventilation systems, along with carbon monoxide (CO) sensors in basement or enclosed car parks, wherever applicable, as required under ECSBC 2024. 4) Submit on-site photographs and control details confirming the installation of carbon dioxide (CO₂) sensors and/or demand-controlled ventilation (DCV) systems in mechanically ventilated spaces, in compliance with ECSBC 2024 ventilation control provisions. 5) Submit manufacturer's technical specification sheets for all ventilation-related equipment, including air circulators, exhaust fans, fan coil units (FCUs), air-handling units (AHUs), and other ventilation appliances, demonstrating compliance with the performance, efficiency, and control requirements of ECSBC 2024. 6) Submit an audit or calculation report demonstrating that the installed ventilation systems achieve the required ACR as per NBC, to be included as part of the final ECSBC compliance documentation Design stage evaluation: Verify that provisions for achieving the required ACR through natural and/or mechanical ventilation strategies are incorporated in the approved architectural and MEP drawings, design narrative, project specifications, BOQs, and tender documents, in accordance with the NBC and as required under the relevant provisions of ECSBC 2024. Construction stage evaluation: Verify actual implementation of the proposed ventilation systems through site inspections and documentary evidence, including technical specification sheets of air circulators, exhaust fans, FCUs, AHUs, and other ventilation equipment, ensuring compliance with ECSBC 2024 requirements. Confirm installation of CO sensors in basement car parks and CO₂ sensors or demand-controlled ventilation (DCV) systems in mechanically ventilated spaces, as applicable. Occupancy stage evaluation: Verify that complete construction-stage ventilation compliance records, including on-site installation photographs and an audit report demonstrating compliance with the required ACR as per NBC, have been submitted and closed as part of the final ECSBC compliance documentation prior to issuance of the occupancy certificate.
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6.2.2	Space-conditioning equipment efficiencies	Provide equipment schedule with type, capacity, efficiency	1) Submit manufacturer's technical specification sheets for all space-conditioning equipment, including chillers, unitary air conditioners, split air conditioners, packaged air conditioners, and solar water heaters, clearly indicating: • BEE star rating • Rated capacity (in kW_r) • Applicable efficiency parameters as per ECSBC 2024 For VRF/VRV systems, submit ISEER details as specified under ECSBC 2024. 2) Submit the design basis report (DBR) highlighting: • Space cooling load calculations. • Space heating load calculations, wherever applicable. • Design assumptions and criteria adopted for HVAC system sizing. 3) Submit approved architectural and MEP drawings and floor plans, clearly highlighting: • HVAC system layout. • Location of chillers, outdoor units, indoor units, AHUs, FCUs, ducts, and associated equipment. 4) Submit on-site photographs of the installed space conditioning equipment, clearly showing nameplates and installation details. 5) Submit commissioning and/or testing reports, demonstrating that the installed systems are operational and consistent with the approved design and ECSBC requirements. Design stage evaluation: Verify that the manufacturer's technical specification sheets and equipment schedules submitted at the design stage clearly specify the type of space conditioning equipment, rated capacity (in kW_r), and efficiency parameters, including BEE star rating for chillers, unitary, split, packaged air conditioners, and solar water heaters, and ISEER values for VRF/VRV systems, in compliance with ECSBC 2024. Verify that the design basis report (DBR) includes space cooling and heating load calculations, along with the design assumptions and HVAC sizing criteria, and that the proposed equipment capacities are appropriately sized to meet the calculated loads. Verify that the approved architectural and MEP drawings and floor plans clearly indicate the HVAC system layout, equipment locations, and distribution systems, and are consistent with the equipment details and DBR submitted.
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			Construction stage evaluation: Verify actual implementation through review of manufacturer's technical specification sheets, procurement documents, and on-site installation photographs, confirming that the installed space conditioning equipment matches the approved design-stage submissions in terms of type, capacity, BEE star rating/ISEER, and efficiency parameters, and complies with ECSBC 2024 requirements. Confirm that the installation locations and configurations of chillers, outdoor and indoor units, AHUs, FCUs, ducts, and associated equipment are consistent with the approved architectural and MEP drawings. Occupancy stage evaluation: Verify submission of on-site photographs, as-built drawings, and commissioning and/or testing reports, confirming that the installed space conditioning systems are operational, commissioned as per design intent, and compliant with ECSBC 2024 efficiency requirements. Ensure that all construction stage compliance documentation has been reviewed, submitted, and closed as part of the final ECSBC compliance documentation.
6.2.3	Controls		
6.2.3 - (a)	Timeclock	Indicate thermostat with night setback, 3 different day types per week, and 2-hour manual override.	1) Submit manufacturer's technical specification sheets for thermostats/time-clock controllers. 2) Submit approved MEP/HVAC drawings indicating thermostat and control locations 3) Submit on-site installation photographs of timeclock. 4) Submit commissioning and functional testing reports Design stage evaluation: Verify that the HVAC control strategy, control schematics, and manufacturer's technical specification sheets indicate provision of timeclock-enabled thermostats with night setback functionality, at least 3 programmable day types per week, and a manual override feature with a maximum duration of 2 hours. Confirm that thermostat locations and control intent are clearly indicated in the approved HVAC/MEP drawings Construction stage evaluation: Verify actual implementation through review of installed thermostat models, manufacturer's technical specification sheets, and on-site installation photographs, confirming that the provided thermostats meet the time-clock, scheduling, night setback, and manual override requirements specified under ECSBC 2024.

			Confirm that installation locations are consistent with the approved drawings. Occupancy stage evaluation: Verify submission of commissioning and functional testing reports, demonstrating that the time-clock schedules, night setback operation, multiple day-type programming, and 2-hour manual override are configured and operational. Confirm that all control-related compliance documentation has been submitted and closed as part of the final ECSBC compliance documentation.
6.2.3 - (b)	Temperature Control	1. Indicate temperature control with 3°C deadband minimum if the system provides both heating and cooling. 2. Indicate thermostats are interlocked to prevent simultaneous heating and cooling, where separate heating and cooling systems are there. Indicate separate thermostat control for space types mentioned in Section 6.2.3.(b).	1) Submit manufacturer's technical specification sheets for thermostats and control devices. 2) Submit control schematics and sequence of operations. 3) Submit DBR describing HVAC control philosophy. 4) Submit approved architectural and HVAC/MEP drawings indicating thermostat zoning and locations. 5) Submit on-site installation photographs. 6) Submit commissioning and functional testing reports. Design stage evaluation: Verify that the HVAC control strategy, DBR, and control schematics demonstrate provision of temperature control with a minimum 3°C deadband for systems serving both heating and cooling. Verify that the control logic clearly indicates thermostat interlocking to prevent simultaneous heating and cooling in systems with separate heating and cooling equipment. Confirm that separate thermostat controls are provided for different space types as specified under ECSBC Section 6.2.3(b) and that thermostat locations and zoning are clearly indicated in the approved HVAC/MEP drawings. Construction stage evaluation: Verify actual implementation through manufacturer's technical specification sheets, installed thermostat models, and on-site photographs, confirming compliance with deadband, interlock, and zoning requirements specified under ECSBC 2024. Confirm that thermostat installations and zoning correspond to the approved design drawings and control schematics. Occupancy stage evaluation: Verify submission of commissioning and functional testing reports, demonstrating that the 3°C deadband, heating-cooling interlock, and separate thermostat controls for different space types are properly configured and operational. Ensure that all temperature control compliance documentation is complete and closed as part of the final ECSBC compliance documentation.

6.2.3 - (C)	Occupancy control	Indicate occupancy controls for space and their types mentioned as per Section 6.2.3.(c)	1) Submit manufacturer's technical specification sheets for occupancy sensors and control devices (PIR, ultrasonic, dual-technology, badge-based, BMS-linked, etc.). 2) Submit control schematics and sequence of operations. 3) Submit DBR outlining the occupancy control strategy. 4) Submit approved architectural and HVAC/MEP drawings indicating sensor locations and zoning. 5) Submit on-site installation photographs. 6) Submit commissioning and functional testing reports. Design stage evaluation: Verify that the HVAC control strategy, DBR, and control schematics indicate provision of occupancy-based controls for the applicable space types as defined in ECSBC Section 6.2.3(c). Confirm that the type of occupancy control (e.g., presence detection, absence detection, scheduling with sensors) is clearly specified and appropriate for each space type. Verify that sensor locations and control zoning are clearly indicated in the approved architectural and HVAC/MEP drawings. Construction stage evaluation: Verify actual implementation through manufacturer's technical specification sheets, installed sensor models, and on-site installation photographs, confirming that the installed occupancy control devices are consistent with the approved design submissions and comply with ECSBC 2024 requirements. Confirm that sensor installation and zoning correspond to the approved drawings and control schematics. Occupancy stage evaluation: Verify submission of commissioning and functional testing reports, demonstrating that the occupancy controls are operational, correctly configured, and effectively controlling HVAC systems in response to space occupancy. Ensure that all occupancy control compliance documentation has been submitted and closed as part of the final ECSBC compliance documentation.
6.2.3 - (d)	Cooling tower fan control	If this type controls are applicable, and capable to reduce fan speed up to 50% of rated speed.	1) Submit manufacturer's technical specification sheets for cooling tower fans and variable frequency drives (VFDs) or equivalent speed control devices. 2) Submit cooling tower equipment schedule indicating fan motor ratings and control type.

			3) Submit control schematics and sequence of operations describing fan speed modulation. 4) Submit approved HVAC/MEP drawings indicating cooling tower layout and control integration. 5) Submit on-site installation photographs showing fans, motors, and VFD panels. 6) Submit commissioning and functional testing reports. Design stage evaluation: Verify that the design documentation, including equipment schedules, control schematics, and manufacturer's technical specification sheets, indicates provision of cooling tower fan controls capable of modulating fan speed to at least 50% of rated speed. Confirm that the proposed control strategy (e.g., VFD-based modulation linked to condenser water temperature or pressure) complies with the ECSBC 2024 cooling tower fan control requirements and is reflected in the approved HVAC/MEP drawings. Construction stage evaluation: Verify actual implementation through review of installed cooling tower fans and VFDs, manufacturer's technical specification sheets, and on-site installation photographs, confirming that the installed system matches the approved design stage submissions and is capable of reducing fan speed to the required limit. Confirm that installation locations and wiring are consistent with the approved drawings and control schematics. Occupancy stage evaluation: Verify submission of commissioning and functional testing reports, demonstrating that the cooling tower fan speed can be reduced to at least 50% of rated speed under part-load operating conditions and that the control logic functions as intended. Ensure that all cooling tower fan control compliance documentation is complete and closed as part of the final ECSBC compliance documentations.
6.2.3 - (e)	AHU fan	Indicate two-speed motor, pony motor, or variable speed drive to control the fans and controls shall be capable to reduce the fan speed to at least two-thirds of installed fan power and as per Section 6.2.3(e).	1) Submit manufacturer's technical specification sheets for AHU fans and VFDs or equivalent speed control devices. 2) Submit AHU schedule indicating fan motor ratings and control type. 3) Submit control schematics and sequence of operations describing fan speed modulation. 4) Submit approved HVAC/MEP drawings indicating AHU layout and control integration. 5) Submit on-site installation photographs showing fans, motors, and VFD panels. 6) Submit commissioning and functional testing reports.

			Design stage evaluation: Verify that the design documentation, including equipment schedules, control schematics, and manufacturer's technical specification sheets, indicates provision of AHU fan controls capable of modulating fan speed to at least two-thirds of the installed fan power. Confirm that the proposed control strategy (e.g., VFD-based modulation linked to chilled water temperature or pressure) complies with the ECSBC 2024 AHU fan control requirements and is reflected in the approved HVAC/MEP drawings. Construction stage evaluation: Verify actual implementation through review of installed AHU fans and VFDs, manufacturer's technical specification sheets, and on-site installation photographs, confirming that the installed system matches the approved design stage submissions and is capable of reducing fan speed to the required limit. Confirm that installation locations and wiring are consistent with the approved drawings and control schematics. Occupancy stage evaluation: Verify submission of commissioning and functional testing reports, demonstrating that the AHU fan speed can be reduced to at least two-thirds of the installed fan power and that the control logic functions as intended. Ensure that all AHU fan control compliance documentation is complete and closed as part of the final ECSBC compliance documentations.
6.2.3 - (f)	Damper Control	Indicate that all automatic shutdown dampers are provided with input from pressure transducers for conditions of Section 6.2.3-(f)	1) Submit manufacturer's technical specification sheets for automatic shutdown dampers and pressure transducers. 2) Submit control schematics and sequence of operations indicating interlocking between dampers and pressure transducers. 3) Submit DBR describing the damper control philosophy. 4) Submit approved HVAC/MEP drawings showing damper locations, pressure sensor locations, and control wiring. 5) Submit on-site installation photographs. 6) Submit commissioning and functional testing reports. Design stage evaluation: Verify that the HVAC control strategy, DBR, and control schematics indicate provision of automatic shutdown dampers integrated with pressure transducers, in accordance with Section 6.2.3(f) of ECSBC 2024. Confirm that damper locations, pressure sensor locations, and interlocking logic are clearly indicated in the approved HVAC/MEP drawings.

			Construction stage evaluation: Verify actual implementation through manufacturer's technical specification sheets, installed damper and pressure transducer models, and on-site installation photographs, confirming that the installed systems are consistent with the approved design submissions and comply with ECSBC 2024 requirements. Confirm that installation locations and control wiring correspond to the approved drawings and control schematics. Occupancy stage evaluation: Verify submission of commissioning and functional testing reports, demonstrating that the pressure transducer inputs correctly actuate automatic shut-down dampers under the operating conditions specified in Section 6.2.3(f). Ensure that all damper control compliance documentation has been submitted and closed as part of the final ECSBC compliance documentation.
6.2.4	Piping and ductwork	Indicate sealing, caulking, gasketing, and weather stripping	1) Submit project specifications and BOQs indicating sealing, caulking, gasketing, and weather-stripping requirements. 2) Submit manufacturer's technical specification sheets for sealants, gaskets, and weather-strips. 3) Submit approved HVAC/MEP drawings showing duct and piping routing. 4) Submit on-site installation photographs. Design stage evaluation: Verify that project specifications, BOQs, and HVAC/MEP drawings indicate provisions for sealing, caulking, gasketing, and weather stripping of piping and ductwork to minimize air leakage, in compliance with ECSBC 2024. Construction stage evaluation: Verify actual implementation through manufacturer's technical specifications, site inspection records, and on-site photographs, confirming that sealing, caulking, gasketing, and weather stripping are provided as per the approved design and ECSBC 2024 requirements. Occupancy stage evaluation: Verify that construction stage records and photographic evidence confirming proper sealing of piping and ductwork have been submitted and closed as part of the final ECSBC compliance documentation.
6.2.4 - (a)	Piping insulation	Indicate R-value of insulation	1) Submit manufacturer's technical specification sheets for piping insulation materials. 2) Submit insulation schedule indicating insulation type and R-value. 3) Submit approved HVAC/MEP drawings. 4) Submit on-site installation photographs.

			Design stage evaluation: Verify that the insulation schedule, technical specifications, and drawings specify piping insulation with the minimum required R-value in accordance with ECSBC 2024. Construction stage evaluation: Verify compliance through manufacturer's specification sheets and on-site photographs, confirming that the installed piping insulation meets the specified R-value and is consistent with the approved design. Occupancy stage evaluation: Verify that installation photographs and insulation documentation confirming compliance with the required R-value have been submitted and closed as part of the final ECSBC compliance documentation.
6.2.4 - (b)	Ductwork and plenum insulation	Indicate R-value of insulation	1) Submit manufacturer's technical specification sheets for duct and plenum insulation. 2) Submit insulation schedule indicating R-values. 3) Submit approved HVAC drawings showing insulated duct and plenum areas. 4) Submit on-site installation photographs. 5) Submit inspection and commissioning reports. Design stage evaluation: Verify that the design documentation specifies ductwork and plenum insulation R-values meeting or exceeding the minimum requirements prescribed under ECSBC 2024. Construction stage evaluation: Verify actual implementation through site inspections, manufacturer's technical specifications, and on-site photographs, confirming that the installed insulation meets the approved R-value requirements. Occupancy stage evaluation: Verify that all ductwork and plenum insulation compliance records have been submitted and closed as part of the final ECSBC documentation.
6.2.5	Condenser location	Condenser location as per Section 6.2.5	1) Submit approved architectural and HVAC/MEP drawings indicating condenser locations. 2) Submit design narrative or DBR describing compliance with Section 6.2.5. 3) Submit on-site installation photographs. Design stage evaluation: Verify that the approved drawings and design narrative indicate condenser locations in compliance with Section 6.2.5 of ECSBC 2024, ensuring adequate clearance, ventilation, and avoidance of adverse heat recirculation.

			Construction stage evaluation: Verify actual installation through site inspection records and photographs, confirming that condensers are installed at the locations shown in the approved drawings and comply with Section 6.2.5 requirements. Occupancy stage evaluation: Verify that as-built drawings and photographic evidence confirming compliant condenser installation have been submitted and closed as part of the final ECSBC compliance documentation.
Standardized requirements (Section 6.3)			
6.3.1	Fans	1. Indicate fan efficiency as per manufacturer catalogue. Calculation of FEI, baseline Electric input power and actual Fan electric input power.	1) Submit manufacturer's technical specification sheets/catalogues indicating: - Fan type (axial, centrifugal, plug fan, etc.) - Rated airflow and pressure - Fan efficiency - Motor efficiency and drive type (direct/ belt driven) 2) Fan equipment schedule 3) FEI calculation report including: - Baseline fan electric input power - Actual fan electric input power - Input parameters, assumptions, and methodology 3) Approved HVAC/MEP drawings 4) On-site installation photographs 5) Commissioning and testing reports (if applicable) Design stage evaluation: Verify that the fan equipment schedule, manufacturer's catalogues, and FEI calculation report clearly specify the fan efficiency parameters and demonstrate compliance with the minimum FEI requirements prescribed under ECSBC 2024. Confirm that the airflow rates, pressure drops, and fan selection used in the FEI calculations are consistent with the design intent and approved HVAC/MEP drawings. Construction stage evaluation: Verify actual implementation through manufacturer's technical specification sheets, site installation photographs, and procurement records, confirming that the installed fans match the design stage specifications in terms of type, capacity, efficiency, and motor characteristics. Confirm that the FEI calculations correspond to the installed equipment, and that any design changes during construction are reflected in updated FEI calculations, if applicable.

			Occupancy stage evaluation: Verify submission of as-built fan schedules, installation photographs, and final FEI calculations, confirming that the installed fan systems achieve the required efficiency and FEI performance as per ECSBC 2024. Ensure that all fan-related compliance documentation is complete and closed as part of the final ECSBC compliance submission.
6.3.2	Chillers	Indicate chiller type, capacity, COP and IPLV	1) Submit manufacturer's technical specification sheets indicating chiller type, rated capacity, COP, IPLV and star rating of the chiller. 2) Submit chiller design-based report with heating and cooling load calculation. 3) Submit approved HVAC/MEP drawings indicating chiller location and system integration. 4) Submit on-site installation photographs showing nameplate details. 5) Submit commissioning and performance test reports. Design stage evaluation: Verify that the equipment schedule and manufacturer's datasheets specify the chiller type, capacity, COP, and IPLV, and that the BEE star rating proposed values comply with minimum ECSBC 2024 efficiency requirements. Confirm that the chiller selection is consistent with the cooling load calculations and system configuration shown in the approved HVAC drawings Construction stage evaluation: Verify through manufacturer datasheets, procurement records, and site photographs that the installed chiller matches the approved design specifications in terms of type, capacity, COP, and IPLV. Occupancy stage evaluation: Verify commissioning and performance reports demonstrating that the installed chillers operate in accordance with the specified COP and IPLV of the BEE star-rated chiller as part of final ECSBC compliance documentation.
6.3.3	Pumps	Indicate pump type (primary, secondary, and condenser), their individual and total installed capacity and efficiency, motor efficiency	1) Submit manufacturer's technical specification sheets/BOQs for pumps and motors. 2) Submit pump schedule indicating type, capacity, efficiency, and international efficiency (IE) of motor rating. 3) Submit on-site installation photographs of pumps and VFD. 5) Submit calculations, showing pumps used in HVAC Systems shall meet or exceed the minimum energy efficiency requirements specified in ECSBC 2024. 4) Submit commissioning and testing reports.

			Design stage evaluation: Verify that the pump schedule, specifications and efficiency calculation indicate required pump types and efficiencies, complying with ECSBC 2024 pumping efficiency provisions for chilled water pumps, condenser pumps, and their motor efficiency. Construction stage evaluation: Verify installed pumps through datasheets and site photographs of pump rated details, confirming pump and motor efficiencies match approved design submissions. Occupancy stage evaluation: Verify commissioning reports confirming pumps operate as per design intent and ECSBC efficiency requirements
6.3.4	Cooling towers	Indicate cooling tower type and installed capacity and rating conditions.	1) Submit manufacturer's technical specification sheets/BOQs of cooling tower highlighting, inlet temperature, outlet temperature, rated flow, range, approach and effectiveness of cooling tower. 2) Submit manufacturer's technical specification sheets/BOQs of cooling tower fan highlighting, motor power. 3) Submit on-site installation photographs of the cooling tower and cooling tower fan rated data nameplate. 4) Submit cooling tower fan efficiency (kW/litre-sec) calculation to comply with ECSBC 2024 requirements. 5) Submit commissioning and testing report of cooling tower. Design stage evaluation: Verify that the cooling tower and cooling tower fan, type, capacity, and rating conditions are clearly specified in the manufactures' technical sheet/BOQs and compliant with ECSBC 2024. Make sure that the efficiency calculation of CT fan as per the rated data is in line with ECSBC 2024 requirement. Construction stage evaluation: Verify installed cooling towers through datasheets and site evidence, ensuring consistency with the efficiency calculation of CT fan and cooling tower entering and leaving temperature are in line with ECSBC 2024 requirement. Occupancy stage evaluation: Verify commissioning and testing report confirming operational compliance to meet ECSBC 2024 requirements.

6.3.5-(a)	Economizers	Air side economizers: Indicate air economizer is capable of modulating Outside-air and return-air dampers to provide 50% of design supply air quantity as outside air for respective building type. Water side economizers: Indicate water economizer is capable of providing 50% of the expected system cooling load at outside air temperatures of 10°C dry bulb/ 7.2°C wet-bulb and below, if the designed building is a respective building type.	Air side economizers 1) Submit HVAC design narrative clearly describing the air side economizer strategy, including modulation logic of outside air and return air dampers. 2) Submit design basis report (DBR) indicating the design supply air quantity and demonstrating that the air side economizer is capable of providing at least 50% of the design supply air as outside air, as applicable to the building type. 3) Submit approved HVAC and MEP drawings showing economizer dampers, actuators, sensors, and control integration within the air-handling system. 4) Submit manufacturer's technical specification sheets for dampers, actuators, sensors, and controllers used for air side economizer operation. 5) Submit commissioning and functional testing reports demonstrating correct air side economizer operation, including damper modulation and control response. B. Water side economizers 1) Submit HVAC design narrative describing the water side economizer system, operating principle, and applicable climatic conditions. 2) Submit DBR demonstrating that the water side economizer is capable of providing at least 50% of the expected system cooling load at outdoor conditions of 10°C dry-bulb / 7.2°C wet-bulb and below, where applicable. 3) Submit approved plant schematics and HVAC drawings showing integration of the water side economizer with chillers, heat exchangers, cooling towers, piping, and controls. 4) Submit manufacturer's technical specification sheets for heat exchangers, valves, pumps, sensors, and control systems associated with the water side economizer. 5) Submit commissioning and functional testing reports verifying water side economizer operation under suitable outdoor conditions. Design stage evaluation: Verify through the HVAC design narrative, DBR, and approved drawings that economizers are provided where required under Section 6.3.5(a) of ECSBC 2024. For air side economizers, confirm that the system is designed to modulate outside air and r
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			return air dampers to provide up to 50% of the design supply air as outside air, as applicable. For water side economizers, verify through DBR calculations and system schematics that the economizer is capable of meeting at least 50% of the expected system cooling load at the specified outdoor air conditions. Manufacturer's technical specifications shall be reviewed to confirm suitability of the proposed components. Construction stage evaluation: Verify actual installation of both air side and water side economizer components through site inspections and photographic evidence. Installed equipment, controls, sensors, and integration shall be checked against the approved drawings and manufacturer's specifications to ensure consistency with the design intent. Any deviations affecting economizer performance shall be documented and evaluated for compliance. Occupancy stage evaluation: Verify operational performance through review of commissioning and functional testing reports. For air side economizers, confirm correct damper modulation, and control response under appropriate outdoor conditions. For water side economizers, confirm effective operation and cooling contribution under qualifying ambient conditions.
6.3.5 - (b)	Partial cooling	indicate where required by Section 6.3.5-(b) economizers shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the cooling load.	1) Submit HVAC control narrative describing partial cooling operation. 2) Submit DBR confirming economizer capability to provide partial cooling when mechanical cooling is simultaneously required. 3) Submit control schematics and sequences of operation. 4) Submit commissioning and functional testing reports Design stage evaluation: Verify that economizer control sequences allow partial cooling contribution even when full cooling demand is not met solely by the economizer. Construction stage evaluation: Verify implementation of control logic through installed controllers and system integration. Occupancy stage evaluation: Review commissioning results demonstrating simultaneous economizer and mechanical cooling operation where required.

6.3.5 - (c)	Economizer controls	Indicate air economizers are equipped with controls as specified in Section 6.3.5-(c)	1) Submit control philosophy and sequence of operations in compliance with Section 6.3.5 (c). 2) Submit approved control drawings showing sensors, setpoints, and interlocks. 3) Submit manufacturer's technical datasheets for control devices. 4) Submit commissioning and testing reports. Design stage evaluation: Verify economizer controls meet ECSBC specifications, including sensing, modulation, and lockout conditions. Construction stage evaluation: Verify correct installation and configuration of control devices and sensors. Occupancy stage evaluation: Review functional testing reports confirming control response and reliability.
6.3.5 - (d)	Testing of economizers	Indicate air side economizers have been tested as per the requirement specified in 6.3.5-(d). Required to meet the cooling load.	1) Submit economizer testing and commissioning reports as per Section 6.3.5(d). 2) Submit test procedures and results documentation. Design stage evaluation: Verify inclusion of economizer testing requirements in specifications and commissioning plans. Construction stage evaluation: Verify completion of testing and documentation during commissioning. Occupancy stage evaluation: Confirm submission and closure of testing reports as part of final ECSBC compliance documentation.
6.3.6- (a)	Variable flow hydronic systems	Indicate pumping system design flow rate, and it is capable of reducing pump flow as per Section 6.3.6 when total system pump power if exceeding 7.5 kW.	1) Submit DBR indicating pumping system design flow rate and total pump power. 2) Submit calculations demonstrating variable flow capability when total system pump power exceeds 7.5 kW. 3) Submit approved HVAC and plant drawings. 4) Submit manufacturer's datasheets for variable speed pumps and drives. 5) Submit commissioning and balancing reports. Design stage evaluation: Verify through DBR and calculations that hydronic systems are designed for variable flow operation in compliance with Section 6.3.6(a). Construction stage evaluation: Verify installation of variable speed drives and control integration. Occupancy stage evaluation: Review commissioning and balancing reports confirming pump flow modulation during operation.

6.3.6-(b)	Automatic shut off of condenser water flow	Indicate water cooled air-conditioning or heat pump units with a circulation pump motor greater than or equal to 7.5 kW shall have two way automatic isolation valve to shut off water flow through the circuit.	1) Submit HVAC design narrative indicating provision of two-way automatic isolation valves. 2) Submit approved drawings showing condenser water piping and valve locations. 3) Submit manufacturer's technical datasheets for isolation valves and actuators. 4) Submit commissioning and functional testing reports. Design stage evaluation: Verify that water-cooled air-conditioning or heat pump units with pump motors ≥ 7.5 kW are designed with automatic two-way isolation valves. Construction stage evaluation: Verify installation of valves and control integration through site inspection and documentation. Occupancy stage evaluation: Review commissioning reports confirming automatic shut-off of condenser water flow when the associated equipment is not in operation.
6.3.7	Unitary, split, packaged air conditioners	Indicate the type of system, cooling capacity.	1) Submit manufacturer's technical specification sheets for, unitary air conditioners, split air conditioners, packaged air conditioners indicating BEE Star Rating and Rated capacity in kW_r or in EER for ducted packaged conditioners. 2) Submit approved HVAC/MEP drawings showing the location of each of the system along with their TR capacity. In case of ducted packaged unit, show the ducting layout as well. 3) Submit on-site installation photographs of each chilling units, showing their BEE star rating and rated capacity in kW_r or in EER. Design stage evaluation: Verify that system type, cooling capacity, and star rating in the manufacturing sheet or BoQ are indicated and they meet ECSBC 2024 requirements and the location of the systems is marked in the approved drawings. Construction stage evaluation: Verify that the installed systems are as per the approved design through site photographs and data sheets. Occupancy stage evaluation: Verify that the systems mentioned in the design phase and construction stage are similar during the occupancy stage. The same could be verified through photographs during the occupancy stage.

6.3.8	Variable refrigerant flow air conditioners	Indicate the cooling capacity and ISEER.	1) Submit manufacturer's technical specification sheets indicating, system type, individual unit capacity (indoor and outdoor units), and total installed cooling capacity. 2) Submit drawing for VRF/VRV, with location of indoor and outdoor units with capacity, areas, and zones served by each unit, refrigerant piping and electrical routing. 3) Submit chiller design-basis report with heating and cooling load calculation. 4) Submit on-site installation photographs of Indoor and outdoor units and nameplates indicating model number and cooling capacity. 5) Submit commissioning /testing reports confirming operational status of installed units is as per the requirement of ECSBC Code compliance. Design stage evaluation: Verify that the equipment schedule and manufacturer's technical specification sheets clearly indicate the type of air-conditioning system and rated cooling capacity, and that the proposed systems comply with the minimum efficiency and applicability requirements of ECSBC 2024. Confirm that the selected system capacities are consistent with the cooling load calculations and the approved HVAC/MEP drawings. Construction stage evaluation: Verify actual implementation through manufacturer's datasheets, procurement records, and on-site installation photographs, confirming that the installed VRF/VRV match the approved design stage specifications in terms of system type and cooling capacity. Confirm that installation locations correspond to the approved drawings. Occupancy stage evaluation: Verify submission of as-built equipment schedules, installation photographs, and commissioning/testing reports, confirming that the installed systems are operational and compliant with ECSBC 2024 requirements. Ensure that all related documentation is complete and closed as part of the final ECSBC compliance submission.
6.3.9	Controls for ECSBC+ buildings	Indicate automated control capability to achieve (a) Zone temperature control (b) AHU fan energy optimization Secondary pump energy optimization	Additional requirement to 6.2.3 to comply with ECSBC + buildings. 1) Submit control philosophy and sequence of operations describing, zone-level temperature sensing and control logic, AHU fan energy optimization strategy (e.g., VFD-based control linked to static pressure, airflow demand, or occupancy) and secondary pump energy optimization (e.g., variable flow control, differential pressure reset, VFD operation)

			2) Submit manufacturer's technical specification sheets of thermostats and zone controllers, VFDs for AHU fans and secondary pumps, sensors (temperature, pressure, flow), building management system (BMS)/automation hardware and software. 3) Submit on-site photographs of installed thermostats and zone controllers, AHU fan VFD panels and sensors and secondary pumps. Submit commissioning and testing reports confirming proper functioning of zone temperature control modulation of AHU fan speed for energy optimization and variable-flow operation and energy optimization of secondary pumps. Design stage evaluation: Verify that the control philosophy, sequence of operations, and design documentation clearly demonstrate provision of automated zone temperature control, AHU fan energy optimization, and secondary pump energy optimization, in accordance with ECSBC+ requirements of ECSBC 2024. Confirm that the proposed control strategies are fully integrated into the approved HVAC/MEP and controls drawings and supported by appropriate equipment specifications. Construction stage evaluation: Verify actual implementation through manufacturer's technical specification sheets, installed control devices, and on-site installation photographs, confirming that the control hardware and system configuration match the approved design-stage submissions. Confirm that VFDs, sensors, and controllers are installed and integrated as indicated in the approved drawings. Occupancy stage evaluation: Verify submission of commissioning and functional testing reports, demonstrating that: • Zone temperature control operates as intended at space level. • AHU fan speeds are automatically optimized based on system demand. • Secondary pumps modulate flow and energy consumption in response to system conditions. Ensure that all control-related compliance documentation is complete and closed as part of the final ECSBC compliance submission.
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6.3.10	Controls for Super ECSBC buildings	Indicate automated control capability to achieve a. Zone temperature control b. Control of fenestration, louvers or blinds c. Occupancy control Chiller plant control	Additional requirement to 6.2.3 and 6.3.9 to comply with Super ECSBC buildings: 1) Submit a comprehensive control narrative describing the advanced automation strategy adopted to achieve Super ECSBC compliance, which includes, zone temperature control with dynamic set-point management, automated control of fenestration, louvers, or blinds based on solar gain, daylight availability, glare control, or thermal comfort logic, occupancy-based controls integrating sensors, schedules, and system enable/disable logic, integrated chiller plant control, including optimization of chillers, pumps, and cooling towers. 2) Submit manufacturer's datasheets for smart thermostats and zone controllers, motorized actuators for fenestration, louvers, or blinds, occupancy sensors (PIR, ultrasonic, dual-technology, or system-integrated), chiller plant control systems, controllers, and optimization software, BMS hardware and software. 3) Submit approved drawings of HVAC zoning and thermostat locations, fenestration, louvers, or blinds control locations and motorization details, occupancy sensor locations and coverage, chiller plant layout and control integration (chillers, pumps, cooling towers). 4) Submit clear on-site photographs showing installed zone controllers and thermostats, motorized fenestration, louvers, or blinds, occupancy sensors and chiller plant control panels and BMS workstations. 5) Submit detailed commissioning and functional testing reports for proper operation of zone temperature control, automated response of fenestration/louvers/blinds to control signals, correct functioning of occupancy-based controls, optimized and integrated operation of the chiller plant through the control system. Design stage evaluation: Verify that the control philosophy and detailed sequence of operations shall be reviewed and the approved HVAC, MEP, and control drawings shall clearly indicate HVAC zoning, thermostat and controller locations, motorized fenestration or shading devices, occupancy sensor coverage, and chiller plant control integration through a centralized BMS. Manufacturer's technical specification sheets and system architecture diagrams shall be reviewed to ensure that the proposed control hardware, sensors, actuators, and BMS platform support the level of automation, integration, and centralized supervision required for Super ECSBC Buildings.
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			Construction stage evaluation: Verify implementation through review of on-site installation photographs confirming installation of zone thermostats and controllers, motorized fenestration or shading devices, occupancy sensors, and chiller plant control panels and BMS infrastructure. The installed control equipment and system configuration shall be verified against the approved design drawings and manufacturer's technical specifications. Pre-commissioning and commissioning records shall be reviewed to confirm correct configuration of control logic, successful integration of HVAC, fenestration, and occupancy controls with the BMS, and reliable communication between field devices and centralized control systems. Occupancy stage evaluation: Verify final commissioning and functional testing reports demonstrating zone temperature control operates effectively under occupied conditions, fenestration, louvers, or blinds respond automatically to control inputs, occupancy-based controls function as intended, and the chiller plant operates in an optimized and coordinated manner through centralized controls. Where applicable, BMS trend logs, system screenshots, or operational records shall be reviewed to confirm continuous monitoring and active implementation of energy optimization strategies. All control-related compliance documentation shall be verified as complete and closed as part of the final Super ECSBC compliance submission.
6.3.11	Energy recovery	Indicate heat recovery effectiveness if hospitality and health care occupancies with energy recovery system with specifications as mentioned in 6.3.11.	1) Submit a detailed HVAC design narrative or DBR clearly describing the energy recovery system proposed for hospitality and health care occupancies. The document shall specify the type of energy recovery system (e.g., heat recovery wheel, plate heat exchanger, run-around coil, or equivalent), design airflows, and the designed heat recovery effectiveness, demonstrating compliance with Section 6.3.11 of ECSBC 2024. 2) Submit manufacturer's datasheets for the proposed energy recovery equipment, including type of energy recovery device, rated heat recovery effectiveness, capacity of recovery system in m3/h. 3) Submit approved HVAC and MEP drawings with integration of the energy recovery system within the air-handling system, fresh air and exhaust air paths, location of energy recovery devices, bypass arrangements, dampers, and associated controls and airflow rates through the energy recovery system.

			4) Submit clear on-site photographs showing, installed energy recovery devices and associated ductwork, dampers, and bypass sections. 5) Submit commissioning and testing reports demonstrating proper installation and operation of the energy recovery system, verification of airflow rates and control sequences, confirmation that the system achieves the required heat recovery effectiveness under operating conditions. Design stage evaluation: Verify that the approved HVAC design documentation incorporates an energy recovery system for hospitality and health care occupancies in accordance with Section 6.3.11 of ECSBC 2024. The design narrative or DBR shall be reviewed to confirm the selected energy recovery technology and the proposed heat recovery effectiveness. Manufacturer's technical specification sheets shall be examined to ensure that the rated effectiveness meets or exceeds ECSBC requirements. Construction stage evaluation: Verify actual installation of the energy recovery system through site inspections and supporting documentation. On-site photographs shall be reviewed to confirm that the installed system matches the approved drawings and manufacturer's specifications. The equipment type, configuration, and rated effectiveness shall be cross-checked against design stage submissions. Pre-commissioning and commissioning documents shall be evaluated to confirm correct installation, airflow balancing, and functional integration of the energy recovery system with the HVAC system. Occupancy stage evaluation: Verify operational performance of the energy recovery system through review of final commissioning and functional testing reports. The documentation shall demonstrate that the system is operational and achieving the heat recovery effectiveness required under ECSBC 2024. Completion and closure of all energy recovery-related documentation shall be verified as part of the final ECSBC compliance submission.
6.3.12	Total system efficiency alternate	Submit simulation report including details as required in Section 6.3.12.	Compliance shall be demonstrated through submission of a comprehensive energy simulation report and supporting documents to the certifying authority having jurisdiction, in accordance with ECSBC 2024. The submission shall include, at a minimum, the following: 1) Submit a detailed building energy simulation report prepared in accordance with Section 6.3.12 of ECSBC 2024, demonstrating compliance through the totalefficiency alternate approach. The report shall include:

			• Brief project description including building location, number of stories, space types, conditioned and unconditioned areas, and hours of operation. • Simulation software/tool used (approved/accepted simulation engines). • Baseline model configuration developed in accordance with ECSBC requirements. • Proposed model configuration reflecting the actual design. • Modelling assumptions, inputs, schedules, and boundary conditions. • Explanation of all significant modelling assumptions, including zoning, system efficiencies, control logic, and part-load performance characteristics. • Explanation of any simulation error messages or warnings and their resolution. • Comparison of annual energy performance between baseline and proposed cases. • Summary of compliance demonstrating that the proposed design meets or exceeds ECSBC performance thresholds. 2. Submit a clear summary of analysis results, including: • Annual energy use (kWh) of the chilled water plant, covering chillers, pumps, and cooling towers. • Annual chilled water energy use (kWh) for the proposed design. • Summary of system-level efficiency metrics. • Identification of any unmet load hours reported by the simulation. 3. Submit the design basis report (DBR) highlighting: • HVAC system selection and overall configuration • Design parameters and assumptions adopted in the simulation • Space cooling and heating load calculations • Control strategies, operational schedules, and efficiency measures incorporated in the proposed design 4. Submit documentation including: • A list of energy-related building features of the proposed design, such as HVAC system type, plant configuration, control strategies, and energy efficiency measures.
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			The simulation input and output reports shall be evaluated to ensure that the baseline and proposed models are correctly developed, mandatory ECSBC provisions are met, unmet load hours are within acceptable limits, and the proposed design demonstrates compliance with ECSBC performance thresholds. Construction stage evaluation: Verify that the systems being installed on site are consistent with the design intent and simulation model submitted at the design stage. Equipment submittals, shop drawings, and manufacturer's technical specifications for chillers, pumps, cooling towers, AHUs, and control systems shall be reviewed to confirm alignment with modelled capacities, efficiencies, and configurations. Any deviations from the approved design that could impact system efficiency shall be documented and evaluated for their impact on simulation results. Where significant changes occur, revised simulation documentation shall be reviewed to ensure continued compliance with ECSBC 2024 under the alternate compliance approach. Occupancy stage evaluation: Verify final compliance by reviewing as-built documentation, final commissioning reports, and confirmation that the installed systems are operational and consistent with the systems modelled under the alternate compliance approach. The commissioning documentation shall confirm correct operation of the chilled water plant and associated HVAC systems. Where required by the authority having jurisdiction, operational data or performance records may be reviewed to verify that system operation aligns with modelled assumptions. Completion and closure of all simulation, commissioning, and compliance documentation shall be verified prior to acceptance of ECSBC compliance.
6.3.13	Low-energy comfort systems (LECSs)	Indicate system type and minimum requirements as mentioned in Section 6.3.13 (including indicated documentation requirements) and list the exemption claimed.	1) Submit a detailed design narrative describing the LECS adopted in the project (such as radiant cooling/heating systems, displacement ventilation, underfloor air distribution, passive or hybrid comfort systems, or other systems recognized under Section 6.3.13 of ECSBC 2024). The narrative shall clearly identify the system type, capacity, and efficiency requirements prescribed in Section 6.3.13. 2) Submit the DBR highlighting, selection rationale and design criteria for the LECS, operating conditions, cooling and/or heating load calculations.

			3) Submit approved drawings with layout and zoning of the LECS, location of system components such as radiant panels, chilled beams, air terminals, or floor systems, integration with architectural elements and envelope design, associated control zones and interfaces with other building systems. 4) Submit manufacturer's technical specification sheets for all major LECS components, indicating performance parameters, efficiency and operating limits, compliance with minimum requirements specified in ECSBC 2024, Section 6.3.13. 5) Submit comparison of installed capacity of the approved LECS as against the conventional system with calculations for energy consumption of both the systems. Design stage evaluation: Verify that the project proposes a LECS recognized under Section 6.3.13 of ECSBC 2024. The system description, design narrative, and DBR shall be reviewed to confirm the selected system type, compliance with minimum technical and performance requirements, and appropriateness of the system for the intended building use. The justification for exemptions claimed shall be evaluated to ensure alignment with ECSBC provisions. Approved drawings and manufacturer's specifications shall be reviewed to verify proper system integration, zoning, and compatibility with thermal comfort and energy efficiency objectives. Construction stage evaluation: Verify actual implementation of the LECS through site inspections and documentary evidence. On-site photographs and as-built drawings shall be reviewed to confirm that system components are installed as per the approved design. Manufacturer's specifications and equipment submittals shall be cross-verified with installed components. Pre-commissioning and commissioning documentation shall be evaluated to confirm correct installation, control integration, and readiness for operation in accordance with ECSBC 2024 requirements. Occupancy stage evaluation: Verify operational performance of the LECS through review of final commissioning and functional testing reports. The documentation shall demonstrate that the system operates as intended and delivers acceptable energy use consistent with the ECSBC intent. Where applicable, operational data, monitoring records, or post-occupancy performance assessments shall be reviewed to confirm continued compliance. Closure of all documentation related to LECS adoption and exemptions claimed shall be verified as part of the final ECSBC compliance submission.
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Chapter 7 turns to lighting systems and their controls. It explains the requirements for internal and external lighting power densities, lighting quality standards, and the use of efficient light sources. The chapter describes how daylight and occupancy sensors must be integrated into the lighting design and elaborates on the power budgeting approaches through both the space-by-space method and the building area method. Exterior lighting controls and energy-efficient exit signage are also mandated, ensuring lighting systems are optimized for both performance and energy savings.

Table 7 Lighting and controls – compliance form

Code Section	Component	Information required	Lighting and controls – compliance form
7.2.1	Lighting quality and quantity	Indicate that the lighting quantity and quality parameters for respective application areas shall be in compliance with the latest version of IS 3646 – Part 1	Lighting layout drawings – showing the location and type of luminaires for each space. Lighting calculations/reports – demonstrating illuminance levels, uniformity, and glare indices for each application area in accordance with IS 3646 – Part 1. Luminaire specifications – datasheets or manufacturer's specifications showing rated wattage, luminous efficacy, and photometric data. Space-by-space analysis – Verification tables showing each area, its lighting design, and compliance with IS 3646 requirements. Design stage evaluation: Verify that lighting design calculations, layouts, and specifications demonstrate compliance with IS 3646 (Part 1) for illuminance levels, uniformity, and glare control, and that space-wise lighting intent is defined at design stage. During construction evaluation: Verify that installed luminaires match approved layouts and specifications through site inspection, luminaire datasheets, and installation photographs. Occupancy stage evaluation: Verify submission of final lighting layouts and calculations confirming that installed lighting systems meet IS 3646 requirements prior to occupancy.
7.2.2-(a)	Automatic lighting shutoff	Indicate automatic shutoff locations or occupancy sensors as per Section 7.2.2-(a) requirements.	1. Lighting control layout plans - Floor plans showing locations of all automatic lighting shutoff devices and occupancy sensors. - Indicate control zones and areas covered. 2. Equipment specifications/datasheets - Manufacturer datasheets for occupancy sensors/timer devices. - Include rated wattage, type of sensor, and time delay capabilities.

			3. Installation records/photos • Photos or inspection reports confirming that sensors or timers are installed in required areas. • Show wall switches for manual override where applicable. 4. Control program/schedule documentation • Programmed schedules for timer-based automatic shutoff devices. • Verification of schedules covering areas $\leq 2,500 \text{ m}^2$ on a single floor. 5. Occupancy sensor coverage reports • Reports or diagrams showing percentage of fixtures controlled by occupancy sensors (minimum 90% by wattage). • Include areas like habitable spaces, storage, toilets, corridors in hospitality buildings, conference/meeting rooms, etc. Design stage evaluation Verify that interior lighting control intent is incorporated in lighting control drawings, layouts, and schedules in accordance with ECSBC Section 7.2.2(a), including: • Automatic lighting shutoff provided for minimum 90% of interior lighting fixtures by connected wattage. • Identification of control strategy (scheduled control or occupancy sensors) for each space. • Sensor zoning and programmed control areas limited to $\leq 2,500 \text{ m}^2$ and not more than one floor for scheduled controls. • Identification of spaces claimed under exceptions (24/7 operation, patient care, safety/security) with justification. During construction evaluation Verify installation and configuration of automatic lighting shutoff devices through site inspection, photographs, and equipment datasheets, including: • Confirmation that occupancy sensors or timer-based controls are installed as per approved drawings. • Verification that occupancy sensors are capable of switch-off or minimum 80% dimming within 15 minutes of vacancy. • Presence of wall-mounted manual ON/OFF switches for occupancy sensor-controlled lighting. • Confirmation that excluded areas align with documented exceptions and are not counted towards the 90% wattage requirement.
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			Occupancy/pre-occupancy stage evaluation Verify operational performance and commissioning of interior lighting controls prior to occupancy, including: • Review of commissioning reports or functional test records confirming proper operation of sensors and scheduled controls. • Verification of programmed schedules for timer-based shutoff systems. • Confirmation that at least 90% of total interior lighting wattage is effectively controlled by automatic shutoff devices. • Validation that lighting in exempted spaces operates as intended without compromising code compliance.
7.2.2-(b)	Space control	Indicate whether at least one control of light is used and controlling the space lighting as per Section 7.2.2-(b)	1. Lighting layout drawings/plans • Show the location of all space control devices (manual switches or occupancy sensors). • Indicate the spaces they control and area coverage for each device. • Clearly show control zones for offices >30 m², limited to 60 m² per zone. • Include zones for larger spaces (≤1,000 m² → max 250 m² per control; >1,000 m² → max 1,000 m² per control) 2. Occupancy sensor and control device specifications/cut sheets • Manufacturer datasheets showing type of control (manual OR occupancy sensor). • Sensor coverage area, response type (motion/occupancy), and compatibility with connected luminaires. • Power ratings and automatic dimming/partial-on capability (for 20% power in unoccupied zones). • Override function (maximum 2 hours) capability as per Section 7.2.2-(b)(D). Operation/commissioning reports • Verification that each control device functions correctly: • Manual operation: • Automatic operation (occupancy sensor response) • Override function (max 2 hours) • Test reports for occupancy sensors: on/off behavior and area coverage compliance.

			Photographs/site verification evidence • Photos of installed control devices in each space. • Labels/pilot lights for remotely installed control devices. • Evidence of accessibility and visibility of all devices for occupants. Control device schedule/table • Table listing: • Each device type (manual/occupancy) • Spaces controlled • Area coverage • Compliance with zoning, partial-on, and override requirements Special spaces verification (additions based on ECSBC specifics) • Occupancy sensors verification in: Habitable spaces <30 m² • Storage/utility >15 m² • Public toilets >25 m² (≥80% of lighting controlled) • Hospitality corridors (70–80% of fixtures controlled) • Conference/meeting rooms (remotely located devices with pilot lights where applicable) Design stage evaluation Verify that space-level lighting control intent is incorporated in lighting layout drawings, control schedules, and specifications in accordance with ECSBC Section 7.2.2(b), including: • Provision of at least one independent control device per enclosed space. • Identification of control type (manual switch or occupancy sensor) for each space. • Compliance with maximum area controlled per device: ≤1,000 m² spaces → max 250 m² per control device. • 1,000 m² spaces → max 1,000 m² per control device. • Office spaces >30 m² subdivided into control zones ≤60 m². • Specification of override capability limited to 2 hours. • Identification of spaces requiring mandatory occupancy sensors and spaces using remotely located controls under permitted exceptions.
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			During construction evaluation Verify installation, zoning, and configuration of space control devices through site inspection, photographs, and equipment documentation, including: • Confirmation that installed control devices match approved drawings and schedules. • Verification of correct zoning and area coverage for each control device. • Installation of occupancy sensors in all spaces mandated under ECSBC 7.2.2(b)(2). • Confirmation that control devices are readily accessible and visible to occupants. • Review of preliminary functional testing demonstrating manual operation, occupancy response, and override functionality. Occupancy/pre-occupancy stage evaluation Verify operational performance of space lighting controls through commissioning records and site verification prior to and during occupancy, including: • Functional testing of: Manual control operation. • Occupancy sensor response in all required spaces. • Automatic partial-on limits ($\leq 20\%$) in unoccupied zones. • Automatic turn-on limits ($\leq 50\%$ of general lighting power). • Override duration not exceeding 2 hours. • Verification that occupancy sensor coverage meets area- and wattage-based requirements for toilets, corridors, storage areas, and conference rooms. • Confirmation that space controls operate independently as intended without interference between zones.
7.2.2-(c)	Control in daylight areas	Provide manual or automatic control device schedule with type and features, indicate locations.	1. Daylight area identification drawings: Floor plans showing: • Daylight areas determined as per Section 5.2.3 (daylighting extent from windows) • Location of luminaires installed within these daylight areas 2. Lighting control drawings for daylight areas: Lighting/electrical drawings indicating: • Control provided for luminaires located in daylight areas • Whether the control is: Manual shut-off, or Automatic daylight-responsive control

			Automatic daylight control product datasheets (if automatic control is provided): Manufacturer datasheets confirming that the automatic daylight control: • Has a minimum 5-minute delay • Can switch off luminaires or dim/step down lighting to $\leq 10\%$ of full power 4. Evidence of no manual override (for automatic controls): Showing that manual override is not provided for luminaires controlled by automatic daylight controls through: • Control drawings, or • Control schematics Design stage evaluation Verify identification of daylight areas as per ECSBC Section 5.2.3 and provision of appropriate lighting controls in accordance with ECSBC Section 7.2.2(c), including: • Delineation of daylight extent from windows and identification of all luminaires located within daylight areas. • Specification of control type for daylight-area luminaires as either: Manual shut-off controls, or • Automatic daylight-responsive controls • Confirmation that automatic daylight controls are specified with: Minimum 5-minute time delay, and • Ability to switch off or dim/step down luminaires to $\leq 10\%$ of full power. • Confirmation that manual override is not provided where automatic daylight-responsive controls are specified. During construction evaluation Verify installation and configuration of daylight-responsive lighting controls through site inspection, photographs, control schematics, and product datasheets, including: • Confirmation that daylight sensors and control devices are installed for all luminaires within designated daylight areas. • Verification that installed control devices match approved drawings and specifications. • Review of manufacturer datasheets confirming compliance with delay time and minimum dimming/switch-off capability. • Confirmation through drawings or verification that no manual override switches are provided for luminaires controlled by automatic daylight controls.
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			Occupancy/pre-occupancy stage evaluation Verify operational performance of daylight-responsive lighting controls through commissioning records and functional testing prior to occupancy including: • Functional testing demonstrating: • Automatic response to daylight availability • Minimum 5-minute delay before control action • Switching off or dimming of luminaires to $\leq 10\%$ of full power • Confirmation that luminaires in daylight areas respond only to the specified control strategy without manual override, where automatic controls are used.
7.2.3	Exterior lighting control	Indicate photosensor or astronomical time switch.	Exterior lighting layout and control zoning drawings: Site and façade lighting drawings clearly indicating: • Locations of all exterior luminaires • Locations of photo sensors and/or astronomical time controls • Separate control circuits/zones for: General exterior lighting • Façade lighting • Façade non-emergency signage • Identification of exterior lighting meant for emergency/firefighting purposes (if applicable) Exterior lighting fixture and control schedule: A consolidated schedule listing: • Exterior luminaire identification • Connected load (wattage) • Type of control provided (photo sensor / astronomical timer) • Control circuit or zone classification (general exterior / façade / signage / emergency) Control device specifications/datasheets: Manufacturer datasheets or technical literature for: • Photo sensors • Astronomical time switches • Central/BMS-based exterior lighting controls (if used) Declaration/control logic confirmation: A signed declaration or brief control logic statement from the electrical/lighting designer confirming: • Exterior lighting is automatically controlled using photo sensors or astronomical time control.

			• Façade lighting and façade non-emergency signage are on separate time controls. • Emergency/firefighting exterior lighting (if any) is exempted as per ECSBC 7.2.3. Design stage evaluation Verify that exterior lighting layouts, control zoning, and control strategies are defined in lighting and electrical drawings in accordance with ECSBC Section 7.2.3, including: • Provision of photo sensors and/or astronomical time controls for all non-exempt exterior lighting. • Identification of automatic shut-off strategy to ensure exterior lighting turns off when daylight is available or lighting is not required. • Clear separation of control circuits/zones for: General exterior lighting • Façade lighting • Façade non-emergency signage • Identification and justification of exterior lighting systems exempted for emergency and firefighting purposes, where applicable. During construction evaluation Verify installation and configuration of exterior lighting control devices and circuits through site inspection, photographs, and product documentation, including: • Confirmation that photo sensors and/or astronomical time switches are installed as per approved drawings. • Verification that façade lighting and façade non-emergency signage are connected to separate time controls. • Confirmation that emergency/firefighting exterior lighting, if provided, is installed on dedicated circuits and excluded from automatic shut-off controls. • Review of control device datasheets confirming suitability for exterior application. Occupancy/pre-occupancy stage evaluation Verify operational performance of exterior lighting control systems through commissioning records and functional testing prior to occupancy, including: • Demonstration that exterior lighting automatically switches off during daylight conditions or as per programmed astronomical schedules. • Verification of correct operation of independent time controls for façade lighting and façade non-emergency signage. • Confirmation that emergency/firefighting exterior lighting remains operational as intended and is not affected by automatic control schedules.
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7.2.4	Controls for ECSBC+ and Super ECSBC buildings	Provide centralized control system schedule with type and features, indicate locations	Centralized lighting control system documentation • System description covering architecture and control capabilities • Manufacturer datasheets/specifications showing: Switching control of internal and external luminaires • Dimming capability • Scheduling for individual and grouped luminaires Lighting control programming and schedule reports Configured schedules showing on/off/dimming programs for: • Internal luminaires • External luminaires Occupancy sensor integration evidence • Occupancy sensor layout and locations plan • Sensor model datasheets and connectivity details Space occupancy feedback verification • Test reports showing occupancy sensor triggering and lighting control response • Commissioning report indicating correct feedback functioning Luminaire failure feedback documentation • System report showing: • Example failure notification log or screenshot • Maintenance response protocol for failures Energy monitoring reports • Separate energy metering documentation for: • Meter specifications and installation details • Periodic energy consumption reports (with date/time stamp) Design stage evaluation Verify that the centralized lighting control system architecture and intended functionality are defined in design and specification documents in accordance with ECSBC Section 7.2.4, including: • Provision of a centralized lighting control system covering both internal and external luminaires. • Defined capability for switching, dimming, grouping, and scheduling of individual and grouped luminaires. • Integration strategy for space occupancy feedback from occupancy sensors.
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			• Provision for luminaire failure detection and feedback at individual or group level. • Design intent for separate energy monitoring of internal and external lighting systems. During construction evaluation Verify installation, integration, and configuration of the centralized lighting control system through site inspection, system configuration records, and commissioning documentation, including: • Confirmation that centralized controllers, communication networks, and control panels are installed as per approved design. • Verification of occupancy sensor installation and successful integration with the centralized system. • Verification that luminaire failure feedback is enabled and visible within the control platform. • Installation of separate energy metering for internal and external lighting loads. • Review of programmed schedules and grouping logic for internal and external luminaires. Occupancy/pre-occupancy stage evaluation Verify operational performance of the centralized lighting control system through commissioning reports, system logs, and live demonstrations prior to and during occupancy, including: • Demonstration of centralized control functions: on/off switching, dimming, grouping, and scheduling. • Verification of real-time occupancy feedback influencing lighting operation. • Confirmation of luminaire failure alerts/logs for maintenance monitoring. • Review of energy monitoring dashboards or reports showing separate consumption data for internal and external lighting. • Confirmation that all mandatory ECSBC Plus / Super ECSBC control features are fully functional and accessible to facility management.
7.2.5	Additional controls	Provide schedule with type, indicate locations.	Lighting layout and control zoning drawings: Drawings shall clearly indicate: • Locations of display / accent lighting • Locations of task lighting (including under-shelf / under-cabinet) • Locations of non-visual lighting (plant growth, food-warming, etc.) • Locations of demonstration lighting

			- Hotel guest room lighting layouts, including all permanently installed luminaires and switched receptacles - Independent control zoning showing that these lighting applications are controlled separately from general lighting Lighting control schedule/legend: Schedule or legend identifying: - Type of lighting application (display/accent, task, nonvisual, demonstration, guest room) - Corresponding control device type (wall switch, integral luminaire control, master switch, restricted access control, etc.) - Confirmation that the control is independent of general lighting. Area statement for display/accent lighting - Area calculations identifying spaces $\geq 300 \text{ m}^2$ - Confirmation that display/accent lighting in such areas has separate controls Hotel guest room control details: Documentation demonstrating: - Presence of a master control device at the main room entry - Master control operates: All permanently installed luminaires All switched receptacles (shown via drawings, wiring diagram, or control narrative) Task lighting control details: Evidence showing: - Task lighting is either: Controlled by an integral luminaire control, or Controlled by a wall-mounted device complying with Section 7.2.2(b) - Shown through drawings and/or control schedules Non-visual lighting control identification: Documentation identifying: - Non-visual lighting applications - Separate control devices dedicated only to these systems Demonstration lighting control access confirmation: Drawings or notes indicating: - Demonstration lighting is on a separate control circuit - Control device is accessible only to authorized personnel
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			Control narrative/compliance statement: A brief narrative or checklist confirming that: • Each lighting application listed under 7.2.5 is provided with independent control • Controls are provided exactly as described in ECSBC 2024 Section 7.2.5 Design stage evaluation Verify that independent lighting control requirements for special lighting applications are incorporated in lighting layouts, control zoning drawings, and schedules in accordance with ECSBC Section 7.2.5, including: • Identification of display/accent lighting in spaces $\geq 300 \text{ m}^2$ and provision of separate controls independent of general lighting. • Provision of a master control device at the main entry for hotel guest rooms and suites controlling all permanently installed luminaires and switched receptacles. • Specification of independent controls for task lighting, either integral to the luminaire or via wall-mounted controls complying with Section 7.2.2(b). • Identification of non-visual lighting applications with dedicated, separate control devices. • Provision of separate, restricted-access controls for demonstration lighting used for sale or educational purposes. • Confirmation that all listed lighting applications are controlled independently of general lighting systems. During construction evaluation Verify installation and zoning of independent lighting controls through site inspection, approved drawings, and photographic evidence, including: • Confirmation that installed control devices correspond to approved control schedules and layouts. • Verification that display/accent lighting, task lighting, non-visual lighting, and demonstration lighting are connected to separate control circuits or devices. • Verification of master control device installation at hotel guest room entry points and its connection to all required luminaires and switched receptacles. • Confirmation that demonstration lighting controls are accessible only to authorized personnel, as indicated in drawings or site conditions.
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			Occupancy/pre-occupancy stage evaluation Verify functional performance and independence of lighting controls through commissioning records and site verification prior to and during occupancy, including: • Functional testing confirming that each special lighting application operates independently of general lighting. • Verification of proper operation of guest room master controls. • Confirmation that task lighting controls operate as intended without affecting general lighting. • Verification that restricted-access controls for demonstration lighting are enforced. • Confirmation that non-visual lighting systems are independently operable for their intended use.
7.2.6	Exit signs	Indicate wattage per face of exit signs.	Lighting schedule/fixture schedule • A detailed lighting schedule showing each exit sign listing, including: Manufacturer and model number of each internally illuminated exit sign • Rated input power (wattage) per face Product data sheets/manufacturer specifications • Manufacturer cut-sheets or datasheets for the exit sign fixtures showing: Actual power consumption (watts per face) • Electrical input ratings • Testing standards/certifications Exit sign layout drawings: Electrical or life-safety plans showing: • Locations of all exit signs • Type (single-face/double-face) Design stage evaluation Verify that exit sign locations, type (single-face or double-face), and rated input power per face (≤ 5 W) are specified in lighting schedules, fixture schedules, and electrical drawings in accordance with ECSBC Section 7.2.6. During construction evaluation Verify installed exit signs through site inspection and manufacturer documentation, including: • Confirmation of exit sign type (single-face/double-face) at each location. • Verification, using manufacturer datasheets or fixture labels that input power does not exceed 5 W per face.

			- Confirmation that installed exit signs match approved models and specifications. Occupancy/pre-occupancy stage evaluation Verify final compliance of all internally illuminated exit signs prior to occupancy, including: - Cross-check of installed exit signs against approved schedules and datasheets. - Confirmation that all exit signs comply with the maximum 5 W per face requirement under ECSBC 7.2.6.
7.2.7	Lighting power	A lighting design plan showing luminaire types, locations, and CLP calculations and efficacy aligned with Section 7.3.5 limits and manufacturing specifications.	(a): Exterior lighting power limits Exterior lighting layout drawings Showing all exterior lighting applications and luminaire locations. Exterior lighting fixture schedule Luminaire ID Type/application Rated wattage per luminaire Quantity Exterior lighting power calculation sheet Connected lighting power for each exterior lighting application Comparison against lighting power limits specified in Section 7.3.5 for ECSBC Buildings (b): Exterior Luminaire Efficacy and Correlated Colour Temperature Exterior Luminaire Technical Datasheets Rated luminous efficacy (lumens per watt) Correlated colour temperature (CCT) Light colour (white light confirmation) Exterior lighting fixture schedule (updated) Efficacy (lm/W) CCT value Identification of decorative/architectural lighting (if any) Building compliance category declaration Confirmation whether the project is ECSBC / ECSBC+ / Super ECSBC (to verify the applicable efficacy threshold: 100 / 110 / 120 lm/W)

			Design stage evaluation Verify compliance of exterior lighting power and luminaire efficacy at design stage in accordance with ECSBC Section 7.2.7, including: • Calculation of connected exterior lighting power for each exterior lighting application and comparison with the applicable lighting power limits specified in Section 7.3.5 for ECSBC Buildings. • Identification and exclusion of exempt exterior luminaires/applications as permitted under Section 7.3.5. Verification that external luminaires emitting white light (CCT 2700 K–6500 K) meet the minimum luminous efficacy requirements based on declared building compliance category: ECSBC: $\geq 100 \text{ lm/W}$ ECSBC+: $\geq 110 \text{ lm/W}$ Super ECSBC: $\geq 120 \text{ lm/W}$ Identification of decorative/architectural lighting, which is excluded from the efficacy requirement under this clause. During construction evaluation Verify installed exterior lighting systems through site inspection, approved drawings, and manufacturer documentation, including: • Confirmation that installed exterior luminaires match approved fixture types, wattages, and quantities used in lighting power calculations. • Verification of luminaire efficacy (lm/W) and CCT using manufacturer datasheets. • Confirmation that decorative/architectural luminaires, if provided, are correctly identified and excluded from efficacy compliance checks. • Verification that no unapproved substitutions affect compliance with Section 7.3.5 power limits or Section 7.2.7(b) efficacy requirements. Occupancy/pre-occupancy stage evaluation Verify final compliance of exterior lighting power and efficacy prior to occupancy through as-built documentation and declarations, including: • Review of as-built exterior lighting schedules and final connected load calculations demonstrating compliance with Section 7.3.5 limits. • Confirmation that all applicable exterior luminaires meet the minimum efficacy requirements corresponding to the declared ECSBC / ECSBC + / Super ECSBC category. • Verification that exemptions and decorative/architectural lighting classifications remain unchanged from approved design intent.
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7.3.1	Interior lighting power	Indicate whether project is complying with the building area method (7.3.2) or the space function method (7.3.3)	Interior lighting layout drawings Floor-wise lighting plans showing all interior luminaires within the scope of compliance Clear identification of areas/building portions considered (whole building or separately metered/permitted portion). Interior lighting fixture schedule Luminaire quantity, type and ID Rated wattage (lamp + ballast/driver) Space/area served by each luminaire Installed interior lighting power calculation Calculation prepared as per Section 7.3.4 (installed interior lighting power) Total installed interior lighting power (W) Interior lighting power allowance calculation Calculation of allowable lighting power using either: Section 7.3.2 – Building area method or Section 7.3.3 – Space function method Comparison statement Document showing that: Installed interior lighting power $\leq$ Interior lighting power allowance List of exempt lighting (if applicable) Identification of lighting claimed under exemptions (a–m) of Section 7.3.1 Confirmation that such lighting is additional to general lighting Independent control confirmation for exempt lighting Drawings or schedules indicating separate/independent control devices for exempt lighting Control type identification (switch, dimmer, controller, etc.) Design stage evaluation Verify compliance with ECSBC Section 7.3.1 at the design stage, including: Selection and documentation of the interior lighting power allowance method: Building area method (Section 7.3.2) or Space function method (Section 7.3.3) Calculation of installed interior lighting power in accordance with Section 7.3.4, including lamp, ballast, and driver power. Calculation of interior lighting power allowance using the selected method. Identification and documentation of lighting claimed under exemptions (a–m). Verification that exempt lighting is additional to general lighting and provided with independent control devices, as required for exemption eligibility. Confirmation that installed interior lighting power $\leq$ allowable lighting power.
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			During construction evaluation Verify installation of interior lighting systems against approved calculations and exemption claims through site inspection and documentation review, including: • Confirmation that installed luminaire types, wattages, and quantities match those used in approved lighting power calculations. • Verification of correct installation of independent controls for lighting claimed as exempt. • Identification and documentation of any luminaire substitutions or quantity changes that may affect compliance. • Interim reconciliation of installed lighting power where design changes occur. Occupancy/pre-occupancy stage evaluation Verify final compliance with interior lighting power limits prior to occupancy through as-built documentation, including: • Preparation and review of as-built interior lighting power calculations as per Section 7.3.4. • Confirmation that final installed interior lighting power does not exceed the calculated allowance under the selected method. • Verification that all exempt lighting remains independently controlled and limited to the claimed applications. • Confirmation that no additional general lighting has been installed that would invalidate exemption claims.
7.3.2	Building area method	Provide lighting schedule with wattage of lamp and ballast and number of fixtures. Document all exceptions.	Approved floor area drawings Floor plans showing building area classification (as per ECSBC building area types) Clearly demarcated gross illuminated area for each building area type Area statement/area calculation sheet Gross illuminated floor area (m²) for each building area type Area breakup corresponding to ECSBC Tables (7.1 / 7.2 / 7.3, as applicable) Lighting power density (LPD) reference Identification of applicable ECSBC compliance level: ECSBC / ECSBC+ / Super ECSBC Extract/reference of allowed LPD values from: Table 7.1 / 7.2 / 7.3 (as applicable) Interior lighting power allowance calculation sheet Mapping of each building area type to its corresponding LPD

			Interior lighting power allowance calculation sheet Calculation showing Gross illuminated floor area (m²) for each building area type Summation of all building areas to derive total interior lighting power allowance (W) Design stage evaluation Verify determination of interior lighting power allowance using the building area method in accordance with ECSBC Section 7.3.2, including: • Classification of building spaces into appropriate ECSBC building area types. • Calculation and documentation of gross illuminated floor area for each building area type. • Selection of applicable allowed lighting power density (LPD) values from: Table 7.1 for ECSBC Buildings, Table 7.2 for ECSBC+ Buildings, or Table 7.3 for Super ECSBC Buildings. Calculation of interior lighting power allowance as the sum of (gross illuminated area × allowed LPD) for all building area types. Confirmation that the selected compliance category (ECSBC / ECSBC+ / Super ECSBC) is consistently applied. During construction evaluation Verify that lighting installation aligns with approved building area method calculations, including: • Confirmation that installed luminaires and lighting coverage correspond to the approved gross illuminated areas. • Verification that no changes in space use or area classification affect the approved building area breakdown. • Identification of any design or site changes that may require recalculation of lighting power allowance under the building area method. Occupancy/pre-occupancy stage evaluation Verify final compliance of interior lighting power prior to occupancy through as-built documentation, including: • Review of as-built area statements confirming gross illuminated areas remain unchanged from approved design. • Confirmation that final installed interior lighting power, calculated as per Section 7.3.4, does not exceed the lighting power allowance derived using Section 7.3.2. • Validation that the building area method has been consistently applied across the project.
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7.3.3	Space function method	Provide lighting schedule with wattage of lamp and ballast and number of fixtures. Document all exceptions.	Space-wise floor plans Floor plans showing individual spaces with room/space names Identification of spaces enclosed by $\geq 80\%$ ceiling-height partitions Identification of retail spaces (if any) Space area calculation drawings/area statement Gross lighted floor area (m^2) for each space Area measured to the centre line of partition walls Inclusion of balconies and projections (where applicable) Lighting design basis for quantity and quality Lighting layout/design demonstrating compliance with IS 3646 (Part 1) Basis of design indicating that the number of luminaires meets IS 3646 lighting quantity and quality parameters Applicable space type and LPD reference Identification of applicable compliance level: ECSBC / ECSBC+ / Super ECSBC Identification of space function type for each space Reference to applicable LPD values from: Tables 7.4 / 7.5 / 7.6 (as applicable) Confirmation that building-specific space type LPD is used where both common and building-specific types exist. Space-wise lighting power allowance calculation Calculation showing: Gross lighted floor area $\times$ Allowed LPD for each space Summation of all spaces to derive total interior lighting power allowance (W) Design stage evaluation Verify determination of interior lighting power allowance using the space function method in accordance with ECSBC Section 7.3.3, including: Confirmation that lighting layouts and luminaire quantities for each space are designed to meet lighting quantity and quality requirements as per IS 3646 (Part 1). Identification and classification of each space based on space function type, including: Enclosed spaces with partitions $\geq 80\%$ of ceiling height Retail spaces (where applicable) Calculation of gross lighted floor area for each space measured to the centre line of partition walls, including balconies and projections where applicable. Selection of applicable allowed lighting power density (LPD) values from: Table 7.4 (ECSBC), Table 7.5 (ECSBC+), or Table 7.6 (Super ECSBC), ensuring that building-specific space type LPD is applied where both common and building-specific space types exist.
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			Calculation of space-wise lighting power allowance as: (gross lighted floor area × allowed LPD), and summation of all spaces to derive the total interior lighting power allowance. During construction evaluation Verify that lighting installation conforms to the approved Space Function Method calculations, including: Verification through site inspection that installed luminaires, quantities, and layouts match the approved IS 3646-based lighting design. Confirmation that space boundaries, partition heights, and space functions remain consistent with approved design documentation. Identification of any changes in space use, enclosure, or layout that would require reclassification of space type or recalculation of lighting power allowance. Occupancy/pre-occupancy stage evaluation Verify final compliance of interior lighting power prior to occupancy through as-built documentation, including: • Review of as-built space area statements confirming gross lighted floor areas. • Confirmation that final installed interior lighting power, calculated on a space-by-space basis, does not exceed the total interior lighting power allowance determined using Section 7.3.3. • Validation that IS 3646 lighting quantity and quality criteria remain satisfied in the final installation.
7.3.4	Luminaire wattage	Indicate the wattage of installed luminaires on the floor plan. In case of luminaires containing permanently in- stalled ballasts, the operating input wattage has to be provided, either from manufacturers catalogues or values from independent testing laboratory reports.	Luminaire schedule • Luminaire type and identification • Quantity of each luminaire • Connection type (direct supply/remote ballast or driver/track or busway system) Manufacturer's technical datasheets • Labelled rated input wattage for luminaires connected directly to supply voltage • Total system input wattage for luminaires with remote ballast/driver (including accessories) Driver/ballast specifications (if applicable) • Input wattage of remote drivers, ballasts, transformers, and associated accessories • Confirmation that total system wattage is accounted for Luminaire packaging/marketing evidence • Rated wattage marked on luminaire body and/or packaging for miscellaneous luminaire types Track/plug-in busway/flexible lighting system details (if applicable) • System type and length (m) • Maximum specified luminaire wattage on the system or 135 W/m basis • Overload protection rating (fuse/circuit breaker) where provided

			Installed interior lighting power calculation sheet - Calculations demonstrating that luminaire wattage has been determined in accordance with the above ECSBC rules. Design stage evaluation Verify that installed interior lighting power calculations are prepared in accordance with ECSBC Section 7.3.4(a), including: - Verification that luminaire wattage values used in calculations are based on: Manufacturer-labelled rated wattage for luminaires connected directly to supply voltage. - Total system input wattage for luminaires with remote ballasts, drivers, transformers, or similar devices, including all associated accessories. - Rated wattage marked on luminaire body and/or packaging for miscellaneous luminaire types. - Verification that track lighting, plug-in busway, and flexible lighting systems are accounted for using: The higher of the specified luminaire wattage or 135 W per meter of system length, or 100% of the maximum rated load of the integral overload protection device, where provided. - Confirmation that the luminaire wattage determination methodology is consistently applied in installed interior lighting power calculations used for compliance under Section 7.3.2 or 7.3.3. During construction evaluation Verify that lighting installations conform to the approved wattage determination methodology, including: - Site verification of installed luminaire types, quantities, and connection methods (direct supply, remote driver/ballast, track/busway). - Cross-checking installed luminaires against manufacturer datasheets and driver/ballast specifications to confirm that total system wattage has been correctly accounted for. - Verification that installed track or busway system lengths and overload protection ratings (if applicable) match the assumptions used in the design-stage calculations. Occupancy/pre-occupancy stage evaluation Verify final compliance of installed interior lighting power prior to occupancy, including: - Review of as-built luminaire schedules and manufacturer documentation confirming final wattage values. - Confirmation that as-built installed interior lighting power, calculated using ECSBC Section 7.3.4(a) wattage determination rules, does not exceed the applicable interior lighting power allowance. - Validation that any deviations from approved luminaire types or system configurations have been reflected in updated calculations.
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7.3.5	Exterior light power	1. Provide lighting schedule with wattage of lamp and ballast and number of fixtures. Document all exceptions.	Exterior lighting layout drawings Showing all exterior lighting applications and luminaire locations. Clear identification of different exterior lighting application areas (as defined in Tables 7.1 / 7.2 / 7.3). Exterior lighting fixture schedule Luminaire ID Exterior lighting application type Rated input wattage per luminaire Quantity of luminaires Exterior lighting power calculation sheet Connected lighting power calculated separately for each exterior lighting application. Comparison of calculated power against the corresponding limits in: Table 7.1 (ECSBC) or Table 7.2 (ECSBC+) or Table 7.3 (Super ECSBC) Confirmation that no trade-off between applications is applied. Building compliance-level declaration Identification of the project as ECSBC / ECSBC+ / Super ECSBC (to determine the applicable table and limits) Documentation for exempted exterior lighting (if applicable): For luminaires claimed under exceptions (a)–(e): Exemption identification list Luminaire ID / application Applicable exemption category as per Section 7.3.5 Supporting evidence Manufacturer datasheet (for equipment-integral lighting) Functional description or drawings (for theatrical / industrial / monument lighting) Statement confirming temporary or removable nature (for temporary lighting) Design stage evaluation Verify that exterior lighting design complies with ECSBC Section 7.3.5 including: • Identification and classification of all exterior lighting applications in accordance with the categories defined in Tables 7.1 / 7.2 / 7.3, as applicable. • Verification that connected lighting power is calculated separately for each exterior lighting application, with no trade-offs between applications. • Confirmation that calculated connected lighting power for each application does not exceed the corresponding limits specified in: Table 7.1 (ECSBC), or Table 7.2 (ECSBC+), or Table 7.3 (Super ECSBC).
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			Review of exemption claims (if any) to confirm that exempted exterior lighting falls strictly under exceptions (a)–(e) and is excluded from connected lighting power calculations. During construction evaluation Verify that exterior lighting installations are consistent with the approved design and calculations, including: • Site inspection to confirm installed exterior luminaires, quantities, wattages, and application types match the approved exterior lighting layout and fixture schedules. • Verification that installed luminaires associated with exempt applications are correctly categorized and supported with appropriate documentation. • Confirmation that no additional exterior lighting applications or luminaires have been introduced that would alter the connected lighting power calculations. Occupancy/pre-occupancy stage evaluation Verify final compliance of installed exterior lighting prior to occupancy, including: • Review of as-built exterior lighting drawings and schedules reflecting the final installed condition. • Verification of as-built connected exterior lighting power, calculated separately for each application, against the applicable ECSBC limits. • Confirmation that: No trade-offs between exterior lighting applications have been applied, and All exemption claims remain valid based on the final installed configuration.
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Chapter 8 discusses electrical systems and renewable energy integration. It describes the minimum efficiency standards for transformers, motors, and power distribution equipment and lays out requirements related to power factor correction, voltage drop limits, UPS efficiency, and vertical transportation systems such as lifts and escalators. The chapter highlights the mandatory integration of renewable energy systems—most notably rooftop solar PV—and sets standards for electrical metering, sub-metering, and safety provisions. It also clarifies how renewable energy contributions are accounted for within the performance-based compliance framework.

Table 8 Electrical systems and renewable energy integration – compliance form

Code Section	Component	Information Required	Electrical systems and renewable energy integration – compliance form
8.2.1	Transformers		
8.2.1 - (a)	Maximum allowable power transformer losses	Indicate losses at 50% load and 100% load, capacity and efficiency	1) Submit manufacturer's datasheets for each transformer highlighting rated capacity and efficiency, no-load losses and load losses at values at 50% and 100% loading. 2) Submit approved electrical drawings indicating, transformer locations and ratings, single-line diagrams (SLDs) showing transformer configuration and connection to downstream electrical systems.

			3) Submit factory test reports or type test certificates confirming to measured no-load and load losses and efficiency values as per approved specifications. It should be noted that the permissible loss shall not exceed the values listed in IS 1180 (latest). 4) Submit clear photographs showing Installed transformers and nameplates indicating capacity and technical details. Design stage evaluation: Verify that the electrical design documentation and transformer schedule specify transformers that comply with the maximum allowable losses prescribed under ECSBC 2024. Manufacturer's technical specification sheets shall be reviewed to confirm declared efficiency and losses at 50% and 100% load. Approved electrical drawings and SLDs shall be checked to ensure that the selected transformer capacities and efficiencies align with the design load requirements and ECSBC loss limits. Construction stage evaluation: Verify that the transformers procured and installed on site match the approved design specifications. Factory test certificates and procurement documents shall be reviewed to confirm compliance with the declared loss values and efficiency. On-site inspection and photographs shall be used to verify installation and nameplate details. Any substitution or deviation from the approved transformer specifications shall be evaluated for ECSBC compliance. Occupancy stage evaluation: Verify final compliance through review nameplate data and submitted test certificates shall be cross-checked to ensure compliance with ECSBC 2024 loss and efficiency requirements. Completion and closure of all transformer-related compliance documentation shall be verified as part of the final ECSBC submission.
8.2.1 - (b)	Measurement and reporting of transformer losses	Indicate that: - For less than 500 kVA transformer meters are calibrated of 0.5 class accuracy and digital meters. - For above 500 kVA additional CT's and PT's are installed.	1) Submit a detailed metering schedule mapped to the transformer schedule, indicating transformer rating and capacity, type of energy meters provided, accuracy class (minimum 0.5 class for transformers below 500 kVA) and provision of additional current transformers (CTs) and potential transformers (PTs) for transformers of 500 kVA and above. 2) Submit manufacturer's technical datasheets for digital energy meters, indicating accuracy class and compliance with relevant standards. For CTs and PTs, submit indicating ratio, accuracy class, burden, and suitability for transformer loss measurement. 3) Submit approved electrical drawings and SLDs indicating location of meters, CTs, and PTs, and metering points for measurement of transformer input and output energy. 4) Submit calibration certificates for energy meters confirming to calibration to at least 0.5 accuracy class and validity of calibration at the time of installation. 5) Submit on-site photographs clearly showing Installed digital energy meters, CTs, and PTs installed for transformers of 500 kVA and above and meter nameplates and wiring arrangements.

			Design stage evaluation: Verify for transformers with capacity less than 500 kVA, confirm that the design provides calibrated digital energy meters with a minimum accuracy class of 0.5. For transformers of 500 kVA and above, verify that the design includes provision for additional CTs and PTs for accurate measurement of transformer losses. Approved electrical drawings and SLDs shall be reviewed to confirm appropriate metering locations and configurations. Construction stage evaluation: Verify actual installation of metering systems through site inspections and documentary evidence. Manufacturer's datasheets and calibration certificates shall be reviewed to confirm meter accuracy class and compliance with approved specifications. On-site photographs shall be checked to confirm installation of digital meters, CTs, and PTs as per transformer capacity and approved drawings. Any deviations from the approved metering configuration shall be documented and evaluated for compliance. Occupancy stage evaluation: Verify that the calibration certificates and installation records shall be cross-checked to ensure continued compliance with ECSBC requirements. Completion and closure of all transformer loss measurement documentation shall be verified as part of the final ECSBC compliance.
8.2.3	Voltage drop	Indicate the voltage drop for feeders shall not exceed 2% at design load. - Voltage drop for branch circuit shall not exceed 3% at design load.	1) Submit approved electrical drawings and SLDs, indicating, feeder and branch circuit routing, panel locations and circuit distribution, cable sizes and lengths used in the voltage drop analysis. 2) Submit the electrical DBR highlighting the design criteria for voltage drop limits and assumptions adopted for load calculations and diversity. Design stage evaluation: Verify through voltage drop calculations, load schedules, and approved drawings that the electrical distribution system is designed such that voltage drop for feeders does not exceed 2% and voltage drop for branch circuits does not exceed 3% at design load, in accordance with ECSBC 2024. The assumptions used in calculations, including conductor sizing, circuit lengths, and load factors, shall be reviewed for consistency and compliance with the approved design intent. Construction stage evaluation: Verify that the installed electrical distribution system conforms to the approved design. Cable sizes, routing, and lengths shall be checked against approved drawings and voltage drop calculations through site inspections and as-built documentation. Occupancy stage evaluation: Verify final compliance through review of as-built drawings and where applicable, testing or measurement records confirming acceptable voltage levels at design load conditions.

8.2.4	Energy efficient motors	Indicate the motor class IE3 / IE4 / IE5 and efficiency in conformation with IS 12615 (latest version). - Motor nameplate indicates nominal full-load motor efficiencies and full-load power factor. - Indicate the motor horsepower ratings do not exceed 20% of the calculated maximum load being served.	1) Submit manufacturer's datasheets with the design details of motor highlighting, motor application and driven equipment, rated horsepower (HP) or kW, motor efficiency class (IE3 / IE4 / IE5) in accordance with IS 12615 (latest version), nominal full-load efficiency and full-load power factor, calculated maximum load being served by each motor, confirmation that motor horsepower does not exceed 20% of the calculated maximum load 2) Submit clear on-site photographs of motor nameplates showing, rated power (HP or kW), efficiency class and efficiency value, full-load power factor and voltage, current, and speed. Design stage evaluation: Verify compliance through review of the motor schedule, load calculations, and manufacturer's technical specification sheets. The evaluation shall confirm that all motors specified are of IE3, IE4, or IE5 efficiency class in accordance with IS 12615 (latest version), that nominal full-load efficiency and full-load power factor are clearly indicated, and that selected motor horsepower ratings do not exceed 20% above the calculated maximum load for the driven equipment. Construction stage evaluation: Verify that the motor ratings, efficiency class, and nameplate details shall be checked through physical verification and photographs to ensure consistency with the approved design and ECSBC requirements. Occupancy stage evaluation: Confirm final compliance by reviewing motor nameplate photographs, as-built documentation, and commissioning records. The evaluation shall ensure that the installed motors are energy-efficient (IE3 or higher), correctly sized relative to the served load.
8.2.5	Standby generator sets	Indicate the star rating of the standby generator set.	1) Submit manufacturer's datasheets for the DG set indicating, type of standby generator set (diesel/gas), rated capacity (kVA / kW), BEE star rating of the DG set, specific fuel consumption (SFC) at rated load. 2) Submit approved drawings and SLDs indicating DG set location and capacity. 3) on-site photographs of the installed DG set clearly showing nameplate details including capacity and star rating and Installation layout and auxiliary systems. 4) Submit DG set testing and commissioning reports demonstrating operational readiness and load acceptance and performance as per manufacturer specifications. Design stage evaluation: Verify through manufacturer's technical specification sheets that the proposed generator sets comply with BEE star rating requirements applicable under ECSBC 2024. The evaluation shall confirm appropriate DG sizing based on emergency and critical load calculations and consistency with approved electrical design intent.

			Construction stage evaluation: Verify through site inspections, installation photographs, and approved drawings that the DG sets installed on site match the approved design specifications. The star rating, capacity, and configuration of the DG sets shall be checked against the submitted manufacturer's datasheets and ECSBC requirements. Occupancy stage evaluation: Confirm final compliance by reviewing as-built documentation, DG set nameplate photographs, and commissioning reports. The evaluation shall ensure that the installed standby generator sets meet the declared BEE star rating, are operational, and are fully documented as part of the final ECSBC compliance submission.
8.2.6	Check metering and monitoring	Indicate the services exceeding 1000 kVA have permanently installed electrical metering to record kVA, kWh, and total power factor and provision for display of current in each phase, voltage between each phase and between each phase and neutral and total harmonic distortion as a percentage of total current.	1) Submit document describing the metering and monitoring strategy for electrical services exceeding 1000 kVA, confirming permanent installation of electrical meters capable of recording kVA, kWh, and total power factor, in line with ECSBC requirements. 2) Submit drawings showing physical locations of meters, CTs, PTs, and display panels, including integration with main LT panels and monitoring systems. 3) Datasheets for energy meters demonstrating capability to measure and display, kVA and kWh, total power factor, phase-wise current (R, Y, B), line-to-line and line-to-neutral voltage, total harmonic distortion (THD) as a percentage of total current, and accuracy class as per applicable standards. 4) Calibration and accuracy certificates issued by NABL-accredited laboratories or as per statutory requirements, confirming compliance with required accuracy class. Design stage evaluation: Compliance shall be evaluated by reviewing the electrical design basis report, approved single-line diagrams, and metering layout drawings to confirm that all electrical services exceeding 1000 kVA are provided with permanently installed electrical metering systems. The evaluation shall verify that the proposed meters are capable of recording kVA, kWh, and total power factor, and can display phase-wise current, voltage between each phase, voltage between each phase and neutral, and total harmonic distortion as a percentage of total current. Manufacturer's technical specification sheets shall be examined to confirm that the selected meters meet the functional and accuracy requirements prescribed under ECSBC 2024. Construction stage evaluation: Compliance shall be assessed through site inspections and review of installation photographs to ensure that the approved meters, CTs, and PTs are installed at the locations indicated in the sanctioned drawings and are wired correctly. The installed meter models shall be cross-verified with the approved technical specifications to ensure consistency with the design intent. Calibration and accuracy certificates shall be reviewed to confirm that the meters meet the required accuracy class and are suitable for continuous monitoring of electrical parameters.

			Occupancy stage evaluation: Compliance shall be confirmed through review of commissioning and functional testing reports demonstrating that the metering system is fully operational and capable of measuring and displaying all required electrical parameters in real time. The evaluation shall verify that data on kVA, kWh, total power factor, phase-wise current, voltage, and harmonic distortion is accessible either locally on the meter display or through integration with the building management system or energy monitoring system, where provided. As-built drawings and operation and maintenance manuals shall be reviewed to ensure they accurately reflect the installed metering and monitoring configuration and support ongoing energy performance tracking.
		Indicate the services not exceeding 1000 kVA but over 65 kVA shall have permanently installed electric metering to record kW, kWh and power factor or kilovolt-ampere reactive hour (kVARh) on hourly basis.	1) Submit calculations indicating connected load, identification of services exceeding 65 kVA and up to 1000 kVA, and the proposed metering strategy. 2) Submit approved electrical drawings and single-line diagrams (SLDs) showing, location of permanent electrical meters, metering points corresponding to individual services, and associated CTs/PTs. 3) Submit Measurement of kW, kWh, and power factor or kVARh, Hourly data logging capability and Accuracy class as per applicable standards for electrical meters 4) Submit calibration Certificates demonstrating compliance with required accuracy and reliability. 5) Submit sample Meter Data Logs / EMS Reports demonstrating hourly recording and data availability. Design stage evaluation: Compliance shall be evaluated by reviewing the Electrical DBR, approved SLDs, and metering layouts to verify that all electrical services with connected loads greater than 65 kVA and up to 1000 kVA are identified and provided with permanent electrical meters. The evaluation shall confirm that the proposed meters can record kW, kWh, and power factor or kVARh on an hourly basis, as required under ECSBC 2024. Manufacturer's technical datasheets shall be reviewed to verify meter functionality, accuracy, and data logging capability. Construction stage evaluation: Compliance shall be verified through site inspections and review of installation photographs to confirm that meters are installed at locations indicated in the approved drawings. The installed meter make, model, and specifications shall be cross-checked against approved documents. Calibration certificates and wiring details, including CT/PT installations where applicable, shall be reviewed to ensure accurate and reliable measurement. Occupancy stage evaluation: Compliance shall be confirmed by reviewing commissioning and functional testing reports demonstrating that the metering systems are fully operational. Sample meter data logs or EMS extracts shall be examined to verify hourly recording of kW, kWh, and power factor or kVARh. As-built drawings and O&M manuals shall be reviewed to ensure the metering systems are properly documented for ongoing energy monitoring and performance evaluation.

		Indicate the services not exceeding 65 kVA shall have permanently installed electric metering to record kWh on hourly basis.	1) Submit list of Identified electrical services with connected load not exceeding 65 kVA and describing the proposed metering approach for energy monitoring. 2) Submit approved electrical drawings and single-line diagrams (SLDs) indicating location of permanently installed energy meters and metering points corresponding to individual services or feeders. 3) Submit metering layout drawings showing meter type, accuracy class, data logging capability, and integration with any centralized monitoring or EMS, where applicable. 4) Submit manufacturer's technical specification sheets showing measurement of kWh, hourly data logging capability and compliance with applicable metering standards, for electrical energy meters. 5) Submit calibration certificates/factory test reports for demonstrating meter accuracy and reliability. 6) Submit sample meter data logs or monitoring system reports for demonstrating hourly kWh recording. Design stage evaluation: Compliance shall be evaluated by reviewing the electrical design basis report, approved SLDs, and metering layouts to verify that all electrical services with connected load not exceeding 65 kVA are provided with permanently installed energy meters. The evaluation shall confirm that the proposed meters are capable of recording kWh on an hourly basis, as required under ECSBC 2024. Manufacturer's technical specifications shall be reviewed to verify functionality, accuracy, and data logging capability. Construction stage evaluation: During construction, compliance shall be verified through site inspections and review of installation photographs to confirm that the energy meters are installed at the designated locations as per approved drawings. The installed meter make and model shall be checked against approved specifications, and calibration certificates shall be reviewed to ensure measurement accuracy. Occupancy stage evaluation: At the occupancy stage, compliance shall be confirmed through review of commissioning and functional testing reports demonstrating that the installed meters are operational and capable of recording hourly kWh data. Sample data logs or monitoring system outputs shall be reviewed to verify hourly energy recording. As-built drawings and O&M manuals shall be examined to ensure accurate documentation for ongoing energy monitoring.
		Indicate in case of tenant based building, for recording metering should be provided at a location from where each tenant could attach the services.	1) Submit narrative describing the tenant-based electrical distribution philosophy and identifying the locations where tenant-level metering is provided for connection of individual tenant services. 2) Submit approved electrical drawings and SLDs indicating tenant distribution boards, dedicated tenant metering locations, incoming and outgoing feeders for each tenant and provision for future tenant connections.

			3) Submit metering and panel layout drawings showing physical location of tenant meters, space allocation and accessibility, meter type and capacity and provision for multiple tenant connections. 4) Submit manufacturer's technical specification sheets indicating the energy measurement parameters (kWh and other applicable parameters), Hourly data logging capability, where required and compliance with applicable standards. 5) Submit load allocation and metering schedule Indicating tenant-wise connected loads and corresponding metering points. Design stage evaluation: Compliance shall be evaluated by reviewing the electrical design basis report, approved SLDs, and tenant metering layouts to verify that electrical metering is provided at locations from which each tenant can attach or connect to the building's electrical services. The evaluation shall confirm that the metering strategy enables clear segregation and individual measurement of tenant energy consumption, in accordance with ECSBC 2024. Construction stage evaluation: Compliance shall be verified through site inspections and review of installation photographs to confirm that tenant-level meters and associated distribution panels are installed at the designated locations as per approved drawings. The installed meters shall be cross-checked against approved specifications, and accessibility, labelling, and readiness for tenant connection shall be verified. Occupancy stage evaluation: Compliance shall be confirmed by reviewing commissioning and functional testing reports demonstrating that tenant-level meters are operational and capable of accurately recording energy consumption for each tenant. As-built drawings and O&M manuals shall be reviewed to ensure the metering locations and configurations are properly documented for ongoing tenant energy monitoring and management.
		Indicate that the energy metering and monitoring system installed in the building shall be capable of catering to all the commissioning and measurement and verification (M&V) aspects related to various utilities in the building.	1) Submit narrative describing the tenant-based electrical distribution philosophy and identifying the locations where tenant-level metering is provided for connection of individual tenant services. 2) Submit approved electrical drawings and SLDs indicating, tenant distribution boards, dedicated tenant metering locations, Incoming and outgoing feeders for each tenant and Provision for future tenant connections and meter type and capacity. 3) Submit manufacturer's technical specification sheets indicating energy measurement parameters (kWh and other applicable parameters), hourly data logging capability, where required and compliance with applicable standards, for tenant meters. 4) Submit load allocation and metering schedule indicating tenant-wise connected loads and corresponding metering points.

			Design stage evaluation: Compliance shall be evaluated by reviewing the electrical design basis report, approved SLDs, and tenant metering layouts to verify that electrical metering is provided at locations from which each tenant can attach or connect to the building's electrical services. The evaluation shall confirm that the metering strategy enables clear segregation and individual measurement of tenant energy consumption, in accordance with ECSBC 2024. Construction stage evaluation: Compliance shall be verified through site inspections and review of installation photographs to confirm that tenant-level meters and associated distribution panels are installed at the designated locations as per approved drawings. The installed meters shall be cross-checked against approved specifications, and accessibility, labelling, and readiness for tenant connection shall be verified. Occupancy stage evaluation: Compliance shall be confirmed by reviewing commissioning and functional testing reports demonstrating that tenant-level meters are operational and capable of accurately recording energy consumption for each tenant. As-built drawings and O&M manuals shall be reviewed to ensure the metering locations and configurations are properly documented for ongoing tenant energy monitoring and management.
8.2.7	Power factor correction	Indicate that the power factor correction has been maintained at the point of connection.	1) Submit an electrical design narrative describing the power factor correction (PFC) strategy adopted for the project, clearly indicating that power factor is maintained at the point of connection. The narrative shall specify the target power factor (as per utility and ECSBC requirements) and the overall approach adopted to achieve it. 2) Submit manufacturer's technical specification sheets for capacitor banks or automatic power factor correction (APFC) panels, the specifications shall indicate rated kVAr capacity. 3) Submit approved electrical drawings and SLDs indicating location of capacitor banks/APFC panels. 4) Submit clear on-site photographs showing installed capacitor banks/APFC panels and nameplates of capacitor bank indicating rated capacity in kVAr, and current. 5) Submit commissioning and testing reports demonstrating that power factor is maintained at the point of connection under load conditions Design stage evaluation: Verify through the design narrative, reactive power calculations, and manufacturers technical specifications that an appropriate power factor correction system has been designed to maintain the required power factor at the point of connection, in compliance with ECSBC 2024. Construction stage evaluation: Verify through site inspections and installation photographs, that the capacity, configuration, and location of capacitor banks or APFC panels shall be checked against submitted technical specifications and ECSBC requirements.

			Occupancy stage evaluation: Confirm final compliance by reviewing as-built documentation, commissioning records, and power factor measurement data. The evaluation shall verify that the power factor is effectively maintained at the point of connection under operational conditions.
8.2.8	Power quality	Indicate the voltage and current distortion limits as per Section 8.2.8.	1) Submit a harmonic analysis study/report demonstrating that total harmonic distortion of Voltage (THDv) and total harmonic distortion of current (THDi) are within the permissible limits specified in ECSBC 2024, under both normal and peak operating conditions. The report shall identify major non-linear loads and their contribution to harmonic distortion. 2) Submit manufacturer's technical specification sheets for passive or active harmonic filters, line reactors or isolation transformers and power quality meters demonstrating harmonics level along with voltage, ampere, current, power factor and kWh readings. 3) Submit on-site photographs showing installed harmonic mitigation equipment and power quality meters and monitoring devices 4) Submit power quality measurement reports recorded at the point of connection and/or critical distribution points, indicating Measured THDv and THDi values and their compliance with ECSBC 2024 limits. Design stage evaluation: Verify compliance through review of harmonic analysis report, load schedules, and approved drawings. The evaluation shall confirm that the proposed electrical system design limits voltage and current distortion within the thresholds specified under Section 8.2.8 of ECSBC 2024, and that appropriate mitigation measures are incorporated where required. Construction stage evaluation: Verify through site inspections, installation photographs, and approved drawings that harmonic mitigation equipment and power quality monitoring devices are installed as per the approved design. Occupancy stage evaluation: Confirm final compliance by reviewing as-built documentation and power quality measurement or monitoring reports. The evaluation shall verify that actual measured voltage and current distortion levels at the point of connection and critical nodes are within the permissible limits specified in ECSBC 2024, and that the power quality strategy is effectively implemented.
8.2.9	Power distribution system	Indicate the power cable has been sized so that the distribution losses do not exceed the values mentioned in the code.	1) Submit an electrical design narrative describing the power distribution philosophy and the strategy adopted to limit distribution losses within the maximum values prescribed in ECSBC 2024. The narrative shall outline the approach to cable sizing, routing, and system configuration used to minimize I²R losses. 2) Submit detailed electrical load schedules indicating connected load and design current, selected cable size and type and circuit length and installation method. These details shall be consistent with the loss calculations.

			3) Submit the electrical DBR highlighting design criteria for allowable distribution losses and assumptions adopted for load and diversity. 4) Submit as-built drawings and updated cable schedules reflecting actual cable sizes and routing installed on site. Design stage evaluation: Verify through the electrical design narrative, distribution loss calculations, load schedules, and approved drawings that the power distribution system is designed such that cable sizing limits distribution losses within the maximum allowable values specified in ECSBC 2024. The assumptions used for current, conductor resistance, and circuit lengths shall be reviewed for consistency and technical adequacy. Construction stage evaluation: Verify through site inspections, installation photographs, and as-built documentation that the installed power cables match the approved sizes, routes, and specifications used in the loss calculations. Any deviations that may affect distribution losses shall be reviewed and assessed for continued compliance with ECSBC requirements. Occupancy stage evaluation: Confirm final compliance by reviewing as-built drawings, updated cable schedules, and available verification or testing records. The evaluation shall confirm that the installed power distribution system maintains distribution losses within ECSBC-prescribed limits.
8.2.10	Uninterruptible power supply	Indicate the UPS meets or exceed the energy efficiency requirements listed in Table 8.8.	1) Submit manufacturer's technical datasheets for each UPS system indicating, UPS type (online double conversion/line interactive/modular, as applicable), rated capacity (kVA/ kW), certified efficiency values at relevant load points (e.g., 25%, 50%, 75%, and 100% load, where applicable), test standards used for efficiency measurement, and operating modes considered (normal, eco mode, etc., if allowed by ECSBC). 2) Submit approved drawings and SLDs clearly indicating UPS location and capacity. 3) Submit on-site photographs showing, installed UPS systems and nameplates indicating capacity and model. 4) Submit as-built electrical drawings and updated UPS schedules reflecting the systems actually installed. Design stage evaluation: Verify compliance through review of manufacturer's technical specification sheets. The evaluation shall confirm that the proposed UPS systems meet or exceed the minimum energy efficiency requirements specified in Table 8.8 of ECSBC 2024, for the declared capacity and operating load range. Construction stage evaluation: Verify through site inspections, installation photographs, and approved drawings that the UPS systems installed on site conform to the approved design and submitted technical specifications. The UPS model, capacity, and configuration shall be checked for consistency with ECSBC efficiency requirements. Occupancy stage evaluation: Confirm final compliance by reviewing as-built documentation or commissioning reports. The evaluation shall ensure that the installed UPS systems are operational, configured as per design intent, and documented as meeting or exceeding the energy efficiency thresholds prescribed under ECSBC 2024.

8.2.11	Indicate the buildings have provision for installation of renewable energy systems on rooftop or the site with minimum renewable contribution towards meeting contract demand as per Section 8.2.11.	Indicate the voltage and current distortion limits as per Section 8.2.8.	1) Submit a design narrative describing the provision made for installation of renewable energy systems, such as rooftop or site-based solar photovoltaic (SPV) systems. 2) Submit calculations demonstrating proposed renewable energy capacity (installed or provisioned). 3) Submit approved architectural, terrace, and site layout drawings clearly indicating, the location of rooftop or ground-mounted renewable energy systems, area reserved for renewable installations and structural or spatial provisions made to accommodate the required capacity. 4) Submit manufacturer's datasheets for solar PV modules, capacity of each panel in watts, rated generation per day and inverters and associated equipment. 5) Submit photographs showing, installed renewable energy systems and reserved rooftop or site areas where systems are provisioned but not yet installed. 6) Submit as-built drawings and updated schedules confirming Installed renewable energy capacity or physical provision for future installation. 7) Submit commissioning reports or initial generation records demonstrating functional operation of installed renewable energy systems. Design stage evaluation: Verify compliance through review of the renewable energy design narrative, capacity calculations, and approved architectural and electrical drawings. The evaluation shall confirm that adequate rooftop or site provisions are made to enable installation of renewable energy systems capable of meeting the minimum renewable contribution toward contract demand as required under Section 8.2.11 of ECSBC 2024. Construction stage evaluation: Verify through site inspections, approved drawings, and installation photographs that the physical provisions or installed renewable energy systems are consistent with the approved design. Structural readiness, reserved areas, and electrical provisions shall be checked to ensure compliance with ECSBC requirements. Occupancy stage evaluation: Confirm final compliance by reviewing as-built documentation and, where applicable, commissioning or performance records. The evaluation shall verify that the renewable energy systems are either installed and operational or that clear, adequate provisions exist for future installation, as permitted under ECSBC 2024.
8.2.11 -(a)	Renewable energy generating zone	Indicate a dedicated REGZ equivalent to at least 50% of roof area or area required for generation of energy equivalent to 4% of total peak demand or connected load of the building, whichever is less, shall be provided in all buildings.	1) Submit a design narrative clearly indicating that a dedicated Renewable Energy Generating Zone (REGZ) has been provided. The narrative shall demonstrate that the REGZ area is, at least 50% of the available roof area, or have Sufficient to generate renewable energy equivalent to 4% of the total peak demand or connected load of the building, whichever is less, in compliance with ECSBC 2024.

			2) Submit calculations demonstrating, total available roof area, REGZ area provided (in m²), total peak demand or connected load of the building and renewable energy generation potential corresponding to 4% of peak demand or connected load. The calculations shall clearly justify compliance with the REGZ requirement.. 3) Submit approved architectural, terrace, and roof layout drawings clearly indicating, dedicated REGZ, boundaries, dimensions and area allocation and any exclusions due to services, shading, or access requirements 4) Submit approved electrical drawings and SLDs indicating electrical provisions for connecting renewable energy systems from the REGZ and space allocation for inverters, meters, and protection devices. 5) Submit on-site photographs showing, clearly demarcated REGZ areas on the roof and installed renewable energy systems., 6) Submit as-built drawings confirming to final REGZ area provided and any changes from the approved design. 7) Submit commissioning or initial generation records demonstrating operational renewable energy systems within the REGZ. Design stage evaluation: Verify compliance through review of the REGZ design narrative, area and energy potential calculations, and approved architectural and roof layout drawings. The evaluation shall confirm that a dedicated REGZ equivalent to at least 50% of roof area or the area required to generate energy equal to 4% of total peak demand or connected load (whichever is less) has been provided in accordance with ECSBC 2024. Construction stage evaluation: Verify through site inspections, approved drawings, and on-site photographs that the REGZ is physically provided as per the approved design. Occupancy stage evaluation: Confirm final compliance by reviewing as-built documentation and, where applicable, commissioning or performance records. The evaluation shall verify that the REGZ is fully provided and either hosts operational renewable energy systems or is demonstrably ready for installation, as required under ECSBC 2024.
		Indicate the REGZ shall be free of any obstructions with- in its boundaries and from shadows cast by objects adjacent to the zone.	1) Submit a design narrative clearly stating that the REGZ is free of permanent and temporary obstructions within its boundaries which includes free from shadows casted by adjacent structures, services, or building elements during effective solar hours. 2) Submit approved roof layout drawings clearly indicating, REGZ boundaries and dimensions, locations of rooftop services such as HVAC equipment, water tanks, lift machine rooms, parapets, and access pathways and Clear separation between REGZ and potential shading elements.

			3) Submit clear on-site photographs showing the REGZ area free of physical obstructions, surrounding rooftop elements, and their distance from the REGZ Design stage evaluation: Verify through the REGZ design narrative, approved roof layout drawings, and shading/shadow analysis that the designated Renewable Energy Generating Zone is free from obstructions and is not adversely affected by shadows cast by adjacent structures or rooftop services, in accordance with ECSBC 2024 requirements. Construction stage evaluation: Verify through site inspections and on-site photographs that the REGZ has been implemented as per the approved design. The evaluation shall confirm that no permanent services, architectural elements, or equipment encroach into the REGZ and that the zone remains free from shading obstructions. Occupancy stage evaluation: Confirm final compliance by reviewing as-built drawings and photographic evidence demonstrating that the REGZ remains obstruction-free and shadow-free under actual site conditions. This verification shall form part of the final ECSBC compliance documentation.
8.2.11 -(b)	Main electrical service panel	Indicate the minimum rating is displayed on the main electrical service panel, and space is reserved for the installation of double-pole circuit breaker for future solar electric installation.	The project ensures that the minimum rating of the main electrical service panel (MESP) is clearly and permanently displayed, and that adequate space is reserved for the installation of a double-pole circuit breaker to enable future solar electric (SPV) system integration, in compliance with the code requirements.
8.2.11 -(c)	Demarcation on documents	Location for inverters and metering equipment	Submit clear demarcation of locations for solar inverters and associated metering equipment on all relevant design and construction documents to facilitate future installation of renewable energy systems.
		Pathway for routing of conduit from the REGZ to the point of interconnection with the electrical service.	Submit a clearly defined and continuous pathway for routing electrical conduits from the REGZ to the point of interconnection with the main electrical service to facilitate future installation of renewable energy systems through electrical layout drawings, rooftop plans, and SLDs.
		Routing of plumbing from the REGZ to the water-heating system.	Submit a dedicated and continuous plumbing pathway from the REGZ to the building's water-heating system to enable future installation of renewable-based water-heating systems such as solar thermal or heat-pump-assisted systems. through plumbing layout drawings, rooftop plans, sections, and schematics.
		Structural design loads for roof dead and live load.	Submit compliance by ensuring that the roof structure is designed to safely accommodate both dead loads and live loads, including additional loads arising from future installation of renewable energy systems such as solar PV or solar thermal collectors, through structural design calculations and a structural design basis report (DBR).

8.2.11 -(e)	Electric vehicle charging infrastructure and parking	Indicate parking places in buildings provided with EV charging infrastructure as per Central Electricity Authority (CEA) guidelines, CEA measures of safety regulations and the Ministry of Power consolidated guidelines and standards for EV charging infrastructure	1) Approved electrical and parking layout drawings indicating the number and location of EV-ready and EV-charging parking spaces in the building. 2) Design basis report (DBR) describing the EV charging strategy, applicable CEA guidelines, Ministry of Power consolidated guidelines, and safety regulations considered in the design. 3) Single-line diagrams (SLDs) indicating dedicated EV charging panels. 4) Manufacturer's technical specification sheets for EV chargers. 5) Installation and inspection records, including site photographs of EV chargers and associated electrical works. Design stage evaluation: Review approved drawings, DBR, SLDs, and load calculations to verify that EV charging infrastructure is provided in parking areas as per CEA and Ministry of Power guidelines. Verify adequacy of charger type, capacity, at the design level. Confirm that provisions for future expansion, metering, and safe integration with the building electrical system are included. Construction stage evaluation: Conduct site inspections to verify installation of EV chargers at designated parking locations in accordance with approved drawings. Check cable sizing, protection devices, earthing, isolation, and signage for compliance with CEA safety regulations. Review drawings, installation records, and photographs to confirm consistency between design intent and actual installation. Occupancy stage evaluation: Review commissioning and functional test reports to confirm safe and reliable operation of EV charging infrastructure. Verify electrical safety test results, earthing resistance values, and correct functioning of metering and protection systems. Confirm availability of final compliance certificates, as-built drawings, and O&M manuals to support safe operation during occupancy.
8.2.12	Vertical transportation	Indicate energy performance of lifts, escalators, and moving walks in conformation with Section 8.2.12.	1) Submit document describing the type, number, capacity, speed, duty cycle, and energy performance strategy for lifts, escalators, and moving walks, demonstrating compliance with Section 8.2.12. 2) Submit drawings indicating lift cores, machine rooms (or MRL), escalator and moving walk locations, rated capacities, speeds, and service zones. 3) Submit manufacturer-provided or consultant-prepared calculations indicating energy performance classification of lifts, escalators, and moving walks in accordance with applicable standards referenced in ECSBC (such as ISO 25745 series or equivalent). 4) Product datasheets for lifts, escalators, and moving walks indicating, energy efficiency class, motor type (e.g., gearless PM motor, VVVF drive), standby and idle power consumption and regenerative drive features, if provided.

			5) Submit documentation describing energy-saving features such as VVVF/VFD drives, group control and destination control systems, sleep/standby modes for lifts, automatic speed reduction or stop-start operation for escalators and moving walks and Regenerative braking (where applicable). 6) Submit reports demonstrating correct installation, operation, and activation of energy-saving features. Design stage evaluation: Review the DBR, energy performance assessment, and manufacturer specifications to verify that lifts, escalators, and moving walks meet the minimum energy performance requirements of Section 8.2.12. Verify inclusion of energy-efficient motors, VVVF drives, standby modes, and regenerative features where applicable. Confirm that rated capacities, speeds, and duty cycles are appropriate for the building use and are aligned with energy-efficient operation. Construction stage evaluation: Verify through site inspections and approved shop drawings that the installed equipment matches the approved make, model, and specifications. Check installation of control systems, drives, and wiring necessary to enable energy-efficient operation. Review installation records and photographs to confirm compliance with approved design and specifications. Occupancy stage evaluation: Review commissioning and functional testing reports to confirm that all energy-saving modes (standby, sleep, regenerative braking, variable speed operation) are enabled and operational. Verify final as-built documentation, O&M manuals, and performance data provided by the manufacturer. Where applicable, review initial operational energy data or test results to confirm performance during normal building operation.
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Chapter 9 focuses on water management and controls. It outlines provisions for water sourcing, treatment, pumping efficiency, flow and pressure control, and service water heating. It also describes requirements for rainwater harvesting, wastewater treatment, reuse, and recharge, along with the implementation of water metering and monitoring. This chapter introduces the water performance index (WPI) as a metric to evaluate building-level water efficiency and ties its thresholds to the performance levels defined in the ECSBC Code.

Table 9 Water management – compliance form

Code Section	Component	Information Required	Water management – compliance form
9.2.1	Source of water	1. Indicate for source of water being used for stable supply of water to building or all purposes. 2. Design and approval for rainwater harvesting systems. 3. Approval for desalination systems for high total dissolved solids (TDS) water, if applicable.	A. Common compliance document for all sources of water to demonstrate reliability of the water supply for the building. a. Water balance diagrams for Dry and Wet seasons, presented in a clear diagrammatic format, showing all water uses, total water inflow, total water outflow, reuse, losses, and discharge within the project boundary. (cross-ref to 9.2.15) b. For the water balance, adopt June–September as the dry season and October–May as the wet season. Where the project location exhibits a different seasonal rainfall distribution, define the dry and wet season periods based on actual long-term rainfall characteristics, supported by documented rainfall evidence and certification from the Meteorological Department (cross-ref. Clause 9.2.15).

			c) Building population calculation statement, prepared in accordance with NBC 2016, Part 9, Section 1, Clause 4.1. Minimum water demand calculation sheets, demonstrating compliance with Table 1 of Clause 4.1.2 of NBC 2016, Part 9, Section 1 (Water Supply), or subsequent revisions (cross-ref. to 9.2.15). d) Sanction/approval proof for the declared source(s) like municipal sanction/groundwater NOC/STP reuse permission/RWH approval / desalination approval (as applicable). B. Compliance documents specific to source of water: 1. For municipal/public utility water a) Water connection sanction letter issued by the local municipal corporation, municipality, or development authority, clearly stating approval for potable water supply to the project. b) Latest annual municipal water bills (typically 12 months) demonstrate continuity and reliability of supply. 2. For bore-well or open-well sources a) Groundwater abstraction permission/NOC issued by the Central Ground Water Authority (CGWA) or the respective state ground water authority (SGWA), depending on local norms. b) Annual groundwater abstraction statements/returns submitted to CGWA or the state authority, evidencing continued regulatory compliance during operation. 3. For reclaimed used water from an STP a) STP design basis report (DBR) defining influent characteristics, treatment technology, design capacity, and intended reuse applications. b) As-built drawings of the STP, confirming installation as per approved design and specifications. c) Treated wastewater quality test reports (quarterly) from NABL-accredited laboratories, demonstrating compliance with applicable reuse standards as per CPCB/SPCB norms for non-potable applications. 4. For harvested rainwater a) Approved rainwater harvesting drawings, sanctioned as part of the building plan approval by the local authority or development authority. Detailed drawings of the entire rainwater harvesting structures, collection, filtration, storage/recharge. b) Photographic documentation of installed rainwater harvesting components such as rooftop collection systems, filters, recharge pits, and storage tanks. 5. For desalination of high-TDS a) Water quality test reports from NABL confirm high TDS levels, establishing the need for advanced treatment such as desalination. .
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			b) Statutory approvals/NOCs from the relevant authority, such as the local body or state pollution control board (SPCB), permitting installation and operation of the system. c) Treated water quality test reports from NABL-accredited laboratories, demonstrating compliance with intended use standards. d) Environmental clearance or consent to establish/consent to operate (where applicable), particularly in cases involving brine or reject disposal into sewer, surface drains, or designated disposal facilities. Design stage: Review the proposed dry and wet season (preferably annual) water balance for completeness and internal consistency; verify NBC-based population and water-demand calculations; confirm that all end uses are captured, reuse pathways are clearly defined, and wastewater generation is computed using NBC-based assumptions. Construction stage: Verify that sampling points are provided and accessible; confirm segregation of freshwater and treated water piping networks; check that treatment units and plumbing provisions match the approved design and are ready for commissioning/testing. Occupancy stage: Verify periodic NABL-accredited test reports for potable and treated reuse water; review STP commissioning/performance logs and O&M records; and, where an exception is claimed, validate that wastewater generation remains <10 kL/day using occupancy evidence and water-use/metering records.
9.2.2	Water quality	1. Reports confirming potable water meets IS 10500:2012 standards. 2. Reports for treated sewage quality, conforming to CPHEEO Manual 2013 standards (if applicable). 3. Quantity of wastewater generation (calculation).	ECSBC mandatory requirements a) Potable water quality compliance, demonstrated through laboratory test reports in conformity with IS 10500:2012, drinking water – specification (Tables 1 to 4), for all uses involving direct human consumption. b) Recycled water quality compliance for non-potable applications, with treated used water meeting the requirements prescribed in the CPHEEO Manual on Sewerage and Sewage Treatment Systems (2013), Chapter 7, including Table 7.19: Recommended norms of treated sewage quality for specified activities at point of use (Modified), issued by the Ministry of Housing and Urban Affairs. c) Wastewater generation calculation statement: NBC-based calculation showing expected wastewater quantity (typically derived from population + water demand assumptions). Should clearly state: design population, per-capita demand adopted, wastewater fraction/assumption, resulting kL/day. d) Water quality sampling and testing details: Sampling locations (source and point-of-use), sampling dates/frequency, and lab accreditation proof (NABL certificate reference).

			Exception a) Wastewater generation statement, supported by population data and NBC-based demand calculations, demonstrating that total wastewater generation is below 10 kL/day. ECSBC Plus Requirements a) Rooftop rainwater harvesting system design, storage, and treatment documentation, including detailed design calculations demonstrating collection of rooftop rainwater in a storage tank sized for a minimum one-day demand or as per applicable local bye-laws (whichever is more stringent), along with documentation of the rainwater treatment system comprising process description and relevant test reports, evidencing that the treated stored rainwater meets IS 10500:2012 potable water quality standards for the applicable end uses. b) STP treated water reuse design and quality compliance documentation, including detailed design demonstrating that reclaimed used water, after adequate treatment in the STP, is reused for domestic non-potable applications excluding drinking and cooking, along with treated wastewater quality test reports from NABL-accredited laboratories confirming the suitability of the reclaimed water for its intended domestic reuse applications. c) HVAC condensate recovery system drawings and calculations, showing collection, storage, and reuse of condensate water for wash basins, showers, pantries, flushing, landscaping, car washing, floor washing, and swimming pool make-up. d) Grey and black water segregation, water treatment - specification sheets, plumbing drawings, clearly indicating separate collection networks for grey water and black water. e) Commissioning reports and operational records, confirming functional performance of rainwater harvesting, condensate recovery, and segregated wastewater treatment systems in accordance with ECSBC Plus requirements. ECSBC Super requirements a) Grey water segregation, treatment, and quality compliance documentation, including detailed plumbing drawings clearly indicating separate collection and conveyance of grey water from wash basins, showers, baths, and laundry areas, fully isolated from black water systems; design and process documentation of an independent grey water-treatment system demonstrating achievement of the required water quality for the intended reuse applications; and treated grey water quality test reports from NABL-accredited laboratories evidencing compliance with applicable standards for non-potable reuse. b) Reuse distribution drawings and schedules, showing utilization of treated grey water for suitable applications such as flushing, landscaping, and washing activities.
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			c) Commissioning certificates, O&M manuals, and logbooks, confirming consistent operation, monitoring, and safe reuse of treated grey water. Design stage: Confirm identified potable source(s) and intended end uses (drinking/cooking vs non-potable). If reclaimed water reuse is proposed, verify that the target treated sewage quality is defined at point of use as per CPHEEO 2013 Table 7.19, mapped to each reuse application (cross-ref 9.2.17). Check wastewater generation calculation: NBC-based population and demand assumptions are consistent with the project water balance (cross-ref 9.2.15). If claiming exception (<10 kL/day): verify the calculation basis and that the project scope/use type realistically supports it. Construction stage: Confirm segregation of pipelines (freshwater vs treated reuse water) and proper identification (colour coding/signage), to avoid cross-connection risks (cross-ref 9.2.5 and 9.2.17). Check that the treatment system and STP are installed as per approved drawings/specs and are ready for testing/commissioning (cross-ref 9.2.3 and 9.2.17). Occupancy stage: Verify periodic NABL test reports potable water meets IS 10500:2012 and treated sewage/reuse water meets CPHEEO 2013 Table 7.19 for the declared reuse applications. Check testing frequency and continuity (e.g., quarterly/half-yearly as adopted) and that sampling locations match the intended compliance points. Review STP performance logs and operational records (flow, dosing, backwash, sludge handling, breakdown history) to confirm stable performance (cross-ref 9.2.17). If exception (<10 kL/day) is claimed: validate using occupancy records + water meter logs (or equivalent evidence) that wastewater generation stays below 10 kL/day over time (cross-ref 9.2.6 and 9.2.15).
9.2.3	Water treatment systems	1. Water quality test reports from all applicable water sources. 2. Design documentation for water treatment systems, including reverse osmosis (RO) treatment (if required).	ECSBC mandatory requirements a) Representative water sampling records, demonstrating that samples from all identified water sources have been collected in accordance with IS 1622:1981 (reaffirmed 2019) and BIS 3025 (Part 1 to Part 79), both prior to installation and during operation of the water treatment system. b) Baseline water quality test reports from NABL-accredited laboratories, used to establish the treatment design basis before commissioning of the water treatment plant. c) Periodic operational water quality test reports, confirming consistency of treated water quality during regular operation. d) Water treatment system design and process documentation, evidencing compliance with the <i>CPHEEO Manual on Water Supply and Treatment Systems (Drink from Tap)</i>, 2024, and alignment with the required water quality for various applications as specified in Section 9.2.2. e) RO system design and performance documents (where applicable), triggered by high TDS levels exceeding IS 10500:2012 limits, including process flow diagrams and specifications.

			f) RO recovery and reject management statement, demonstrating a minimum system recovery rate of 65% and clearly defining reject handling and disposal arrangements. g) Commissioning and performance certificates for the water-treatment system, confirming achievement of prescribed quality parameters and operational efficiencies. ECSBC Plus requirements a) Water quality monitoring system layout and specifications, demonstrating provision of monitoring for key parameters including flow, pH, TSS, and TDS at the outlet of the treatment system. b) Monitoring and data logging records, evidencing regular measurement and tracking of treated water quality parameters. c) Water quality test reports from NABL-accredited laboratories, identifying TDS levels in treated water and establishing the need for advanced treatment where applicable. d) RO recovery and reject management statement, confirming a minimum system recovery rate of 75%, supported by manufacturer specifications and commissioning test results. e) Commissioning and operational performance reports, validating continuous compliance of the treatment system with monitoring and recovery requirements. ECSBC Super requirements a) Water quality test reports from NABL-accredited laboratories, establishing that treated water TDS levels exceed the limits prescribed under IS 10500:2012, thereby justifying the requirement for RO treatment. b) Multi-stage RO system design and process documentation, demonstrating achievement of a minimum recovery rate of 85%, supported by process flow diagrams and manufacturer specifications. c) RO performance and commissioning reports, validating recovery efficiency and treated water quality under operating conditions. d) RO reject water treatment system documentation, evidencing treatment measures adopted to reduce TDS levels of reject water to ≤ 2100 mg/L, in line with CPCB Guidelines for Utilization of Treated Effluent in Irrigation. e) Treated effluent quality test reports, confirming compliance with irrigation norms prescribed under the Environment (Protection) Rules, 1986. f) Authorized disposal records and agreements (where reuse is not feasible), evidencing disposal of RO reject water with TDS > 2100 mg/L through SPCB-authorized agencies. g) Operational logbooks and monitoring records, confirming continuous compliance with recovery, treatment, reuse, and disposal requirements.
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			Design stage Verify identification of all water sources and availability of baseline sampling/testing plan as per IS 1622 and IS 3025. Verify that NABL baseline test reports are used to justify the selected treatment process. Verify the design basis report (design basis, process flow, specifications) for references to <i>CPHEEO Manual on Water Supply and Treatment Systems (Drink from Tap)</i> (2024) and that treated water quality targets are linked to intended end uses as per Section 9.2.2. Where RO is proposed, verify the justification against IS 10500:2012 and confirm the recovery and reject-management pathway meets the applicable ECSBC level (65%/75%/85%). Construction Verify the installed treatment system matches the approved design and submitted specifications (process sequence, capacity, make/model, controls). Verify provision and accessibility of representative sampling points for raw and treated water. Verify reject line routing, storage, and reuse/disposal arrangements are executed as per approved drawings and method statements. Review installation records (as applicable) and pre-commissioning checklists demonstrating readiness for performance verification. Occupancy Verify commissioning and performance verification reports confirm achievement of treated water quality and required operational performance. Verify periodic NABL test reports demonstrate sustained compliance. For Plus/Super, verify monitoring and data logs demonstrate ongoing tracking of prescribed parameters. For RO systems, verify recovery performance records and reject handling documentation (treatment/reuse/disposal) align with the stated compliance pathway. Verify O&M manuals, routine logbooks, maintenance/breakdown records, and corrective-action documentation are maintained to demonstrate continued compliance.
9.2.4	Pumping systems	1. Manufacturer's specifications for pumps, showing flow-head characteristics. 2. Indicate conformation with efficiency standards for pump motors (IE 2/IE 3 motors). 3. Calculations and data indicating that pumps meet the minimum overall efficiency requirements.	ECSBC mandatory requirements a) Pump selection calculations and datasheets, demonstrating that all water transfer pumps are selected with operating points between 70% and 110% of the flow at the best efficiency point (BEP) of the pump curve. b) Pump performance curves and duty point plots, submitted by the manufacturer or designer, confirming compliance with the specified BEP operating range. c) Motor technical specifications and nameplate details (photographs), evidencing minimum efficiency class compliance: • IE3 or higher for all non-submersible pumps • IE2 or higher for all submersible pumps d) Overall pump-motor efficiency calculations, demonstrating compliance with the minimum efficiency requirements prescribed in ECSBC/ECSBC Plus/Super ECSBC buildings, specific to pump application type.

		e) Manufacturer test certificates or third-party test reports, validating pump efficiency and motor efficiency values claimed in the design. f) As-built pump schedules and equipment submittals, clearly identifying pump type (domestic, flushing, surface water, wastewater, sewage, hot water circulation), motor efficiency class, rated capacity, and overall efficiency. g) Commissioning and performance verification records, confirming that installed pumps operate at the designed duty points and meet the minimum overall efficiency requirements during operation. ECSBC Plus requirements a) Pump schedules and equipment specifications, identifying all pumps installed in the project and clearly distinguishing non-submersible pumps. b) Motor nameplate details and manufacturer datasheets, evidencing that all non-submersible pumps are coupled with minimum IE3 or higher efficiency class motors. c) Procurement and submittal documents, confirming selection of compliant motors at the design and installation stage. d) As-built drawings and equipment schedules, reflecting installed pump–motor combinations and their respective efficiency classes. e) Commissioning and performance verification records, confirming installation and operation of IE3-or-higher efficiency motors in accordance with ECSBC Plus requirements. ECSBC Super requirements a) Motor technical datasheets and nameplate details, evidencing that all non-submersible pumps are coupled with minimum IE4 or higher efficiency class motors. b) Manufacturer certificates and test reports, validating the efficiency class of the installed motors. c) As-built pump and motor schedules, clearly identifying pump type, duty, and associated motor efficiency class. d) Commissioning and performance verification records, confirming installation and operation of motors in accordance with ECSBC Super requirements. Design stage At the design stage, verify the complete pump selection package to confirm that each pump is sized and selected such that its operating point lies within the prescribed BEP operating envelope (i.e., 70%–110% of the BEP flow). This verification should be supported by pump performance curves, duty-point plots, and hydraulic sizing calculations (design flow, total dynamic head, and head-loss computations), together with the finalized pump schedule. Verify that the proposed motor efficiency class meets the code requirements (minimum IE3 for non-
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			submersible pumps and IE2 for submersible pumps, with higher classes as applicable for ECSBC Plus/Super), supported by manufacturer datasheets and declarations. Further, verify overall pump–motor efficiency calculations against the minimum overall efficiency thresholds specified in the code for each pump application (domestic, flushing, wastewater/sewage, hot water circulation, etc.), and ensure procurement specifications and technical submittals commit to the same makes/models, duty points, and efficiency classes reflected in the design documentation. Construction stage During construction, verify that the installed pumps and motors correspond exactly to the approved submittals and pump schedule, including type, rated duty, and motor efficiency class. Nameplate details and photographic evidence shall be checked to confirm motor IE class and rated parameters. Inspect the installation quality to confirm that suction and discharge piping, valves, strainers, and fittings are configured to support the designed duty point, and that any controls such as VFDs (where provided) are installed and integrated as per the approved control scheme. Manufacturer test certificates, third-party test reports (where submitted), and installation/inspection records shall be reviewed to validate that the performance and efficiency claims used for compliance are traceable to the installed equipment. Occupancy stage At occupancy, evaluate commissioning and performance verification records to confirm that each pump operates at or near the intended duty point under normal operating conditions. This shall include measured flow, head, and input power (or equivalent commissioning measurements) and shall be compared against the design duty and pump curve to confirm that the pump remains within the permitted BEP operating range. Verify documentation demonstrating compliance with overall pump–motor efficiency requirements and shall review O&M logs (run-hours, maintenance records, breakdown history) to ensure that performance is sustained and that efficiency class compliance is maintained over time, including like-for-like replacement practices where pump motors are replaced.
9.2.5	Piping systems	Design documentation showing piping systems comply with NBC 2016 guidelines.	ECSBC mandatory requirements - Approved plumbing and piping layout drawings, demonstrating compliance with NBC 2016 (Part 9, Section 1: Water Supply) and applicable subsequent revisions. - Design specifications and material submittals for piping systems, confirming adherence to NBC requirements for pipe materials, sizing, jointing, and installation practices. - Hot water piping insulation details, shown on drawings and schedules, complying with the specified insulation requirements. - Insulation material datasheets and thickness, substantiating thermal performance and conformity with prescribed standards.

			e) As-built piping drawings, reflecting actual site installation and confirming compliance with approved designs. f) Inspection and commissioning records, verifying correct installation of piping systems and insulation prior to system handover. Design stage: Verify approved plumbing/piping layouts (plans, risers, schematics) demonstrate compliance with NBC 2016 Part 9, Section 1 (Water Supply); confirm pipe material specifications, sizing basis, jointing/installation notes, and maintainability/access provisions. Verify segregation and identification of different water qualities (potable/treated/recycled) to avoid cross-connections. Verify hot-water piping insulation intent is shown (cross-reference: detailed R-value compliance under 9.2.12). Construction stage: Verify installed pipe materials, diameters/pressure class, and jointing match approved submittals; verify supports, sleeves, slopes (where applicable), valve placement, and labelling/colour coding for different water lines. Verify insulation is installed where specified and protected in exposed areas (cross-reference: thickness/R-value verification under 9.2.12). Verify hydro/pressure test records, flushing/cleaning/disinfection records (as applicable), and inspection photos/notes are maintained. Occupancy stage: Verify final as-built piping drawings reflect actual installation and segregation; verify commissioning signoffs and leak/pressure test documentation are available. Verify O&M and maintenance logs show like-for-like compliant replacements and that modifications (if any) are documented without compromising NBC compliance or water-quality segregation.
9.2.6	Metering	1. Installation plans and specifications for all water meters (inflow and outflow). 2. Compliance certification for water meters 3. Photographs indicating water meter installation on water feed lines entering the building premises.	ECSBC Mandatory requirements a) Water metering layout and schematic drawings/as-built drawings, indicating the location of meters on all water inflow and outflow lines serving the building. b) Meter technical datasheets and compliance certificates, demonstrating conformity with IS 779 for approved meter types such as positive displacement, velocity, or multi-jet meters. c) Specifications for advanced metering systems (where adopted), including electromagnetic, ultrasonic, or IoT-enabled smart meters, along with manufacturer documentation. d) Installation and calibration certificates, confirming correct installation and accuracy of water meters at source and distribution points. e) Operation, monitoring, and maintenance records, including periodic meter readings and calibration logs, evidencing ongoing measurement and effective water management. Design stage: Verify metering plan and schematic show meters on all water inflow and outflow lines (source entry, major uses, discharge/reuse as applicable);

			confirm meter type and compliance with IS 779 (or equivalent referenced standard), accuracy class, size/range, and installation requirements (straight lengths, orientation, bypass if required). Verify data recording format, and responsibility matrix (FM/O&M) are defined. Construction stage: Verify meters are installed at approved locations with correct orientation, accessibility, and isolation valves/strainers where required; tag meters and capture photographs with line identification. Verify installation, manufacturer test certificates, and commissioning checks for accuracy/leak-tightness; confirm any smart/advanced meters (if used) are integrated and functioning as per design intent. Occupancy stage: Verify meter-reading logs (monthly/weekly as adopted), water accounting summaries, and anomaly follow-up records (leaks/unusual consumption). Verify periodic verification schedule and maintenance records; for smart metering, verify exported data/trends/alerts demonstrating continuous monitoring and use in water management.
9.2.7	Controls	Documents indicating requirements as per Section 9.2.7	ECSBC Mandatory requirements - Water storage sump and tank drawings, showing provision of float switch and level controllers integrated with the pumping systems. - Technical specifications and datasheets for float switches and level controllers, confirming suitability for automatic pump start–stop operation and overflow prevention. - Hydro-pneumatic system design documentation (where applicable), indicating installation of pressure switches to maintain consistent pressure at both suction and delivery manifolds. - Auto-changeover logic and control schematics for pumping systems, evidencing provision of automatic switchover between duty and standby pumps during failures or emergencies. - Mechanical flow meter layout and schedules, confirming installation on all water supply lines carrying different water qualities for varied applications. - Flow meter datasheets and installation records, validating correct selection and placement for accurate measurement of water supplied to each application. ECSBC Plus requirements - Water storage sump and tank control system drawings, indicating provision of solenoid-based level controllers with automatic ON/OFF operation for all pumping systems to prevent overflow and water wastage. - Level controller specifications and control logic diagrams, demonstrating integration of solenoid valves with pump automation for safe and efficient operation.

			c) Hydro-pneumatic system design documentation (where applicable), evidencing installation of pressure transmitters at suction and delivery manifolds. d) Pressure monitoring and protection schematics, confirming measures to avoid dry running at the suction side and to maintain, monitor, and control delivery pressure. e) Flow metering layout and schedules, showing installation of flow meters on all water supply lines within the project. f) Flow meter technical datasheets and calibration records, validating accuracy and suitability for continuous monitoring. g) As-built drawings and commissioning records, confirming correct installation and functional performance of level controllers, pressure transmitters, and flow meters in accordance with ECSBC Plus requirements. ECSBC Super requirements a) Water storage sump and tank control system drawings, indicating provision of infrared-level indicators integrated with controllers having automatic ON/OFF operation and alarm functions for all pumping systems. b) Infrared-level sensor and controller specifications, including datasheets and functional descriptions, confirming suitability for continuous level detection, alarm generation, and pump control. c) Alarm and notification logic documentation, demonstrating audible/visual alarms and signal transmission in case of abnormal water levels or system faults. d) PLC-based pumping system control schematics, evidencing that all pumping systems are operated through a PLC-controlled automation system. e) Building management system (BMS) integration details, confirming connectivity between PLCs and the BMS for centralized supervision. f) Remote monitoring and data transmission documentation, showing parameters monitored (status, levels, alarms, run hours) and method of data transmission for remote management. g) As-built drawings, commissioning reports, and functional test records, confirming correct installation, integration, and operational performance of IR level indicators, PLC controls, and BMS connectivity. Design stage: Verify drawings and control schematics show level control for sumps/tanks (float switch/level controller as per level), overflow prevention logic, and pump start–stop integration. Verify hydro-pneumatic systems (if any) include suction/delivery pressure sensing (switch/transmitter as applicable) with dry-run protection. Verify duty–standby auto changeover logic is provided for critical pumps. Verify flow metering requirements for different water qualities/uses are reflected in layouts and
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			schedules (cross-reference: meter compliance under 9.2.6). For Plus/Super, verify upgraded control intent (solenoid/IR sensors, alarms, PLC/BMS integration, remote monitoring) is clearly documented in DBR. Construction stage: Verify installed sensors (level/pressure/flow) match approved makes/models and are correctly located, wired, and protected; confirm control panels and interlocks are implemented as per schematics. Verify auto-changeover, alarm functions, and dry run/overflow protection through functional testing records (FAT/SAT where available). Verify calibration certificates for flow meters and pressure transmitters (as applicable), and maintain photo evidence with tagging. For Super, verify PLC panels, BMS connectivity, and signal mapping are commissioned. Occupancy stage: Verify commissioning and functional test reports demonstrate stable control performance (no overflow/dry-run incidents under normal operation) and correct duty-standby switchover. Verify alarm/event logs and trend data (PLC/BMS where applicable), including run-hours and fault history. Verify routine inspection and maintenance logs for sensors/actuators, periodic calibration records (flow/pressure where applicable), and evidence that control systems remain enabled and operational.
9.2.8	Service water heating	- Heat pump specifications, showing compliance with COP requirements. - Solar water heating system, gas-fired heaters and evacuated tube collector's installation documents, if applicable/BOQ/purchase. - Automation system specifications for temperature and timer controls.	ECSBC Mandatory requirements - Hot water system design basis and schematic drawings, demonstrating provision of a centralized hot water system in ECSBC-compliant buildings across all climatic zones. - Heat pump equipment specifications and manufacturer datasheets, confirming compliance with minimum coefficient of performance (CoP) requirements: - Air source heat pumps: $COP \geq 3.5$ - Water source heat pumps: $COP \geq 4.5$ - Ground source heat pumps: $COP \geq 3.0$ - Equipment performance test certificates or third-party verification reports, validating declared CoP values under standard test conditions. - System sizing and capacity calculations, demonstrating adequacy of the heat pump system to meet the building's hot water design demand. Exception - Solar water heating system design and capacity calculations, demonstrating provision of at least 40% of total hot water demand, along with installation drawings and commissioning certificates. OR Solar PV installation documentation, evidencing installation of PV capacity equal to 5% of total contractual power demand or 200 W/sq. m (whichever is less). - Heat recovery system design documentation, such as condenser heat recovery from chillers, demonstrating ability to meet the required hot water capacity based on building type and size.

			ECSBC Plus requirements a) Solar water heating system design and compliance documentation, including hot water system design calculations and schedules demonstrating that hospitality and healthcare buildings meet at least 60% of the total hot water design requirement through solar water heating, along with detailed solar water heating system design drawings and capacity calculations evidencing the adequacy of collector area, storage capacity, and overall system configuration to achieve the minimum 60% contribution. b) Supplementary hot water system documentation, confirming that the remaining 40% hot water demand is met through other approved hot water generation systems. c) Solar water heating equipment specifications and test certificates, demonstrating compliance with applicable Indian Standards and performance requirements. Exception a) Solar PV system capacity calculations, demonstrating installation of PV capacity equal to 7.5% of total contractual power demand or 300 W/m² (whichever is less). b) PV system design drawings, commissioning certificates, and generation estimates, evidencing operational readiness and compliance with the exception criteria. c) As-built drawings and commissioning reports, confirming installation and functional performance of solar water heating or qualifying Solar PV systems in accordance with Section 9.3.5(a) requirements. ECSBC Super requirements a) Solar water heating system design and full demand compliance documentation, including the hot water system design basis and demand calculations demonstrating that 100% of the total hot water design requirement for hospitality and healthcare buildings is met through solar water heating systems, along with detailed solar water heating system design drawings and capacity calculations evidencing the adequacy of collector area, storage volume, and overall system configuration to fully meet the hot water demand. b) Solar water heating equipment specifications and performance certificates, confirming compliance with applicable Indian standards and required performance levels. Exception a) Solar PV system capacity calculations, demonstrating installation of PV capacity equal to 10% of total contractual power demand or 400 W/m² (whichever is less). b) Solar PV system design drawings, commissioning certificates, and generation estimates, evidencing operational readiness and compliance with the exception criteria.
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			c) As-built drawings and commissioning and performance verification reports, confirming installation and functional operation of solar water heating systems or qualifying Solar PV systems in accordance with Section 9.3.5(b) requirements. Design stage: Verify hot water system basis and schematic confirm a centralized service water heating system as required; verify design hot water demand and sizing calculations (storage, peak load, diversity, temperature set-points, recirculation concept cross-reference 9.2.11). Verify heat pump selection and manufacturer datasheets confirm minimum CoP compliance (air ≥ 3.5, water ≥ 4.5, ground ≥ 3.0) with supporting test certificates. Where an exception pathway is claimed (solar water heating/solar PV/heat recovery), verify demand coverage calculations (40%/60%/100% as applicable for hospitality/healthcare by level), PV capacity calculations (5%/7.5%/10% of contractual demand or W/m² limits), and heat recovery capacity calculations. Verify automation intent (timer/temperature controls) is shown in controls schematics (cross-reference safety/controls under 9.2.13). Construction stage: Verify installed equipment matches approved makes/models and capacity (heat pump/solar system/heat recovery/PV as applicable); capture nameplate/photos and installation certificates. Verify correct installation of storage tanks, pumps, sensors, insulation provisions, and recirculation arrangements (cross-reference 9.2.11 and 9.2.12). Verify control wiring and set-points (timer/thermostat, differential controls for solar) are implemented as per approved schematics, and collect commissioning checklists and test sheets. Occupancy stage: Verify commissioning and performance verification reports confirm system delivers required hot water demand and CoP/efficiency intent (as applicable), with stable temperature control at points of use. Verify operational logs (run-hours, set-points, alarms), maintenance records, and—where PV/solar/heat recovery is used—evidence of functional operation (generation/production logs, heat recovery trends). Verify that control strategy (timer/temperature) is active and maintained to minimize water and energy losses.
9.2.9	Other water heating system		ECSBC mandatory requirements a) Supplementary heating system design report and schematics, demonstrating an energy-efficient design approach and integration with the primary hot water system. b) Heat recovery system documentation, detailing maximum recovery of waste heat from hot discharge sources such as air-conditioning unit condensers, including system sizing and heat recovery capacity calculations. c) Gas-fired heater specifications and approvals (where gas is available), including equipment datasheets, efficiency ratings, and statutory gas authority approvals.

			d) Electric coil heater specifications (where provided), including rated capacity, control strategy, and intended use as supplementary or backup heating. e) As-built drawings and commissioning records, confirming installation and functional performance of the supplementary heating systems in accordance with the approved design. ECSBC Plus and Super requirements – (common parameters) a) Heat pump system design drawings and equipment schedules, identifying installation of heat pumps in ECSBC Plus and ECSBC Super buildings b) PLC-based control panel specifications and schematics, demonstrating that heat pumps are operated through a PLC-based control system. c) BMS integration documentation, confirming seamless connectivity between the heat pump PLC panels and the central Building Management System (BMS). d) As-built drawings and commissioning reports, confirming installation, integration, and functional performance of PLC-controlled heat pump systems in compliance with ECSBC Plus and Super requirements. Design stage: Verify supplementary water heating rationale and integration with the primary hot water system (schematics, sequencing, control philosophy). Verify heat recovery calculations (if claimed) demonstrate recoverable capacity and intended utilisation. If gas-fired heaters are proposed, verify statutory gas approvals/permissions, safety ventilation/exhaust intent (cross-reference 9.2.13), and efficiency specifications. If electric coil heaters are proposed, verify rated capacity, intended role (backup/trim), and control strategy to prevent continuous/inefficient operation. For Plus/Super, verify PLC-based control panel intent for heat pumps and planned BMS integration/points list. Construction stage: Verify supplementary system installed as per approved design (equipment make/model, capacity, controls, interlocks); capture photos and installation certificates. For gas systems, verify flue/exhaust routing, ventilation provisions, leak safety devices, and compliance documentation; record functional checks. For Plus/Super, verify PLC panel installation, control wiring, BMS connectivity, and completion of functional tests for sequencing and alarms. Occupancy stage: Verify commissioning and performance verification records for the supplementary system, including set-points, sequencing with the primary system, and safety control operation. Verify O&M manuals and logs show the supplementary heater operates only as intended (backup/trim), with alarms/events recorded and resolved. For Plus/Super, verify BMS trend logs (run-hours, alarms, staging) and periodic inspection/maintenance records confirming continued integration and safe operation.
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9.2.10	Heating equipment efficiency		ECSBC mandatory requirements a) Any service water heating equipment specifications and schedules, identifying the type of heating system proposed and the applicable Indian standards for performance and minimum efficiency. b) Solar water heater performance certificates and test reports, demonstrating compliance with IS 13129 (Parts 1 and 2) and IS 16368, along with manufacturer datasheets. c) Gas instantaneous water heater compliance documentation, including test certificates and manufacturer declarations confirming conformity with IS 15558 and a minimum fuel utilization efficiency of 80% or higher. d) Electric water heater specifications and BEE labels, evidencing compliance with IS 2082 and mandatory BEE star labelling requirements. e) Electric coil heater test certificates and datasheets, confirming compliance with IS 4149:2021. f) Evacuated tube collector system compliance documents, including: i. Storage tank conformity certificates as per IS 16542 ii. Evacuated tube specifications as per IS 16543 and IS 16544 iii. System-level test reports and manufacturer declarations for the complete solar water heating system g) Commissioning and performance verification reports, confirming that installed service water heating equipment meets or exceeds the prescribed efficiency and performance requirements. ECSBC Plus requirements a) Plumbing segregation drawings, clearly indicating separate collection networks for grey water and black water within the building premises. b) Independent grey water and black water treatment system design documents, demonstrating provision of separate treatment processes sized to handle respective wastewater streams. c) Treatment capacity calculations, confirming adequacy of grey water and black water treatment systems for 100% of the generated wastewater. d) Treated grey water quality test reports from NABL-accredited laboratories, evidencing suitability for all non-potable applications, including HVAC cooling tower make-up (where water-cooled chillers are installed). e) Grey water reuse distribution drawings and schedules, showing allocation of treated grey water to non-potable uses. f) Treated black water quality test reports, demonstrating compliance with reuse standards for flushing and landscape irrigation.
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			g) Reuse hierarchy and augmentation logic documentation, confirming that treated black water is the primary source for flushing and irrigation, and that treated grey water is used to supplement demand in case of shortfall. h) Commissioning reports, O&M manuals, and operational logbooks, confirming continuous, safe operation and reuse of segregated wastewater treatment systems. ECSBC Super requirements a) Grey water treatment system design basis and process documentation, demonstrating treatment of grey water to achieve IS 10500:2012 quality standards. b) Advanced grey water treatment system specifications, including polishing or advanced treatment units required to meet potable-quality parameters as per IS 10500:2012. c) Treated grey water quality test reports from NABL-accredited laboratories, evidencing compliance with IS 10500:2012 standards. d) Grey water reuse distribution drawings and schedules, confirming reuse of treated grey water for non-potable applications and HVAC cooling tower make-up (where water-cooled chillers are installed). e) HVAC system interface documentation, demonstrating compatibility of treated grey water quality with cooling tower make-up requirements. f) Commissioning reports, O&M manuals, and operational monitoring records, confirming sustained compliance of grey water treatment and reuse systems in Super ECSBC buildings. Design stage: Verify service water heating equipment schedule and specifications clearly identify the proposed technology (solar/heat pump/gas/electric/ETC) and demonstrate compliance with the applicable Indian standards and minimum efficiency requirements. Verify supporting certifications/test reports as applicable: solar water heater compliance (IS 13129 Parts 1 and 2, IS 16368), gas instantaneous heater compliance (IS 15558 and ≥80% fuel utilization efficiency), electric water heater compliance (IS 2082 with valid BEE star label), electric coil heater compliance (IS 4149:2021), and evacuated tube collector system compliance (IS 16542/16543/16544). Where higher-level (Plus/Super) wastewater segregation and reuse provisions are being claimed in the framework, keep these under the correct water reuse/quality sections (cross-reference 9.2.2 / 9.2.17 / 9.3.1, as applicable) rather than mixing them into equipment efficiency. Construction stage: Verify procured and installed equipment matches the approved makes/models and efficiency class/label claims; capture nameplates, BEE labels, and product model numbers. Verify submission of manufacturer certificates and third-party test reports referenced at design stage, and confirm installation follows manufacturer requirements including controls and safety devices; cross-reference 9.2.13).
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			(Verify commissioning records confirm equipment is operational and configured to the intended set-points/staging. Occupancy stage: Verify commissioning and performance verification documentation is available and reflects installed equipment efficiencies and stable operation. Verify O&M manuals, maintenance/service records, and replacement logs demonstrate that any replacement equipment remains equivalent (same standard compliance and efficiency/label). Where monitoring exists (BMS/PLC), verify trend logs or runtime records support continued efficient operation and that equipment is not being overridden into inefficient modes.
9.2.11	Return re-circulation line		Mandatory compliance requirements a) Centralized hot water system layout drawings, indicating provision of a return re-circulation line from the end of the hot water supply network. b) Re-circulation pump specifications and schedules, confirming installation of an automated pumping system for hot water return. c) Temperature and timer control details, including control logic diagrams and equipment datasheets, demonstrating automatic operation to minimize water loss and energy consumption. d) Piping and insulation details for return lines, shown on drawings and specifications, ensuring thermal efficiency and system effectiveness. e) As-built drawings and commissioning records, confirming installation and proper functioning of the return re-circulation system in accordance with the design intent. Design stage: Verify centralized hot water system drawings show a continuous return re-circulation line from the end of the distribution network back to the plant room/storage. Verify re-circulation pump selection and schedules (duty/standby if applicable), and confirm automation strategy (timer and/or temperature control) to minimize water draw-off and energy losses. Verify return-line routing, balancing provisions (as applicable), and insulation intent for both supply and return (cross-reference detailed insulation compliance under 9.2.12). Construction stage: Verify return line is installed end-to-end as per approved drawings, including correct routing, valves/balancing provisions, and connection to the hot water plant. Verify re-circulation pump installation, electrical/control wiring, sensor placement (if temperature-controlled), and that timer/thermostat logic is implemented. Verify insulation is installed on return lines with required protection where exposed (cross-reference 9.2.12). Verify functional tests demonstrate circulation and temperature stabilization at distant outlets. Occupancy stage: Verify commissioning records confirm stable hot water availability at endpoints with re-circulation operating as intended. Verify operating set-points/schedules (timer/temperature)

			are documented and maintained, with logs showing pump runtime and any alarms/faults. Verify maintenance records for pumps, valves, sensors, and insulation condition; confirm controls are not permanently bypassed, and evidence of reduced water wastage (complaint logs/temperature checks) is retained where available.
9.2.12	Piping insulation	Insulation materials specifications and compliance with required R-values	ECSBC mandatory requirements a) Hot water supply and return piping insulation drawings and schedules, indicating insulation thickness and R-values for all heating, space conditioning, and service hot water systems in accordance with applicable ECSBC Table. b) Insulation material specifications and datasheets, demonstrating compliance with the required insulation R-values based on operating temperature and pipe size, as well as suitability for indoor and outdoor applications. c) Weather protection details for exposed insulation, showing aluminium foil cladding or water-resistant protective coatings for cellular foam insulation. d) Hot water storage tank temperature control data sheets, confirming compliance with NBC 2016, Part 9, Clause 4.14.2.2 and subsequent revisions, including thermostat settings and control logic. Exception a) Reduction of insulation R-value by 0.2 (to a minimum of R-0.4) for pipes located within partitions in conditioned spaces or laid underground. b) Increase of insulation R-value by 0.2 above requirements for pipes located outside the building or exposed to weather. c) Alternative insulation performance documentation (where Table 9.2 R-values are not adopted), evidencing use of insulation materials that improve system performance by at least 85%, supported by manufacturer test reports or third-party certifications. d) As-built drawings, inspection, and commissioning records, confirming installation of piping insulation and temperature controls as per approved design and specified performance criteria. ECSBC Plus and ECSBC Super requirements a) Hot water, heating, and space-conditioning piping insulation drawings and schedules, clearly identifying pipe sizes, operating temperatures, and insulation R-values for ECSBC Plus and ECSBC Super buildings. b) Insulation material specifications and manufacturer datasheets, demonstrating compliance with the minimum insulation R-values as per the requirement of ECSBC Plus and ECSBC Super based on pipe diameter and operating temperature. c) Weather protection details for exposed insulation, showing aluminium foil cladding for all insulation exposed to external conditions.

			d) Cellular foam insulation protection details, evidencing either aluminium foil cladding or application of approved water-resistant protective paint. Exception a) Thermal performance calculations or test reports demonstrating at least 88% performance improvement for ECSBC Plus buildings. b) Thermal performance calculations or test reports demonstrating at least 92% performance improvement for ECSBC Super buildings. c) As-built piping and insulation drawings, confirming installation in accordance with approved designs and specified insulation levels. d) Inspection, commissioning, and verification records, evidencing correct installation, protection, and thermal performance of piping insulation systems. Design stage: Verify insulation drawings/schedules specify pipe sizes, operating temperatures, and required R-values/thickness for hot water supply and return lines as per the ECSBC tables. Verify insulation material datasheets confirm thermal performance and suitability for indoor/outdoor use. Verify weather protection details for exposed insulation (aluminium cladding / water-resistant coating for foam) are shown. Verify hot water storage tank thermostat/control details comply with NBC requirements. If an exception is claimed (reduced/increased R-value based on location or alternate performance path), verify the supporting calculation/test documentation and clear marking of affected pipe segments. Construction stage: Verify insulation is installed with the specified thickness/R-value on all applicable pipes and fittings (including bends/valves where required) and that exposed insulation has the required protective cladding/paint. Verify workmanship and continuity (no gaps, compression, or missing sections), and record inspection notes with photo evidence. Verify any deviations are updated in as-builts and supported with approved alternative compliance documentation if applicable. Occupancy stage: Verify as-built insulation drawings/schedules and commissioning/inspection records are available. Verify periodic inspection/maintenance logs include checks for insulation damage, wetting, missing cladding, or deterioration and corrective actions taken. Where alternate performance compliance was used, verify supporting test/calculation evidence is retained in the O&M file and remains valid for the installed system.
9.2.13	Water heating control and safety	1. Indicate, exhaust system and thermostat details for gas heaters. 2. Control system specifications for heat pumps and solar systems. 3. Energy consumption calculations.	ECSBC mandatory compliance a) Gas heater system drawings and specifications, demonstrating provision of a properly designed exhaust system for safe removal of carbon monoxide (CO) generated during gas combustion. b) Exhaust and ventilation design details, including flue routing, termination, and materials, supported by manufacturer recommendations and applicable safety standards.

			c) Thermostat specifications for gas heaters, confirming provision of temperature control to regulate hot water output and prevent overheating. d) Heat pump control schematics and control data sheet, evidencing installation of the following safety and operational controls: i. High- and low-pressure cut-off controls for refrigerant gas ii. Temperature cut-off and automatic restart controls, with provision for differential temperature settings iii. Chilled/cooling water temperature cut-off controls (applicable for water source heat pumps) e) Solar water heating system control specification sheets, describing automatic circulation pump control based on energy gain availability from solar collectors. f) Differential thermostat specifications and control logic, demonstrating optimization of energy gain and system efficiency in active solar water heating systems. g) Thermostatic mixing valve (TMV) specifications and installation drawings, confirming measures to prevent excessively high-temperature water delivery from solar panels. h) Commissioning and functional test reports, validating correct operation of safety controls and automation across gas heaters, heat pumps, and solar water heating systems. Design stage: Verify gas heater drawings/specs include a compliant exhaust/flue and ventilation concept for safe CO removal, along with thermostat specifications for temperature control. Verify heat pump control schematics include required protections: high/low refrigerant pressure cut-offs, temperature cut-off with automatic restart and differential settings, and (for water-source systems) chilled/cooling water temperature cut-off. Verify solar water heating controls specify automatic circulation based on collector energy gain (differential thermostat logic), and include TMV (thermostatic mixing valve) specifications and placement to prevent scalding from high outlet temperatures. Verify the basis for energy consumption calculations is documented where the code requires it (method, assumptions, inputs). Construction stage: Verify exhaust/flue routing, terminations, and materials are installed as per approved design and manufacturer requirements; capture installation photos and certificates. Verify sensors, thermostats, cut-outs, and TMVs are installed at the correct locations and wired correctly. Verify functional testing records demonstrate trip/restart logic, set-point response, solar pump control logic, and TMV operation; record any nonconformities and closures. Occupancy stage: Verify commissioning certificates and functional test reports are available for gas heaters, heat pumps, and solar systems, including set-points and safety
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			cut-off verification. Verify periodic safety inspection logs (flues, ventilation, TMVs, sensors) and maintenance records are maintained, along with any alarm history (BMS/PLC where connected). Verify energy consumption/operational records are retained as applicable to demonstrate ongoing stable, safe operation.
9.2.14	Swimming pool heating	Indicate pool cover is used.	ECSBC mandatory requirements a) Swimming pool heating system drawings and specifications, identifying all heated pools within the project and their operating temperature ranges. b) Pool cover specifications and datasheets, demonstrating provision of a vapour-retardant pool cover on the water surface for all heated pools. c) Insulated pool cover compliance documents for pools heated above 32°C, confirming a minimum insulation value of R-4.1, supported by manufacturer test reports. d) Installation drawings and photographic evidence, verifying correct installation and coverage of pool covers over the pool surface. e) Energy consumption calculation sheets, prepared in accordance with the table given in ECSBC, demonstrating energy use for the selected hot water or pool heating systems. f) Commissioning and operational records, confirming availability and use of pool covers as part of energy-efficient pool operation. Design stage: Verify identification of all heated pools and their design operating temperatures. Verify pool cover specifications demonstrate a vapour-retardant cover for all heated pools, and for pools heated above 32°C, verify an insulated cover meeting minimum R-4.1 with supporting manufacturer data/test evidence. Verify pool heating system drawings/schematics and control intent. Verify energy consumption calculation sheets are prepared as per the code table for the selected heating system. Construction stage: Verify procurement and installation of the specified pool cover (vapour-retardant / insulated as applicable); capture photos showing full surface coverage and storage/handling provisions. Verify heating equipment installation and controls match approved drawings/specs. Verify installation checklists and commissioning readiness records are maintained. Occupancy stage: Verify commissioning and operational records confirm pool heating system functionality and that the cover is available and used in operation. Verify maintenance logs for the cover and heating system, and retain energy consumption/operational monitoring records where required to demonstrate continued compliance.

9.2.15	Water balance	1. Water balance diagrams for dry and wet seasons, population estimates, and water demand calculations as per NBC 2016 and IS 17650. 2. Fixture details adhering to water efficiency and indications on other requirements of the Section 9.2.15.	ECSBC mandatory requirements h) Water balance diagrams for Dry and Wet seasons, presented in a clear diagrammatic format (Calculations), showing total water inflow, outflow, reuse, losses, and discharge within the project boundary. i) Seasonal assumption notes, defining dry season and wet season durations, with justification based on rainfall characteristics of the project location. j) Building population calculation statement, prepared in accordance with NBC 2016, Part 9, Section 1, Clause 4.1(b), including: i. NBC-based population calculations for covered building typologies. ii. Design occupancy declaration and basis of calculation certified by the architect or competent authority for typologies not covered under NBC. k) Minimum water demand calculation sheets, demonstrating compliance with Table 1 of Clause 4.1.2 of NBC 2016, Part 9, Section 1 (Water Supply), or subsequent revisions. l) Plumbing fixture unit calculations, including: i. Fixture-wise unit values as per Table 2, Clause 4.7.3.1 of NBC 2016. ii. Probable simultaneous demand calculations derived using Table 3, Clause 4.7.3.2 of NBC 2016. m) Water efficiency compliance documentation for fixtures and sanitary ware, evidencing conformity with star rating requirements as per IS 17650 Part 1 and Part 2 (Tables 1 and 4), supported by manufacturer datasheets and labels. n) Exception justification for seasonal definition (where applicable), supported by documented rainfall data and certification from the Meteorological Department, demonstrating that dry and wet season periods are defined based on actual long-term rainfall records. o) Summary compliance notes or declaration, confirming that the water balance has been prepared in accordance with NBC requirements and applicable seasonal assumptions, and is suitable for water conservation planning and shortfall assessment. Design stage: Verify dry- and wet-season water balance diagrams (with calculations) include all inflows, outflows, reuse, losses, and discharge within the project boundary. Verify seasonal assumptions (dry/wet duration) are documented and justified using local rainfall characteristics; where certification is required, retain the supporting IMD/meteorological documentation (cross-reference 9.2.1). Verify population estimation and minimum water demand calculations follow NBC 2016 Part 9, including demand tables and assumptions. Verify plumbing fixture unit and probable simultaneous demand calculations are included as per NBC tables. Verify fixture efficiency evidence (IS 17650 star rating compliance) is compiled and linked to the water balance
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			(cross-reference 9.2.16). Verify a short compliance declaration notes, methodology, assumptions, and that the balance supports water conservation planning and shortfall assessment. Construction stage: Verify installed fixtures and water systems match the assumptions used in the design-stage water balance (no paper savings); confirm procurement submittals and site photos align with the specified star-rated fixtures (cross-reference 9.2.16). Verify major reuse systems assumed in the balance (STP reuse/RWH/condensate recovery, if applicable) are installed and connected as per drawings (cross-reference 9.2.17 and 9.2.18). Verify as-built markups capture any deviations affecting demand or reuse. Occupancy stage: Verify meter readings and operational logs support the declared water balance at occupancy; where actual occupancy differs, verify an updated water balance or reconciliation note is maintained. Verify reuse performance records (treated water volumes, RWH yield where measurable) and periodic water quality reports support continued functioning of reuse pathways (cross-reference 9.2.2, 9.2.17, 9.2.18). Verify records of ongoing shortfall assessment and corrective actions (leak repair, fixture replacement, operational adjustments) are retained.
9.2.16	Water efficiency	Indicate for fixtures and sanitary ware conforming to water efficiency criteria as per IS 17650.	ECSBC mandatory requirements - Fixture and sanitary ware schedules, identifying all water fixtures installed in the project along with their applicable star ratings. - Manufacturer datasheets and product specifications, demonstrating compliance with the minimum 1-Star rating criteria as prescribed under IS 17650 Part 1 and Part 2, in accordance with the ECSBC. - Approved plumbing drawings and schedules, correlating installed fixtures with the specified star-rated products. - As-built documentation (Photographs) and inspection records, confirming installation of fixtures and sanitary ware in line with the approved specifications and minimum star rating requirements. Design stage: Verify the fixture and sanitary ware schedule lists all water fixtures with their IS 17650 star ratings (minimum required rating as per ECSBC). Verify manufacturer datasheets, test evidence, and labels/certifications substantiate the claimed star ratings. Verify plumbing drawings and schedules reference the selected star-rated fixture models so the specification is unambiguous. Cross-reference: 9.2.15 (fixture efficiency inputs used in demand calculations). Construction stage: Verify procurement submittals match the approved star-rated models (model numbers, datasheets, labels). Verify on-site installation matches the approved schedule through spot checks and photo documentation of installed fixtures and packaging/labels where available. Verify any substitutions are evaluated and documented as equivalent or better star rating before installation, with updated as-builts/schedules.

			Occupancy stage: Verify an as-built fixture inventory is maintained (model, location, star rating) and that replacement/maintenance records ensure like-for-like compliant replacements over time. Where water meters/logs are available, verify consumption trends are consistent with the intended water-efficiency strategy (cross-reference 9.2.6 and 9.2.15).
9.2.17	Wastewater treatment and reclamation	1. Indicate capacity of on-site wastewater treatment plant (as per CPHEEO Manual) 2. Details on flow meters (inlet and outlet) and online water quality monitoring systems. Reuse of treated water and designs for STP and pump room.	ECSBC mandatory requirements a) Wastewater treatment plant (STP) design basis report and capacity calculations, demonstrating installation of an STP capable of treating 100% of the wastewater generated within the building premises. b) STP design drawings and process flow diagrams, confirming compliance with: i. CPHEEO Manual on Sewerage and Sewage Treatment Systems ii. NBC 2016, Part 9 (Plumbing Services), Section 2 (Drainage and Sanitation), Subsection 4.13 (Sewage Treatment Systems) c) Statutory documentation, evidencing that treated wastewater quality meets the requirements prescribed under the Environmental (Protection) Rules, 1989, and subsequent amendments. d) Tertiary / polishing treatment system specifications, including dual media filters, activated carbon filters, and disinfection systems, demonstrating achievement of PCB-prescribed treated water quality norms. e) Advanced treatment system documentation (where provided), such as softeners or membrane filtration systems, justifying enhanced treated water quality for specific reuse applications. f) Flow meter installation drawings and specifications, confirming provision of flow meters at both STP inlet and outlet for accurate monitoring of treated and untreated wastewater volumes. g) Water quality monitoring system details, including equipment specifications and layout, demonstrating monitoring of key parameters such as pH, TSS, BOD, COD, and TDS at the STP outlet. h) Treated wastewater quality test reports from NABL-accredited laboratories, confirming compliance with reuse norms as specified in the CPHEEO Manual (2013), Chapter 7, Table 7.19. i) Basement STP and pump room ventilation drawings, demonstrating compliance with NBC 2016, Part 8 (Building Services), Section 11, Clause 11.3, Table 11, and subsequent revisions. j) Commissioning certificates, O&M manuals, and operation logbooks, confirming functional performance, safe operation, and continued compliance of the wastewater treatment and reuse system.

			Design stage: Verify STP design basis report and capacity calculations demonstrate treatment of 100% of generated wastewater. Verify process flow diagram and design drawings align with <i>CPHEEO Sewerage and Sewage Treatment Manual</i> and NBC 2016 Part 9 (Drainage and Sanitation), including treatment stages and intended reuse applications. Verify statutory compliance basis for treated effluent quality (applicable Environmental rules / SPCB requirements) and inclusion of tertiary/polishing units (filters, disinfection, etc.) to meet reuse norms. Verify inlet/outlet flow metering provisions and online/at-outlet monitoring scheme for key parameters (pH, TSS, BOD, COD, TDS as applicable). Verify basement STP/pump room ventilation design complies with NBC provisions where applicable. Verify a clear reuse plan and reuse plumbing intent is documented (cross-reference 9.2.2 for quality targets and 9.2.6/9.2.7 for metering/controls). Construction stage: Verify STP is installed/built as per approved drawings and specifications, including tertiary/polishing units and sampling points. Verify inlet and outlet flow meters are installed and functional; verify online/at-outlet monitoring equipment is installed per layout and calibrated where required. Verify ventilation provisions (especially for basement installations) are executed as designed. Verify reuse pipeline connections and segregation are correctly implemented and labelled (fresh vs treated). Maintain inspection checklists, photographs, and as-built updates. Occupancy stage: Verify commissioning certificates and performance verification reports confirm stable operation at design capacity. Verify NABL-treated wastewater quality reports demonstrate compliance with CPHEEO (Table 7.19 for point-of-use) and applicable SPCB/CPCB requirements for intended reuse. Verify continuous/periodic monitoring records (online logs where provided), inlet/outlet flow logs, and O&M manuals and daily logbooks are maintained. Verify reuse is actually occurring as per design intent using flow records and distribution logs, and corrective actions are documented when quality or performance deviates.
9.2.18	Rainwater harvesting (RWH) and reuse	Indicate conformation with requirement RWH and conservation as per CPHEEO manual/local bylaws	ECSBC mandatory requirements - RWH design drawings and layout plans, showing collection from rooftops and paved surfaces, conveyance systems, filtration units, storage tanks, recharge pits, or percolation structures. - Design basis and capacity calculations, demonstrating adequacy of the RWH system for collection, storage, and recharge based on catchment area, rainfall data, and runoff coefficients. - Compliance documentation with <i>CPWD Rainwater Harvesting and Water Conservation Manual</i>, 2019, evidencing alignment of system design, sizing, and implementation. - Reference compliance with CPHEEO manuals, confirming that RWH and reuse provisions meet national best-practice guidelines.

			e) Local bye-law approval records, demonstrating adherence to municipal or development authority requirements, with confirmation that the most stringent provision has been adopted. f) Building plan approval with sanctioned RWH details, issued by the competent authority, confirming statutory acceptance of the rainwater harvesting system. g) Completion certificate and photographic evidence, verifying on-site installation of rainwater harvesting components as per approved designs. h) Operation and maintenance guidelines, detailing cleaning, desilting, and upkeep of RWH structures to ensure long-term functionality and recharge effectiveness. ECSBC Plus and ECSBC Super requirements a) Rooftop RWH system drawings and calculations, demonstrating that 100% of available rooftop rainwater is collected, conveyed, and stored. b) Rainwater treatment system documentation, including process description and treatment stages, evidencing suitability of treated rainwater for potable applications in compliance with IS 10500:2012. c) Treated rainwater quality test reports from NABL-accredited laboratories, confirming compliance with potable water quality standards. d) Recharge percolation pit design drawings and soil investigation reports mentioning ground water level, demonstrating adoption of recharge structures based on site-specific soil suitability. e) Local authority approvals and sanctioned drawings, evidencing acceptance of RWH and recharge systems. f) Completion certificates and photographic evidence, confirming on-ground implementation of rooftop rainwater harvesting and recharge percolation pits as per approved design. Design stage: Verify RWH drawings cover rooftop (and paved areas if included), conveyance, first-flush/filtration, storage and/or recharge structures, overflow routing, and access for maintenance. Verify sizing calculations (catchment area, runoff coefficients, rainfall basis, storage/recharge capacity) and stated compliance references (CPWD RWH Manual 2019, CPHEEO guidance, and local bye-laws—apply the most stringent). Verify sanctioned building plan/approval includes RWH. For ECSBC Plus/Super, verify calculations explicitly demonstrate 100% rooftop rainwater capture and, where potable use is claimed, verify treatment process design and target quality alignment with IS 10500:2012 (cross-reference quality evidence under 9.2.2). Where recharge pits are used, verify soil investigation/groundwater-level notes supporting recharge suitability.
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			Construction stage: Verify RWH system is constructed exactly as sanctioned: gutters/downpipes, filters, storage tanks, recharge pits/percolation structures, overflow lines, and inspection/cleaning access points. Record geo-tagged photos and installation checklists. Verify safe segregation from wastewater lines and that the route prevents contamination. Verify any treatment units (if potable use is proposed) are installed with sampling points for testing (cross-reference 9.2.2 and 9.2.3). Occupancy stage: Verify completion certificate (where issued), as-built drawings, and O&M procedures for desilting, filter cleaning, and periodic inspection. Verify maintenance logs and functionality checks during rainfall events (ponding/overflow issues, recharge performance). For Plus/Super, verify evidence of 100% rooftop capture is maintained (as-built confirmation + storage/recharge operation), and retain periodic NABL test reports if treated rainwater is used for potable applications (cross-reference 9.2.2).
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Chapter 10 addresses waste management, encompassing both construction-stage waste and post-occupancy waste streams. It explains how waste must be categorized, stored, diverted, or processed. The chapter elaborates on the requirements for on-site waste processing systems, including organic waste converters, and provides guidance on calculating expected waste generation and diversion rates. It seeks to ensure that buildings minimize their environmental burden through responsible handling and recycling of materials.

Table 10 waste management - Compliance documents required and evaluation

Code Section	Component	Information Required	Waste management - Compliance documents required and evaluation
10.2,10.3	Construction waste management	Indicating safe handling and disposing of C&D waste as per CPCB guidelines/ (C & D Waste Management Rules, 2016).	- Submit a copy of the agreement/work order/tender document with an authorized waste management agency or contractor for handling construction and demolition (C&D) waste, clearly outlining procedures for on-site segregation, safe handling, storage, collection, transportation, and disposal, in compliance with CPCB guidelines and the C&D Waste Management Rules, 2016. The document should explicitly include clauses demonstrating compliance with applicable statutory requirements and responsibilities of all stakeholders involved in C&D waste management. - In cases where C&D waste is directly handed over to municipal authorities or reused on-site, copies of municipal challans/receipts and reuse records shall be provided in lieu of the agreement. Design stage evaluation: Verify that provisions for segregation, safe handling, storage, transportation, reuse, recycling, and disposal of C&D waste are incorporated in project specifications, BOQs, and tender documents in accordance with CPCB guidelines and C&D Waste Management Rules, 2016, as required under ECSBC Clause 10.2. Construction stage evaluation: Verify actual implementation through site inspections and documentary evidence such as agreements with authorized agencies, municipal challans, invoices, and records confirming segregation, safe handling, transportation, reuse, or disposal of C&D waste in compliance with ECSBC Clause 10.3.

			Occupancy stage evaluation: Verify that complete construction-stage C&D waste management records have been submitted and closed as part of final ECSBC compliance documentation prior to issuance of the occupancy certificate.
10.2,10.3	Construction waste management	An inventory of the waste generated during construction by either weight or volume. Classify the quantities of waste generated as per Section 10.2.1.	- Provide a detailed inventory of all types of construction waste generated, including soil, sand, gravel, brick and masonry debris, concrete fragments, metals, wood, packaging materials, etc., clearly indicating the weight or volume, total quantity generated, quantity diverted from landfill, and the method of diversion (reuse, recycling, or authorized disposal). - Submit copies of waste log sheets recording the quantity of each waste type generated, total waste generated, quantities reused on-site, sold to authorized recyclers, and/or handed over to the municipal authority or other authorized agencies. - Submit copies of challans/receipts for all waste materials sold or handed over to the authorized recyclers or disposal facilities, as applicable. Design stage evaluation: Verify that methodology and formats for estimation, classification, and recording of construction waste quantities (by weight or volume) are defined at design stage in accordance with ECSBC Clause 10.2.1. Construction stage evaluation: Verify actual quantities of waste generated, reused, recycled, or disposed by reviewing waste log sheets, challans, and recycler receipts, and cross-checking them with construction progress and material consumption, as required under ECSBC Clause 10.3. Occupancy stage evaluation: Verify submission of a final consolidated construction waste inventory demonstrating compliance with minimum waste diversion requirements prescribed under ECSBC Clause 10.3.
10.2,10.3	Construction waste management	Indicate a waste management plan (construction period) which should be developed which include: - Estimate the quantum of waste generated daily. - Area for collection of daily waste. - Site logistics plan including designated collection, segregation, and storage areas for construction waste.	- Submit a site waste management plan (SWMP) for the construction period, highlighting estimated daily waste generation, designated areas for collection, segregation, and storage of construction waste, and site logistics for handling different waste streams. - Provide a site layout clearly indicating the location of designated storage areas for generated construction materials such as steel, building blocks, stone, etc. including empty cement bags, packaging waste, and construction/demolition debris. - Submit an implementation plan detailing on-site reuse of C&D waste materials and procedures for resale or handover of recyclable waste to authorized recyclers or municipal authorities.

			• Provide copies of agreements/MoUs and corresponding challans/receipts demonstrating that at least 50% of non-hazardous waste generated during construction (75% for ECSBC Plus and 95% for Super ECSBC), by weight or volume, has been reused, repurposed, recycled, or salvaged through authorized recyclers, transporters, or municipal authorities. Provide copies of agreements/MoUs and challans/receipts evidencing that 100% of packaging and recyclable waste generated during construction has been handed over to manufacturers, authorized recyclers, or municipal entities for appropriate collection, recycling, and disposal. • Provide copies of agreements/MoUs and challans/receipts demonstrating that 100% of construction waste, by weight or volume, generated during the construction process has been reused, repurposed, salvaged on-site, or diverted to authorized recycling facilities, or safely handed over to municipal authorities for final disposal, as applicable. Design stage evaluation: Verify that a SWMP is prepared at design stage detailing estimated waste generation, segregation, and storage areas, site logistics, and reuse/recycling strategies, demonstrating intent to meet ECSBC Clause 10.3 diversion thresholds (50%/75%/95%, as applicable). Construction stage evaluation: Verify implementation of the approved SWMP through site inspections, photographic evidence, reuse records, recycler agreements, and challans confirming achievement of waste diversion targets in line with ECSBC Clause 10.3. Occupancy stage evaluation: Verify that construction-period waste diversion targets have been achieved and documented as a prerequisite for final ECSBC compliance and occupancy certificate issuance.
10.2, 10.3	Post-construction waste management	Site and building floor plans, highlighted area for floor-wise waste collection, bins provision, organic waste composting location and its calculation, type and catering capacity.	• Submit a detailed narrative describing the post-construction organic waste management strategy, including procedures for waste collection, segregation, on-site treatment, and final disposal. • Submit the site plan indicating the plinth area and total built-up area of the project. • Provide site and building floor plans clearly indicating floor-wise waste collection areas, locations of colour-coded waste bins (minimum five streams: dry waste, organic/wet waste, sanitary waste, hazardous household waste, and e-waste), locations of composting/organic waste treatment facilities, and associated infrastructure.

			• Provide copies of agreements/MoUs and challans/receipts demonstrating that dry, sanitary, and hazardous waste is being collected and transported by authorized recyclers or the municipal corporation, as applicable. • For projects with built-up area $\geq 5,000$ sq. m: Submit technical specification sheets of the on-site organic waste treatment system, detailing the technology adopted and system capacity, demonstrating composting (manual or mechanical) of at least 50% of projected post-occupancy organic waste (75% for ECSBC Plus and 95% for Super ECSBC). Provide sizing calculations for the composting system based on building occupancy, organic waste generation rates, and catering capacity, where applicable. • For projects with built-up area $< 5,000$ sq. m: Provide copies of agreements/MoUs and challans/receipts demonstrating that segregated organic waste is handed over to the concerned local body (where a municipal collection mechanism exists) or to an authorized/professional waste management agency in the absence of municipal arrangements. • Provide date-stamped contextual photographs of installed organic waste management systems, waste collection areas, and treatment facilities demonstrating on-site implementation. Design stage evaluation: Verify that post-construction waste management provisions are integrated into building design, including floor-wise waste collection areas, colour-coded bins, and sizing of organic waste treatment systems based on projected occupancy and catering capacity, in accordance with ECSBC Clause 10.3. Construction stage evaluation: Verify installation of waste collection infrastructure and organic waste treatment systems as per approved drawings and specifications, supported by site photographs, technical datasheets, and agreements with authorized waste management agencies. Occupancy stage evaluation: Verify operational functionality of waste segregation, organic waste treatment systems, and authorized waste collection mechanisms through commissioning records, contracts, and on-site verification during occupancy, ensuring continued compliance with ECSBC Clause 10.3.
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Chapter 11 sets out the provisions related to Indoor Environmental Quality. It describes the minimum ventilation, filtration, and contamination-control requirements necessary for a healthy indoor environment. The chapter explains standards for thermal comfort, glare control, visual comfort achieved through daylighting, and acoustic performance. These provisions aim to ensure occupants experience comfortable, productive, and health-supportive indoor spaces while maintaining high-energy performance.

Table 11 Indoor Environmental Quality -Compliance documents required

Code Section	Component	Information Required	Indoor Environmental Quality -Compliance documents required
11.2.1	Indoor air quality (IAQ)	1. Specification sheet or certification of air filters conforming to IS/ISO 16890 Part 1-4. 2. Indicate the ventilation system design aligned with Section 6.2.1. 3. CO₂ sensors and their integration with HVAC controls.	1. Submit a copy of the Design Basis Report (DBR) that clearly mentions the technical specification of air filters demonstrating source control for PM2.5 and PM10. 2. Submit the simulation report in accordance with the requirements of Section 6.2.1 (Part 8: Building Services, Section 1: Lighting and Natural Ventilation, Subsection 5: Ventilation) 3. Submit a copy of DPR clearly mentioning the CO₂ sensor specifications and integration with HVAC control for the specified category of spaces as per ECSBC Clause 11.2.1 Design stage evaluation • Verify the DPR specifies air filters conforming to IS/ISO 16890 (Part 1-4) with appropriate filtration class to ensure source control of PM2.5 and PM10, as required under ECSBC Clause 11.2.1. • Verify the simulation report of ventilation provisions for each space in accordance with Section 6.2.1 as required under ECSBC Clause 11.2. • Verify the CO₂ sensor requirements with HVAC controls in the DPR as required under ECSBC 11.2. Construction stage evaluation • Verify installation of air filter and its actual implementation through site inspections and documentary evidence conforming to the specified technical specification in compliance with ECSBC Clause 11.2.1. • Verify the installed provisions for the ventilation system meet the criteria as mentioned in Section 6.2.1 of ECSBC through site inspection measurements or photographs. • Verify the installed CO₂ sensor's integration with HVAC controls as specified in Section 6.2.1 of ECSBC by site inspection or photograph.

			Occupancy stage evaluation • Verify the final submission of the air filter specification, confirming the standard IS/ISO 16890 Part 1–4. • Verify the final submission draft of IAQ documentation conforming ventilation standard as Section 6.2.1. • Verify the final submission confirming CO2 sensors with HVAC control at the occupancy stage.
11.2.2	Thermal comfort	1. Simulation report demonstrating thermal comfort compliance: (a) Input and output files simulation file. (b) Details of the thermal comfort model used. (c) Maximum unmet hours (not exceeding 300). (d) Operative temperature calculation or simulation results. 1. Drawings showing area distribution for air-conditioned, non-air-conditioned and mixed mode space. 2. Single-line diagram (SLD) for HVAC systems (high-side and low side) with seasonal set-points.	1. Submit the thermal comfort simulation report that clearly demonstrates the space-wise thermal unmet hours (not exceeding 300), proof of the adopted thermal comfort model and its comfort range for summer and winter, and adopted unmet hours calculated based on operative temperature. 2. Submit the simulation zoning of each building space that clearly illustrates the distribution of conditioned, non-conditioned and mixed-use spaces. 3. Submit a copy HVAC DPR that illustrate single line layout of the HVAC system installed and proof of seasonal set-point design consideration. Design stage evaluation • Verify the simulation report of thermal comfort, confirming to meet the criteria of ECSBC Clause 11.2.2. • Verify the space zoning in the simulation report. • Verify the document of the HVAC layout and seasonal set-point used in heat load calculation or verify the HVAC simulation modelling and the defined zone seasonal set-point temperature. Construction stage evaluation • Verify the indoor operative temperature within the limit of the adopted comfort model temperature range through the site visit measurement and photographs. • Verify the space zoning through the site visit or photographs. • Verify the installed HVAC system and set-point through a site visit and photograph. Occupancy stage evaluation • Verify the final thermal comfort calculation documentation prior to OC. • Verify the documentation of the functioning building space at the occupancy stage. • Verify the submitted documentation of the installed HVAC system and set point prior to OC.

11.2.3	Visual comfort	Indicate visual comfort requirements conforming to compliance with: IS 3646 Part 1 (illuminance level and glare index) Illuminance level thresholds as per National Lighting Code (SP72:2010) 2010 Uniformity of illuminance for task and surrounding areas	1. Submit a copy of the visual comfort simulation report that clearly meets the criteria of illuminance level and glare index as per IS3646 Part 1 of ECSBC Clause 11.2.3. 2. Submit the proof of the undertaken illuminance level threshold as per NLC 2010 of ECSBC Clause 11.2.3. 3. Submit a copy of the calculation sheet or simulation report of the uniformity of illuminance of the specified area mentioned in the ECSBC Clause 11.2.3. Design stage evaluation • Verify the required illuminance level and glare as per IS 3646 Part 1 specified in ECSBC Clause 11.23. • Verify the simulation report that meets the threshold of illuminance in accordance with ECSBC Clause 11.2.3. • Verify the uniformity of illuminance for specified spaces with ECSBC Clause 11.2.3. Construction stage evaluation • Verify the illuminance level and glare through the instrument and photographs meet the criteria of IS 3646 Part 1 in accordance with ECSBC 11.2.3. • Verify the illuminance level threshold criteria are maintained in the building spaces as specified in the ECSBC Clause 11.2.3 through instrument measurement and photograph. • Verify the provisions considered for visual comfort, such as skylight, light shelves, meet the uniform distribution of illuminance in the specified spaces in accordance with ECSBC Clause 11.2.3 through measurement or manual calculation. Occupancy stage evaluation • Verify the submitted document of illuminance level and glare index prior to OC. • Verify the submitted document of the illuminance level threshold at the design stage. • Verify the uniformity of illuminance for the specified area at the design stage.
11.3.4	Acoustics comfort	1. Acoustic insulation properties of building materials as per Table 11.4 (walls and glazing) 2. Transmission losses calculation	1. Submit a copy of the DPR of building materials, clearly mentioning the acoustic insulation properties in accordance with Table 11.4 (wall and glazing) of ECSBC 11.3.4. 2. Submit a copy of the transmission loss calculation sheet for different attributes. 3. Submit the noise isolation level for different spaces.

		3. Noise isolation between building elements 4. Compliance with threshold Noise Isolation Class (NIC) levels for different spaces (as per Table 11.7)	4. Submit the report of the noise level for each space that meets the threshold of NIC level in accordance with Table 11.7 of ECSBC Clause 11.3.4. Design stage evaluation • Verify the insulation properties in accordance with Table 11.4 (wall and glazing) of ECSBC Clause 11.3.4. • Verify the transmission losses as specified in the ECSBC Clause 11.3.4. • Verify the noise isolation of the defined building elements in accordance with ECSBC Clause 11.3.4. • Verify the noise threshold level for each space meets the criteria of Table 11.7 of ECSBC Clause 11.3.4. Construction stage evaluation • Verify the acoustic insulation properties of building materials as per Table 11.4 through site visit, photographs and documentary evidence. • Verify the transmission loss through site visit and photographs in accordance with ECSBC Clause 11.3.4. • Verify the noise isolation between building elements through a site visit and photograph as specified in ECSBC Clause 11.3.4. • Verify the noise isolation threshold for different spaces as per Table 11.7 through measurement and site visit. Occupancy stage evaluation • Verify the submitted documents of insulation material and properties during the design stage. • Verify the submitted transmission losses calculation prior to OC. • Verify the documents for noise isolation of building elements during the design stage. • Verify the submitted NIC threshold maintained during the construction stage.
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11.3.2	Thermal comfort	1. Detailed HVAC design showing humidity control 2. Indicate relative humidity control for summer and winter seasons 3. Indicate relative humidity control for summer and winter seasons 4. Indicate the radiant temperature asymmetry, vertical air temperature difference and floor surface temperature as in Table 11.3.	1. Submit the DPR of HVAC that clearly shows the installation of the humidity control. 2. Submit the simulation report that indicates the humidity control in both summer and winter seasons in accordance with ECSBC Clause 11.3.2. 3. Submit the simulation report that shows the radiant temperature asymmetry, vertical air temperature and floor surface temperature in accordance with ECSBC Clause 11.3.2. Design stage evaluation • Verify the HVAC DPR that illustrates the humidity control in accordance with ECSBC Clause 11.3.2. • Verify the simulation report that clearly shows the integration of relative humidity control as indicated in ECSBC Clause 11.3.2. • Verify the report that meets the criteria of temperature difference between radiant temperature asymmetry, vertical air temperature, and floor surface temperature in accordance with Table 11.3 of ECSBC. Construction stage evaluation • Verify the installed humidity control through site visit and photographs. • Verify the relative humidity control in accordance with ECSBC Clause 11.3.2 through the site visit, documentary evidence such as photographs, videos. • Verify the temperature difference between the radiant temperature asymmetry, vertical air temperature and floor surface temperature comes under the threshold mentioned in Table 11.3 through site visit measurement, recording and photographs. Occupancy stage evaluation • Verify the submitted documents at the design stage • Verify the submitted documents prior to the construction stage in accordance with ECSBC Clause 11.3.2. • 3. Verify that the submitted documents meet the criteria of Table 11.3, which were submitted during the design stage.
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11.3.1-(a)	CO ₂ source control	Indicate source control of CO ₂ as per Section 11.3.1-(a)	1. Submit the document demonstrating CO₂ control as Clause 11.3.1-(a) and maintain and monitor the ventilation rate and comfort level in accordance with Chapter 6, Section 6.2.1. (C) of ECSBC. Design stage evaluation - Verify the DPR that shows the CO₂ control, and maintain, regulate, and monitor the ventilation rate and comfort level in accordance with ECSBC Clause 11.3.1. (a) Construction stage evaluation - Verify the CO₂ control and provisions to maintain, regulate and monitor the ventilation rate and comfort level through site visit, measurement, and photographs. Occupancy stage evaluation - Verify the submitted document prior to the construction stage
11.3.1-(b)	VOC source control	Indicate the source control of volatile organic compounds (VOCs) and aldehydes emissions through compliance with listed standards Minimum requirement	1. Submitted the DPR with technical specification/ Lab report demonstrating the VOC control as per the ECSBC requirement of Clause 11.3.1-(b) Design stage evaluation - Verify the DPR/material specifications and manufacturer certificates demonstrating compliance with approved low-VOC and low-aldehyde emission standards. Construction stage evaluation - Verify VOC and aldehyde source control through site visit by checking installed material labels, supporting TDS/certificates, purchase invoices, and photographs. Occupancy stage evaluation - Verify the submitted document prior to the construction stage.

11.3.3	Visual comfort	Indicate confirmation with the requirement for ECSBC and Super ECSBC buildings	1. Submit the simulation report/calculations that confirm the required illuminance and visual comfort meet the criteria of ECSBC Clause 11.3.3. Design stage evaluation - Verify the lighting simulation report/calculations and layout drawings, confirming that the required illuminance levels and visual comfort criteria as per ECSBC Clause 11.3.3. Construction stage evaluation Construction stage evaluation - Verify through site visit, measurement and photographs that the installed lighting system matches the approved design and maintains visual comfort as per ECSBC Clause 11.3.3. Occupancy stage evaluation - Verify that the submitted documents and the illuminance level prior to the construction stage comply with ECSBC Clause 11.3.3.
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Chapter 12 presents the whole-building performance methodology used under the integrative compliance method. It defines how annual energy consumption of the proposed design is compared with a standardized baseline building to determine compliance. The chapter elaborates on metrics such as modelled energy performance intensity (MEPI) and percentage energy savings (PES), and sets the minimum PES thresholds required for ECSBC compliant, ECSBC+, and Super ECSBC levels. It further details the modelling rules, simulation tools, schedules, climatic data, and assumptions required to ensure uniformity, reliability, and verifiability of performance assessments across projects. There is no separate compliance form in Annexure for whole building performance in ECSBC as Compliance requirement are detailed out in section 3 Approach to compliance of ECSBC code in detail. Following minimum documentation is required for the review of whole building's performance.

- Summary describing the results of the analysis, including the annual energy use for the Proposed Design and the Baseline design, and software used.
- Brief description of the project with location, number of stories, space types, conditioned and unconditioned areas, hours of operation.
- List of the energy-related building features of the Proposed Design. This list shall also document features different from the Baseline design.
- List showing compliance with the mandatory requirements of this code.
- The input and output report(s) from the simulation program including a break up of energy usage by all the following components: lighting, internal equipment loads, service water heating equipment, space heating equipment, space cooling and heat rejection equipment, fans, and other HVAC equipment (such as pumps). The output reports shall also show the number of hours any loads which are not met by the HVAC system for both the Proposed Design and Baseline design.

6. Explanation of any significant modeling assumptions made.
7. Explanation of any error messages noted in the simulation program output.
8. Building floor plans, building elevations, and site plan.



Questions

Section A: Objective Questions (MCQs) – 10 Nos

1. **According to the ECSBC 2024 compliance framework, what are the two primary methodologies available for demonstrating conformity with the Code?**
 - A) The voluntary labeling scheme and the mandatory audit method
 - B) The thermal analysis method and the mechanical efficiency method
 - C) The integrative compliance method (ICM) and the standardized compliance method (SCM)
 - D) The renewable energy offset method and the grid-connected assessment
2. **When utilizing the Integrative Compliance Method (ICM), which specific metric must be determined through whole-building performance simulation?**
 - A) Specific Fuel Consumption (SFC)
 - B) Lighting Power Density (LPD)
 - C) Carbon Credit Multiplier (CCM)
 - D) Modelled Energy Performance Intensity (MEPI)
3. **Which compliance approach is characterized by adopting prescriptive, component-level requirements that building systems must meet to ensure conformity?**
 - A) Integrative Compliance Method (ICM)
 - B) Standardized Compliance Method (SCM)
 - C) Building Envelope Trade-off Method
 - D) Whole Building Performance Simulation
4. **Which specific performance-based compliance pathway allows a building to meet code requirements if individual envelope components (such as specific walls or windows) do not meet prescriptive limits, provided the overall envelope performance matches or exceeds the baseline?**
 - A) HVAC System Efficiency Alternate Approach
 - B) Total System Efficiency Alternate Compliance
 - C) Building Envelope Trade-off Method
 - D) Modelled Energy Performance Intensity Simulation
5. **For an existing building undergoing additions or alterations that result in a connected load of 100 kW or above, how may compliance with the Code be demonstrated?**
 - A) Existing buildings are entirely exempt from compliance regardless of load changes.
 - B) Only the new addition is permitted to be evaluated for code compliance.
 - C) The addition alone must comply, or the addition together with the entire existing building must comply as if it were a new building.
 - D) Compliance is only required if the building changes its occupancy classification to healthcare.
6. **Which specific organizational initiative has the Bureau of Energy Efficiency (BEE) undertaken in states and union territories to facilitate the effective rollout of the building energy codes?**
 - A) Establishing local "Building Cells" to support technical capacity and code adoption.
 - B) Creating a national task force for the direct manufacturing of energy-efficient windows.
 - C) Launching a mandatory insurance program for all energy-efficient construction projects.
 - D) Implementing a centralized water distribution network for all commercial complexes.
7. **Regarding topsoil preservation, which specific document is required at the design stage to confirm the quality of the soil being preserved?**
 - A) construction waste management plan
 - B) A fertility test report of topsoil from an Indian Council of Agricultural Research (ICAR)-accredited laboratory.
 - C) Date-stamped photographs documenting top-soil stripping measures.
 - D) As-built site layout drawings consistent with the approved site plan.

7. **During the design stage evaluation for opaque construction thermal performance , what must be verified to ensure code compliance?**
 - A) That installed materials match invoices and test reports through site inspection.
 - B) Submission of as-built envelope documentation confirmed at the occupancy stage.
 - C) That opaque envelope assemblies and corresponding U-factor values are defined using ISO-6946 or ECSBC Appendix A defaults.
 - D) The manufacturer's labels and site photographs confirming the final SRI values.
8. **According to the construction stage evaluation for timeclock controls, what is a primary responsibility of the evaluator?**
 - A) To prepare the initial HVAC control strategy and sequence of operations.
 - B) To verify actual implementation through review of installed models and on-site photos confirming night setback and 2-hour manual override functionality.
 - C) To submit commissioning and functional testing reports demonstrating the system is operational.
 - D) To verify that the design basis report (DBR) includes space cooling load calculations.
9. **What is required during the occupancy stage evaluation regarding thermal comfort?**
 - A) Verification of the Design Basis Report (DBR) specifying air filter filtration classes.
 - B) Submitting initial simulation files and details of the thermal comfort model used.
 - C) Verification of the systems installed as per DBR , and material specifications meet the prescribed values as per design document.
 - D) Site visit measurements confirming indoor operative temperature within limits prior to issuance of OC. .
 - D) It removed the requirement for residential building compliance.
10. **Which set of documents is required at the design stage to support the compliance evaluation for voltage drop ?**
 - A) As-built drawings and updated cable schedules reflecting actual routing.
 - B) Measurement records confirming acceptable voltage levels at design load conditions.
 - C) Approved electrical drawings/SLDs indicating routing and cable sizes, plus an electrical DBR highlighting design criteria and assumptions.
 - D) Clear photographs showing installed transformers and nameplates.

Section B: Short Answer Questions – 5 Nos

1. What are the three progressive performance levels defined under the ECSBC 2024 framework?
2. Which two primary methodologies are available for demonstrating a building's conformity with the ECSBC?
3. What are the statutory load and demand thresholds for a commercial building to fall under the purview of ECSBC 2024?
4. Briefly explain the purpose of the "Building Envelope Trade-off Method."
5. How must compliance be demonstrated for an existing building undergoing additions or alterations that result in a connected load of 100 kW or above?

Section C: Long Answer Questions – 2 Nos

1. Compare and contrast the Integrative Compliance Method (ICM) and the Standardized Compliance Method (SCM) as defined in the ECSBC 2024.
2. Describe the systematic evaluation process for ECSBC compliance across the different stages of building development, citing specific documentation required.

Answer Key for MCQs

1. B	6. B
2. D	7. C
3. B	8. B
4. C	9. C
5. C	10. C



6. CODE COMPLIANCE FOR RESIDENTIAL BUILDINGS (ENS 2024)

The ECSBC- Residential also known as Eco Niwas Samhita (ENS)–2024 is India's national energy conservation building code for residential buildings, notified under the provisions of the Energy Conservation Act, 2001 and administered by BEE under the Ministry of Power. It provides a comprehensive regulatory framework to ensure energy-efficient design, construction, and operation of residential buildings in India.

6.1. Scope and Applicability

The ENS-2024 is a consolidated energy conservation and sustainable building code for residential buildings. The ENS–2024 derives statutory authority from Section 14 of the Energy Conservation Act, 2001, which empowers Central and state governments to notify and enforce energy conservation measures for buildings. It applies to:

Clause (c)(ii) and (iii) of Section 2 of the Energy Conservation Act, 2001 defines a 'building' as one having a connected load of 100 kW or more or a contract demand of 120 kVA or more, and which is intended to be used for commercial, office, or residential purposes.

6.2. Definition of Residential Building

For the purposes of ENS-2024, residential buildings are defined in accordance with the National Building Code (NBC) 2016, and include:

- **Private residences** accommodating one or two families, with sleeping accommodation for not more than 20 persons.
- **Apartment buildings/group housing projects** accommodating three or more families living independently of one another, with independent cooking facilities.
- **Mixed-use buildings**, wherein residential and commercial occupancies coexist within the same structure, provided that compliance is demonstrated separately for each classification.

6.3. Mixed-use Buildings – Compliance Criteria

In the case of mixed-use buildings, compliance shall be determined as follows:

Where one occupancy classification (residential or commercial) constitutes less than 10% of the total above-grade floor area, the entire building shall demonstrate compliance based on the classification having the higher proportion of floor area.

Where one or more building-use classifications constitute more than 10% of the total above-grade floor area, each such classification shall independently demonstrate compliance with the code applicable to that occupancy type.

Basements and common service areas designed for a particular building use, or documented as such before the authority having jurisdiction, shall comply with the relevant code provisions applicable to that occupancy.

6.4. Exclusions

Although defined as residential occupancies under NBC, the following building categories are excluded from the scope of ENS-2024 and shall be treated as commercial buildings for compliance purposes:

- Lodging and rooming houses
- Dormitories

- Hotels and similar accommodation facilities

Such buildings shall be governed by the applicable provisions of the ECSBC.

The Eco-Niwas Samhita (ENS) 2024 is structured to provide a coherent regulatory framework for energy-efficient and sustainable residential buildings. The Code is organized into thematic chapters that collectively address planning, design, construction, and operation of residential buildings.

Chapters 1 to 3 define the 'legal and administrative framework' of the Code. These chapters establish the background, objectives, and scope of ENS-2024, specify the types of buildings covered, define compliance requirements, and introduce the three-tier compliance approach—ENS, ENS+, and Super ENS. They also set out the applicability thresholds, interpretation rules, and overall methodology for adoption and enforcement by authorities having jurisdiction.

Chapters 4 to 8 define the 'technical and performance requirements' of the Code. These chapters prescribe both mandatory provisions and voluntary incremental measures across five key sustainability domains.

6.5. ENS compliance

To qualify as ENS-compliant, a building is required to meet only the minimum mandatory provisions prescribed in Chapters 4 to 8 of the Code. There is no requirement to achieve any incremental or weighted points for ENS certification. Compliance is assessed strictly on a pass/fail basis against the mandatory clauses related to site planning, energy efficiency, water conservation, waste management, and indoor environmental quality. A building that fulfils all mandatory requirements is declared ENS-compliant, irrespective of performance beyond the baseline.

The point-based evaluation framework becomes applicable only when a project seeks classification under ENS+ or Super ENS. In such cases, the building must first satisfy all mandatory provisions and then additionally achieve minimum prescribed percentages of incremental points under each applicable chapter in order to qualify for higher-performance levels.

6.6. Structure of the point-based system (for ENS+ and Super ENS)

The Code provides incremental provisions to demonstrate enhanced compliance; ENS + and Super ENS as per Table 1.

Table 12 Points required to achieve ENS+ and Super ENS compliance

Project category	ENS+	Super ENS
All residential buildings	30% of the total points applicable in each section (4.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 6.3, 7.3, 8.3)	50% of all the total points applicable in each section (4.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 6.3, 7.3, 8.3)

A summary of the incremental points available in each chapter is given in Table 2.

Table 13 Maximum incremental points in each chapter

Section	Provisions	Maximum incremental points available	Compliance for ENS+ (30% of maximum incremental points available)	Compliance for Super ENS (50% of maximum incremental points available)
4.3	Sustainable site management	30	9	15
4.3.1	Landscaping	16		
4.3.2	Mitigation of urban heat island	14		
5.3.1	Building envelope	40	12	20
5.3.1.1	Roof	4		
5.3.1.2 / 5.3.1.3	Building envelope (except roof)	36		
5.3.2	Building services design	28	8	14
5.3.2.1	Common area and exterior lighting	6		
5.3.2.2	Elevators	9	9	15
5.3.2.3	Pumps	8	9	15
5.3.2.4	Electrical systems	5	9	15
5.3.3	Indoor electrical End-use	42	13	21
5.3.3.1	Indoor lighting	8		
5.3.3.2	Comfort systems	34		
5.3.4	Renewable energy systems	10	3	5
5.3.4.1	Solar water heating	5		
5.3.4.2	Solar photovoltaic	5		
6.3	Water conservation and management	43	13	22
6.3.1	Site water-use reduction	17		

Section	Provisions	Maximum incremental points available	Compliance for ENS+ (30% of maximum incremental points available)	Compliance for Super ENS (50% of maximum incremental points available)
6.3.2	Building water-use reduction	26		
7.3	Waste management	7	2	4
7.3.1	Construction waste management	2		
7.3.2	Post-construction waste management	5		
8.3	Indoor environmental quality (IEQ)	10	3	5
8.3.1	Cross-ventilation	4		
8.3.2	Daylight availability (useful daylight)	4		
5.3.2.1	Common area and exterior lighting	6		
8.3.3	Air quality in car parking (CO sensor)	2	9	15

Compliance Levels under ENS 2024

ENS 2024 defines the following three levels of performance:

ENS (Base Compliance)

ENS is the minimum mandatory compliance level. Buildings must comply with all mandatory provisions prescribed in Chapters 4 to 8 of this code.

ENS compliance does not require fulfillment of any incremental point criteria.

ENS+ (Enhanced Compliance)

ENS+ represents enhanced performance and is achieved when:

- All mandatory provisions are complied with.
- A minimum of 30% of the available incremental points in each chapter are achieved.

Super ENS (Advanced Compliance)

Super ENS represents the highest level of performance and is achieved when:

- All mandatory provisions are complied with.
- A minimum of 50% of the available incremental points in each chapter are achieved.

The building project can demonstrate compliance using the software/toolkit that has been approved by the BEE or authority having jurisdiction and submit the following list of documents to

show compliance with the Code. The Code recommends following set of documentation to be provided for showing compliance to requirements of the ENS 2024.

Mapping of compliance requirements as per document requirements provided in Annexure 1 of ENS 2024

Table 14 Compliance requirements as per Sustainable site management

1. Sustainable site management		
1a	Site plan highlighted trees (existing mature trees, preserved trees, transplanted, removed), along with highlighting topsoil excavation and topsoil storage and preservation area with volume.	Detailed documentation required 1) Submit a site plan in .dwg format highlighting areas of excavation and topsoil preservation. 2) Submit calculations indicating the total quantity of topsoil preserved and reused in landscape activity. 3) Submit date-stamped photographs documenting topsoil stripping, storage, protection, and reuse measures. 4) Submit site survey plan and landscape plan clearly indicating existing trees proposed for preservation, transplantation, and removal, along with locations of new plantations. 5) Submit official permission letter from the competent local authority approving tree cutting on site. 6) Submit detailed calculations specifying the number of existing trees preserved and the number of new trees planted, in compliance with ENS requirements. 7) Submit date-stamped photographs documenting protection of existing trees, transplantation or cutting activities (where permitted), and on-site plantation of new trees. ENS clause 4.2.1.1 Ensure to protect or preserve existing mature trees naturally or as per guidelines of the local bye-laws/authority, whichever is more stringent. Else, in compliance with the Model Building Bye-laws, compensatory plantation for felled/transplanted trees in the ratio 1:3 within the premises under consideration must be ensured. Design stage Check number of trees on site and verify with the information provided by the project team. • Check availability of permission letter for trees to be removed or transplanted in the project. • Check calculation of topsoil volume to be preserved on site. Construction stage • Verify the protected, cut, and transplanted trees on site • Verify preserved soil on site Post-construction stage • Verify the preserved and new trees planted on site are as per the design documents.

1b.	Fertility report of soil from a certified lab.	Detailed documentation required 1) Submit a fertility test report of topsoil from an ICAR-accredited laboratory indicating soil fertility. ENS Clause 4.2.1.2 Preservation of fertile topsoil a) Fertile topsoil up to 150–200 mm (6–8 inches) must be preserved, stabilized, and its fertility must be maintained. b) The stored topsoil shall be used as finished grade for planting areas within the site or outside. In case the stored topsoil is not being used within the site, proper reuse of the soil must be ensured. Design stage Review the fertility test report and identify the deficiency if any, review what measures the project has proposed for maintaining the soil fertility. Construction stage Review the storage condition of the soil on site for contamination during construction. Post-construction stage If any deficiency is identified in the soil fertility report, check how the quality is enhanced to meet the landscaping requirements.
1c.	Survey-plan highlighted existing features of the site like existing water bodies, power or communication lines, sewerage lines.	Detailed documentation required Survey-plan highlighted existing features on site ENS Clause 4.2.1.3 In compliance with Model Building Bye-laws construction shall not hinder existing water bodies, power or communication lines, sewerage line. Design stage • Verify the survey plan on site along with existing features. • Review the design document in compliance for Model Building Bye-laws for any development happening against the prescribed guidelines for water bodies, power or communication lines , sewerage lines, etc. as per the state/ urban local bodies' (ULBs) norms. Construction stage Carry out review of construction works as per the proposed plans, the construction work should not be conflicting with the existing site features. Post-construction stage Check and verify that development on site does not hinder existing features of site as per state/ ULBs norms.
1d.	Accessibility plan highlighted measures (ramps with handrails on entrances and grade change, tactile guiding system, easily accessible play	Detailed Documentation required 1) Submit architectural drawings clearly indicating ramps, entrance gates, elevators, and washrooms designed for differently abled persons. 2) Compliance with the universal accessibility as per chapter 8 of Model Building Bye-laws and/or local bye-laws, including dimensions, slopes, clearances, handrails, signage, and turning radii.

	areas, etc.) to ensure universal accessibility including features for differently abled, children, and elderly.	3) Submit as-built drawings reflecting the implemented accessibility provisions. 4) Submit date-stamped photographs confirming the construction, continuity, and usability of ramps, accessible entrances, elevators, and washrooms. ENS Clause 4.2.2.1 Universal accessibility in accordance with Chapter 8 of the Model Building Bye-laws Design stage Check the compliance of architectural drawings as per Chapter 8 of Model Building Bye-laws or ULB norms as applicable. Construction stage Review the compliance of design document on site during construction e.g. provision for ramps, handrails. Post-construction stage Review the compliance of design document on site post-construction for ramps with handrails on entrances and grade change, tactile guiding system, easily accessible play areas, etc.
1e.	Landscape plan highlighted the following: Plant/tree schedule for all vegetated species being planted along with measures taken to preserve local biodiversity and ecology. All type of finishes used on site with legend. Waterbodies/ water features, Vegetated areas, paved areas, building footprint.	Detailed documentation required 1) Site survey plan showing natural features and landscape plan showing turf areas, pavers, pathways, vegetation on site segregated in native and adoptive vegetation species. The drawing should include the area statement highlighting the above. ENS Clause 4.2.3.1 (4.3.1.1) Minimum disturbance to the topography and gradient of site by retaining natural features. Mandatory 20%, 6 incremental points for 30%, 8 incremental points for 40%. ENS Clause 4.2.3.2 (4.3.3.2) If turf grass is to be used for landscaping, it should not be planted on more than 30% mandatory, 2 incremental points for 20%, and 4 incremental points 15% of the landscape area. ENS Clause 4.2.3.3 (4.3.3.3) The landscaped area to be planted with native/adoptive species of plants /trees 30% (mandatory) of landscaped area, 40% for 2 incremental points, 50% for 4 incremental points. ENS Clause 4.2.4.1(4.3.2.1) For mitigating urban heat, limit the paved area under parking, road, path, or any other use to 25% of site area (mandatory) 20% for 4 incremental point, 15% for 6 incremental points. ENS Clause 4.2.4.2 (4.3.2.2) Pervious paving/grass pavers/open grid pavers for 50% of total paved area (mandatory), 60% for 5 incremental points, 70 % for 8 incremental points. Design stage Review the area statement for landscape features as per the ENS requirement for mandatory and incremental points. Construction stage - Review the design drawings with onsite development of landscape during construction. Post-construction stage - Review the design drawings with onsite development of landscape post construction and match with the area statement provided at design stage.

• Table 15 Compliance requirements as per Envelope and electro-mechanical and renewable energy

2 Envelope and electro-mechanical and renewable energy system		
2a	Construction drawings and specifications shall show all pertinent data and features of the building, equipment, and systems in sufficient detail to permit the authority to have jurisdiction to verify that the building complies with the requirements of this code	Detailed documentation list building envelope 1. Submit the site plan, master plan, building floor plans, elevations, sections, fenestrations in (.dwg format). 2. Provide the specification sheet (or cut sheet) from manufacturers for materials/products/installed fixtures along with copy of purchase invoice/BOQ/tender documents. 3. Submit the site plan, master plan, building floor plans, elevations, sections, fenestrations schedule (in .dwg format). 4. Submit the wholistic list of all opaque construction materials (walls, roofs) used in the construction and their thermal properties including thermal conductivity, specific heat, density along with thickness. 5. Submit the photographs of all the opaque construction materials (walls, roofs). 6. Submit the wholistic list all the fenestration materials (windows and skylights) used in the construction and their U-factors, solar heat gain coefficients (SHGC), visible light transmittance (VLT). 7. Submit the photographs of all the fenestration materials (windows and skylights). 8. Submit the design of the shading devices such as overhangs and side fins along with the operable window area calculation.
2b	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.	ENS 5.2.1 (5.3.1) Building envelope ENS Clause 5.2.1.1 Openable window to floor area ratio to comply with minimum requirement specified for project climatic zone in Table 8 of ENS 2024, calculations of window to floor area ratio is specified Chapter 9, Section 9.1. ENS Clause 5.2.1.2 Visible light transmission is specified for different categories of window to wall ratio (WWR) the project shall comply with the requirements mentioned in Table 9 of ENS 2024, the calculation of WWR is specified in Chapter 9, Section 9.2. ENS Clause 5.2.1.3 (5.3.1.1) Thermal Transmittance of Roof shall be as per Table 14 of ENS 2024 (up to 4 incremental points are available). ENS Clause 5.2.1.4 Residential envelope transmittance value (RETV) of building envelope (except roof) shall comply with Maximum RETV of 15 W/m^2, the calculations are provided in Chapter 9, Section 9.5 for incremental points for RETV (except roof) shall be as per Table 15 of ENS 2024 (up to 36 incremental points are available). ENS Clause 5.2.1.5 Thermal transmittance of roof (cold climate) shall comply with maximum roof U-value of $1.8 \text{ W/m}^2\text{K}$, the calculations are provided in Chapter 9, Section 9.7 for incremental points for RETV (except roof) shall be as per Table 16 of ENS 2024 (up to 36 points are available). Design stage • Review the design documents and calculations for WFR and WWR are done as per ENS 2024.

		- Check the calculations of U-values roof and RETV calculation is as per ENS 2024 for the respective climate zone of the project. The document shall provide layer by layer construction details of each component of building envelope along with reference of thermo-physical properties from Table 46 or test certificate from NABL accredited lab. Construction stage - Check the specification of building components (roof wall and windows) as implemented on the site shall be as per the design document. - Check the WFR and WWR and RETV is consistent with the document submitted at design stage Occupancy stage - Check and confirm the specification of final building component and calculation of WFR, WWR, RETV, VLT shall be as per the calculation provided at the design stage. Detailed documentation list building services - MEP design basis report mentioning details of power factor correction, energy monitoring of services, different end uses, electricity generation, electricity vehicle charging system, electric systems, common area lighting of outdoors and indoors, elevators, pumps, and other electrical systems such as transformers, renewable energy systems as per ENS 2024. - Artificial lighting design drawings including details of luminaire lamps and ballast details, and lighting power density calculations for interiors and exterior lighting; basement and parking areas. - Design specification of elevators along with cutsheets for motors used in elevators and commissioning documents of Elevators installed in the project. - MEP DBR to include pump specification mentioning efficiency/BEE star label. - MEP DBR to include transformer specification mentioning losses at 50% and 100% /BEE star label. - MEP DBR to include specification of ceiling fan and air conditioning system as per BEE standards and labelling programme. - MEP DBR to include design requirement for the renewable energy systems planned to be installed in the project. Area statement for provision of renewable energy system in the project on the site plan, design documents of renewable energy systems. - Design documents for building services installed in the project. - Commissioning documents for building services installed in the project. ENS 5.2.2 (5.3.2) Building services Electrical system ENS Clause 5.2.2.1 Power factor correction as per ENS ENS Clause 5.2.2.2 Energy monitoring A) Residential buildings exceeding the threshold defined as per Section 2.2 of this code shall monitor the total electrical energy use for each of the following sections separately:
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		a) Services: Services above 65 kVA to have submetering with provision of half hourly monitoring of demand (kW/kVA), energy (kWh/kVAh), and total power factor (or kVARh); services less than 65 kVA shall have permanently installed electrical metering to record energy (kWh) on hourly basis. b) Energy consumption of following applicable end uses: i) common area lighting (outdoor lighting, corridor lighting, basement lighting), ii) elevator, iii) water pump, iv) basement car parking ventilation, and v. lift pressurization system as per project applicability. c) Provision of monitoring of energy generation from power backup and or renewable energy system as per project applicability. B) Provision of energy metering at building mains, the electrical energy use shall be recorded at a minimum interval of 15 minutes and reported at least on an hourly, daily, monthly, and annual basis. The monitoring equipment shall 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 period of 36 months. a) At building mains, installed meters shall monitor energy use (kWh, kVARh, kVAh), energy demand (kW/ kVA), THD (V and I). The metering shall also be displaying current (in each phase and the neutral), voltage (between phases and between each phase and neutral). ENS Clause 5.2.2.3 If an electric vehicle charging infrastructure is installed on the premises, it shall be as per revised guidelines issued by the Ministry of Power for Charging Infrastructure for Electric Vehicles (EV) on 17th September 2024, or any subsequent amendments. ENS Clause 5.2.2.4 Electric system: a) The power cabling shall be sized so that the distribution losses does not exceed 3%, a record of design calculation with possible effect of harmonics shall be maintained. b) Voltage drop for feeders shall not exceed 2% at design load. Voltage drop for branch circuit shall not exceed 3% at design load. c) The conductor used for fixed wiring shall be of class 2 as per IS 8130. Design stage Review the MEP DBR and other design documents for the inclusion for requirements of ENS 2024 for • Power factor correction • Energy monitoring • Electric vehicle charging infrastructure • Electrical (cabling) systems Construction stage Check the provisions for power factor correction, energy monitoring, electric vehicle charging infrastructure, electrical (cabling) systems are made in the design document are implemented on site.
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		Occupancy stage • Power factor correction: check the power factor in the utility bill and meter/ submeter installed on site. • Energy monitoring: Check the provision of submetering requirement of ENS 2024 are met. • Electric vehicle charging infrastructure: Check the provisions of EV charging infrastructure are as per guidelines issued by the Ministry of Power. • Electrical (cabling) systems: Check if the cable sizing and technical specifications are as per prescribed ENS requirement. Lighting ENS Clause 5.2.2.5 Common area and external lighting LPD and luminous efficacy to meet requirement of Tables 10 and 11 of ENS 2024 as detailed below. Common area lighting: Corridor Lighting: Maximum allowable LPD 3W/m^2 and permanently installed lighting fixtures shall use lamps with minimum luminous efficacy of 95lm/watt. Basement and stilt car parking: Maximum allowable LPD 1W/m^2 and permanently installed lighting fixtures shall use lamps with minimum luminous efficacy of 95lm/watt. Exterior lighting (applicable if exterior lighting greater than 100 W) the permanent lighting shall use lamps with luminous efficacy at least 95lm/watt or meet LPD requirement given in Table 11 of ENS 2024. ENS Clause 5.3.2.1 A) The Following incremental points are available if all the installed lamps are having 105lm/watt with lumen depreciation $>L70B10$ for 50000 hrs Corridor and stilt parking – 1 point Basement lighting – 1 point Exterior lighting areas- 1 point ENS Clause 5.3.2.1 B) The Following incremental points are available if all the installed lamps are having 115lm/watt with lumen depreciation $>L80B10$ for 50000 hrs and controlled by astronomical switch for exterior lighting. Corridor and stilt parking – 2 points Basement lighting – 2 points Exterior lighting areas – 12 points Design stage • Check design basis report and design document has the lighting power densities, and luminous efficacies of the spaces are as per the ENS requirements. • Check the illumination requirements for artificial lighting design as per the National Building Code. Construction stage • Check the installation of lighting fixtures is as per the lighting design and same lighting fixtures and lamps are used as described in the design documents.
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		Occupancy stage - Check the illumination requirements are as per design basis reports/National Building Code. ENS Clause 5.2.2.6 Elevators (if applicable) Elevators installed in the building shall meet all the following requirements of ENS 2024: - Install high-efficacy lamps for lift car lighting having a minimum luminous efficacy of 95 lm/W. - Install automatic switch-off controls for lighting and fan inside the lift car when are not occupied. - Install minimum class IE 3 high-efficiency motors. - Group automatic operation of two or more elevators coordinated by supervisory control. ENS Clause 5.3.2.2 Elevator incremental points (maximum 9) are available for - Installing variable voltage variable frequency drives – 4 points - Installing regenerative drives – 3 points - Installing IE4 motors – 2 points Design stage - Check the specification of elevator for the ENS requirements. Construction stage - Check elevators commissioning document for ENS requirements. Occupancy stage - Check for elevators measures mentioned in ENS are functional in the operation stage. ENS Clause 5.2.2.7 Pumps Pumps that are either hydro-pneumatic having a minimum overall pump efficiency of 60% or BEE 4-star rated shall be installed in the building. ENS Clause 5.3.2.3 Pump incremental points (maximum 8) are available for: - Installation of BEE 5 star-rated pumps – 5 points - Installation of hydro-pneumatic system for water pumping having minimum overall pump efficiency of 70% – 3 points Design stage - Check the specification of pump for the ENS requirements/BEE 4 star-rated pump requirement in the design documents. Construction stage - Check nameplate data of pump to show efficiency/BEE 4 star rating. Occupancy stage - Check nameplate data of pump to show efficiency/BEE 4 star rating.
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		ENS Clause 5.2.2.8 Electrical system (power transformers) (if applicable) A. Power transformers with a minimum efficiency as per ENS 2024 at 50% and full load rating shall be installed for dry type and oil-type transformer. The permissible loss shall not exceed the values listed in Table 12 for dry-type transformers and the BEE 4-star rating in Table 13 for mineral oil-type transformers or ester oil-type transformer. B. All measurements 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 the capacity of 500 kVA and above would be equipped with additional metering class current transformers (CTs) and potential transformers (PTs) in addition to the requirements of utilities so that periodic loss monitoring studies may be carried out. ENS Clause 5.3.2.4. Electrical system incremental points (maximum 5) are available for: Providing all oil-type transformer with BEE 5-star rating – 5 points. Design stage Check the DBR/design specification of transformer for the ENS requirements of losses at 50% and 100% loading / BEE 4 star rated pump requirement in the design documents. Construction stage - Check nameplate data of transformer as per DBR/BEE 4 star rating. Occupancy stage - Check nameplate data of transformer as per DBR/BEE 4 star rating. ENS 5.2.3 Indoor electrical end use ENS Clause 5.2.3.1 Indoor lighting: All the lighting fixtures shall have lamps with a luminous efficacy of a minimum of 95 lm/W installed in all the locations. ENS Clause 5.3.3.1 For internal lighting fixture incremental points (maximum 8) are available for: - Lamp lumen efficacy >105 Lm/W with lumen depreciation > L70B10 for 50000 hrs – 3 points - Lamp lumen efficacy >115 Lm/W with lumen depreciation > L80B10 for 50000 hrs – 8 points ENS Clause 5.2.3.2 Comfort system A) Ceiling Fan A) Ceiling fans: All ceiling fans installed in all the spaces in all the dwelling units shall have a minimum of BEE 3 star for all sweep sizes. ENS Clause 5.3.3.2 A) Incremental points (1 point) are available for using BEE 4 star-rated fans and (4 points) for using BEE 5 star-rated fans. ENS Clause 5.2.3.2 Comfort system B) Air Conditioner B) Air conditioner: All the air conditioners in all the dwelling units (either unitary, split, VRF, or centralized plant) shall have the following specifications and shall meet or exceed
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		the minimum efficiency requirements under BEE Standards and Labelling Programme as and when updated by BEE. • Unitary type: 5 stars • Split AC: 3 stars • VRF: 3.28 EER, or 4.36 IEER11 (BEE Standards and Labelling requirements of 3 stars for VRF shall take precedence over the current minimum requirement) • Chiller: 3 stars ENS Clause 5.3.3.2 B. Air conditioners (either unitary, split, VRF or centralized plant) installed in all the bedrooms in all the dwelling units, shall comply with requirements as per Table 24 and shall meet or exceed the minimum efficiency requirements under BEE Standards and Labelling Programme as and when updated by BEE. 9 incremental points are available for split AC – 4 stars, VRF system of 3.6 (or BEE 4 stars) and chiller 4 stars. 30 incremental points are available for split AC – 5 stars, VRF system of 3.8 (or BEE 5 stars) and chiller 5 stars. In case, the air conditioners installed are of mixed types, the points shall be calculated based on the following formula: $\text{Points achieved for AC} = \frac{\sum (\text{Installed tonnage of particular system} \times \text{points claimed as per Energy efficiency level})}{\sum \text{Total tonnage installed in the dwelling unit}}$ Design stage • Check the DBR/design specification of ceiling fan and air conditioner for the ENS requirements. Construction stage • Check nameplate data of transformer as per DBR / BEE star labelling. Occupancy stage • Check nameplate data of transformer as per DBR/BEE star labelling as per ENS. ENS 5.2.4 Renewable energy system: The renewable energy systems, solar water heating as per Section 5.2.4.1 or solar photovoltaic as per Section 5.2.4.2 to be installed collectively, or any of them, at the project site as per the total renewable energy installation requirement. ENS Clause 5.2.4.1. Solar water heating: The installed solar water heater shall meet the minimum efficiency level mentioned in IS 13129 Part (1 and 2) and for the 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, and shall comply with requirements as solar water heating system of minimum BEE 3-star label installed in at least 10% of the plot area. ENS Clause 5.2.4.2 Solar photovoltaic: The renewable energy generation zone (REGZ) shall be free of any obstructions within its boundaries and from shadows cast by objects adjacent to the zone. It must adhere to the installation standards of solar photovoltaic systems and meet the requirements for a minimum BEE 3-star label.
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		It shall comply with the requirements of installing solar photovoltaic: equivalent to at least 10% of the plot area. ENS 5.3.4. Incremental points are available if the above system are provided for 13% plot area – 4 points 16% of plot area – 10 points. Design stage • Check the installation area of renewable energy system is minimum 10% as per ENS document. • Check the DBR/design specification of ceiling fan and air conditioner for the ENS requirements for BEE star labelling. Construction stage • Check nameplate data of transformer as per DBR/BEE star labelling. Occupancy stage Check nameplate data of transformer as per DBR / BEE star labelling as per ENS.
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Table 16 Compliance requirements as per Water conservation

3. Water conservation		
3a.	Landscape irrigation layout highlighted areas with different type of irrigation system and efficiency	ENS 6.2.1 Site water-use reduction Details of documents required Landscape plan and irrigation plan with irrigation system layout drawings, clearly identifying planting beds, turf areas, trees and the corresponding irrigation methods adopted. Area statements of each and list of species of shrubs, trees, and grass indicating nativity. Monthly landscape irrigation demand calculations. Irrigation equipment specifications and datasheets, confirming suitability and efficiency of drip and sprinkler systems. As-built drawings and photographs, verifying installation and functional performance of irrigation systems in line with the prescribed requirements. Logbooks of STP operation (inlet and outlet). ENS Clause 6.2.1.1 (6.3.1.1.) Water balance and source allocation statement, evidence that a minimum of 40% of irrigation demand is met through recycled water and/or rainwater harvesting. Incremental points are available 5 points for 60%, and 8 points for 80%. ENS Clause 6.2.1.2 Landscape irrigation demand calculations, demonstrating total irrigation water requirement based on landscaped area and compliance with 8 litres/ m²/day as prescribed by the National Building Code. ENS Clause 6.2.1.3 ((6.3.1.2) Drip irrigation coverage plans, demonstrating that at least 70% of landscaped planting beds are served through drip irrigation systems to minimize evaporation

		losses. Incremental points are available 3 points for 80%, and 5 points for 90%. ENS Clause 6.2.1.4 (6.3.1.3) Sprinkler system layout for turf areas, evidencing that a minimum of 60% of planted turf grass areas is provided with sprinkler irrigation systems. Incremental points are available 2 points for 70%, and 4 points for 80%. Design stage Check the water balance for irrigation demand, and how much of the requirement is met by recycled water/rainwater. Check the landscape plan or irrigation plan for area of trees, plant beds and turf areas and irrigation systems. Also, check area statements should both match, and the total of the area statements should be equal to the site area. Ensure the irrigational demand per sq. m of landscaped area is as per ENS Clause 6.2.1.2. Check area statements and irrigational plan to compute how much of the percentage planted turf grass is irrigated with sprinkler systems. Check area statements and irrigational plan to compute how much of the percentage plant beds is irrigated with drip irrigation. Construction stage Check if the implementation on site is as per the landscape plan/irrigation plan. Check if there is provision for channelizing the recycled water to the landscaped areas like trees, plant beds and turf areas. Occupancy stage Check all the design stage requirements so that there is no discrepancy. Ensure there is a dedicated piped supply or provision to irrigate the landscaped areas. Check the irrigation systems are installed and operated as per ENS requirement.
3b.	Good for construction plan and sections of the building highlighting the plumbing layout along with the dual pipes system, water recycling and reuse provisions	ENS 6.2.5 Recycle and reuse of wastewater Details of document required Area statement and applicability statement indicating the total wastewater generation and non-availability of centralized sewage treatment unit. Water balance indicating wastewater generation and reuse. Design basis report of sewage treatment plant (STP) efficiency, design and capacity calculations, evidencing provision of treatment systems capable of handling grey and black water generated within the premises. Design basis report indicates calculations to be in line with NBC requirements. Plumbing drawings indicating the location and piped connection to and from the STP, as well as dedicated infrastructure like tanks for storing treated wastewater. STP detail drawing Treated wastewater quality test reports, from NABL-accredited laboratories, confirming suitability for intended reuse applications.

		Commissioning certificates, O&M manuals, and operational records, validating effective treatment, reuse, and continued compliance of the on-site wastewater treatment systems. ENS Clause 6.2.5.1 Project area and applicability statement, demonstrating that the residential complex has a plot area of 1.0 lakh sq. ft or more and generates a substantial quantity of wastewater, thereby considering on-site wastewater treatment in the absence of a centralized sewerage system. Wastewater generation and reuse calculations, demonstrating that at least 50% of total wastewater generated is treated, recycled, and reused within the residential complex. ENS Clause 6.2.5.2 STP design drawings and process documentation, confirming compliance with applicable provisions of the National Building Code of India. Separate treated water storage tank drawings and schedules, clearly identifying dedicated tanks for storing treated wastewater. Separate plumbing line drawings, evidencing independent distribution networks for treated water reuse, segregated from potable water systems, in accordance with Section 2 of the National Building Code of India. Design stage Verify project applicability based on plot area and non-availability of centralized sewerage. Check the STP design basis report, process details, capacity calculations, and detail drawings for compliance with NBC provisions. Review the water balance to confirm that at least 50% of total wastewater generated is proposed to be treated, recycled, and reused within the premises. Verify provision of separate treated water storage tanks and independent treated water plumbing lines, segregated from potable water systems. Cross-check all design calculations, drawings, and schedules for consistency. Construction stage Verify installation of the STP as per approved design and specified treatment capacity. Check construction of dedicated treated water storage tanks. Verify installation of separate plumbing lines for treated water reuse and their segregation from potable systems. Confirm physical connections to intended reuse applications such as flushing, irrigation, and other non-potable uses. Review as-built drawings, site photographs, and installation records for conformity with design. Occupancy stage Verify that the STP is commissioned and operational. Review flow records, reuse logs, and operating records to confirm that at least 50% of wastewater generated is treated and reused within the premises. Check treated wastewater quality test reports from NABL-accredited laboratories for suitability of intended reuse applications.
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		Verify continued operation of separate treated water storage and distribution systems. Review O&M manuals, maintenance logs, and commissioning records to confirm sustained compliance.
3c.	Good for construction site plan and building plans highlighting the rainwater harvesting system, storage tanks and recharge provisions	ENS 6.2.4 Rainwater harvesting Details of documents required Local bye-laws/statutory requirement for rainwater harvesting Rainwater harvesting (RWH) design document showing RWH capacity and yield calculations, drawings and layout plans with details, showing recharge of surplus rainwater (including runoff from non-roof areas) after filtration through tube wells, recharge pits, trenches, or other approved techniques. Separate storage tank and pipeline drawings, evidencing dedicated infrastructure for harvested rainwater reuse in households. Rainwater quality monitoring and test reports, from NABL-accredited laboratories, periodic water quality testing records, demonstrating half-yearly (once every six months) testing of stored rainwater as required. Photographic evidence, confirming installation of RWH and groundwater recharge systems as per approved designs. ENS Clause 6.2.4.1 Rainwater harvesting design drawings and layout plans, demonstrating collection, storage, and/or recharge of rainwater in compliance with local bye-laws/ authority guidelines or Model Building Bye-laws, whichever is more stringent. Residential RWH system component drawings and specifications, clearly indicating provision of the following elements: - Roof catchment - Gutters - Downpipes - Rainwater/stormwater drains - Filter chambers - Storage tanks/pit / sumps - Groundwater recharge structures such as pits, trenches, tube wells, or combinations thereof ENS Clause 6.2.4.2 Rainwater harvesting capacity and yield calculations, demonstrating that at least 80% of effective rooftop rainwater (after applying runoff coefficient) is harvested and stored for reuse. Separate storage tank and pipeline drawings, evidencing dedicated infrastructure for harvested rainwater reuse in households, with no interconnection with potable municipal water supply. ENS Clause 6.2.4.3 Rainwater quality monitoring and test reports, from NABL-accredited laboratories, confirming compliance with BIS IS 10500:2012, particularly where harvested rainwater is used for potable purposes. ENS Clause 6.2.4.4 The remaining rainwater harvested including the water falling on non-roof areas, after filtering should be recharged back to groundwater through tube well bore or through any other technique in the premise.

		Design stage Verify the applicable local bye-laws/authority guidelines for RWH and confirm compliance with the more stringent requirement as compared to Model Building Bye-laws. Review the RWH design drawings and layout plans to confirm provision of all required components including catchment, conveyance, filtration, storage, and recharge structures. Check the rainwater yield and capacity calculations to confirm that at least 80% of effective rooftop rainwater is proposed to be harvested and stored for reuse. Verify provision of separate storage tanks and dedicated pipelines for household reuse of harvested rainwater, with no interconnection to potable municipal water supply. Check that the remaining harvested rainwater, including runoff from non-roof areas after filtration, is designed to be recharged to groundwater through suitable recharge structures. Review proposed water quality monitoring provisions, particularly where harvested rainwater is intended for potable use. Construction stage Verify installation of the complete RWH system including catchment, conveyance, filtration, storage, and recharge components in accordance with approved design. Check the construction of dedicated rainwater storage tanks and separate pipelines for harvested rainwater reuse. Verify that recharge structures for remaining rainwater, including filtered runoff from non-roof areas, have been provided as per design. Confirm that harvested rainwater reuse systems are physically segregated from potable municipal water supply. Review as-built drawings, specifications, and photographic evidence for conformity with approved plans. Occupancy stage Verify that the RWH system is operational and functioning for collection, storage, reuse, and recharge. Check rainwater quality test reports from NABL-accredited laboratories and confirm periodic testing at least once every three months, particularly where harvested rainwater is used for potable purposes. Review records demonstrating ongoing use of harvested rainwater through dedicated tanks and pipelines. Verify maintenance of filters, storage tanks, and recharge structures through inspection and O&M records. Confirm continued segregation of harvested rainwater infrastructure from potable municipal water supply.
3d.	Good for construction site plan and building plans highlighting the rainwater harvesting system, storage tanks and recharge provisions	ENS 6.2.2 Building water-use reduction Details of documents required Plumbing fixtures and sanitary ware schedules with make, model, and flow rates, star rating details along with number of fixtures installed in the project

		Manufacturer datasheets and product specifications for all plumbing systems and star rating labels or certification documents (where applicable), substantiating the declared water efficiency performance of faucets and showerheads. Approved plumbing drawings and schedules, correlating specified star-rated sanitary fittings with their installation locations. As-built documentation and photographs, confirming installation of plumbing and sanitary fixtures in line with approved specifications and minimum water efficiency requirements. Mandatory requirements ENS Clause 6.2.2.1 (6.3.2.2) Sanitary fitting schedules, identifying all faucets (taps) and showerheads installed in the project. Shall comply with minimum 1-star rating criteria for water efficiency as prescribed under IS 17650 Part 1:2021 (plumbing fixtures) and IS 17650 Part 2:2021 (sanitary ware), in accordance with Table 26 of ENS 2024 detailing out water consumption and efficiency rating for following plumbing fixture: • Metered faucets for basin use • Wash basin/lavatory faucet (also applies to sensor faucets) • Sink faucet • Overhead shower • Hand held shower • Handheld ablution spray Sanitary ware • Water closet, squatting pan, flushing cistern, and flush valve • Urinal Incremental points are available if the plumbing fittings meet 2-star rating – (5 points) and 3-star rating (8 points)/ and incremental points for sanitary ware with 2-star rating – (5 points) and 3-star rating (8 points). Design stage Review the plumbing fixture and sanitary ware schedules to confirm that all applicable fixtures are identified with make, model, water consumption/flow rate, quantity, and star rating. Verify that all faucets and showerheads comply with at least 1-star rating criteria under IS 17650 Part 1:2021. Verify that all sanitary ware complies with at least 1-star rating criteria under IS 17650 Part 2:2021. Check manufacturer datasheets, product specifications, and star-rating/certification documents to substantiate the declared water-efficiency performance. Cross-check approved plumbing drawings and schedules to ensure that compliant fixtures are specified for all installation locations. Where incremental points are claimed, verify compliance with the relevant 2-star or 3-star criteria. Construction stage Verify on site that the installed plumbing fixtures and sanitary ware match the approved make, model, flow/flush rate, and star rating.
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		Check that the quantity and installation locations correspond to approved plumbing drawings and schedules. Review product labels, procurement records, installation documentation, and site photographs to confirm conformity with approved specifications. Verify that no lower-rated substitutions have been made during procurement or installation. Occupancy stage Verify that the installed plumbing fixtures and sanitary ware continue to comply with the required water-efficiency rating criteria at the time of occupancy. Check that fixtures are operational and have not been altered, replaced, or retrofitted in a manner that compromises water efficiency. Review handover documents, maintenance records, and replacement logs to confirm continued compliance. Verify that any replacement fixtures provided after installation are of equivalent or higher compliant rating.
3e.	Water usage monitoring	ENS 6.2.3 Water-use monitoring Details of documents required MEP DBR showing the inclusion of water-use monitoring as per ENS 2024. SLD of plumbing system showing the location of flow and demand meter of residential premises and dwelling units. Meter specifications and manufacturer datasheets. As-built drawings, photographs and metering schedules, reflecting final meter locations, sizes, and measurement points in line with CPHEEO guidelines. ENS Clause 6.2.3.1 Buildings exceeding the threshold defined under Section 2.2 of this code shall install bulk flow meters in the premises to record the flow and demand of the residential premises and the demand requirements of the particular dwelling unit as per Chapter 13 of the <i>Manual on Water Supply and Treatment Systems (Drink from Tap)</i>, 2024, published by CPHEEO, MoHUA. Design stage Verify project applicability with reference to the threshold defined under Section 2.2 of ENS 2024. Review the MEP design basis report to confirm inclusion of water-use monitoring in the project design. Check the SLD of the plumbing system to verify the location of bulk flow meters for monitoring flow and demand of the residential premises and the demand requirements of individual dwelling units. Review meter specifications and manufacturer datasheets to confirm suitability of the selected meters. Cross-check meter locations and metering schedules with the approved plumbing drawings. Construction stage Verify physical installation of all required water meters at the

		approved locations. Check that installed meters match the approved make, model, size, and specification. Verify that meter locations, accessibility, and installation condition are in accordance with the approved design. Review as-built drawings, metering schedules, and site photographs to confirm conformity with the approved metering layout. Occupancy stage Verify that the installed water meters are functional and record readings at the required monitoring points. Review meter reading logs, monitoring records, or digital/BMS outputs to confirm active water use monitoring. Check calibration, maintenance, or testing records are available. Verify that the installed metering arrangement remains consistent with the approved design and has not been bypassed or altered.
3f.	Water quality requirements	ENS 6.2.6 Water quality requirements Details of documents required • Water sampling and periodic testing of potable water and reused water sources in accordance with applicable BIS procedures. • Water quality test reports from NABL-accredited laboratories, evidencing compliance with the updated Table 7.19 norms for recycled water quality. • MEP DBR detailing the water treatment processes in compliance with CPHEEO requirement of ENS 2024. • Water balance mapping, reuse application, clearly identifying use of treated wastewater for toilet flushing, vehicle exterior washing, non-contact impoundments, and landscape irrigation. • Operational monitoring records and logbooks, confirming ongoing compliance of treated water quality during building operation. ENS Clause 6.2.6.1 Potable / domestic water quality test reports, issued by NABL-accredited laboratories, demonstrating compliance with IS 10500:2012 – Drinking Water Specification, as prescribed under Tables 1 to 4, for all uses involving human consumption and domestic activities. ENS Clause 6.2.6.2 Varied recycled applications of treated used water quality such as toilet flushing, vehicle exterior washing, non-contact impoundments, and landscape irrigation shall comply with the requirements of updated Table 7.19 which has been circulated to the states/UTs by CPHEEO and mentioned under Section 9.2.2 (c) of the <i>Sewerage and Sewage Manual</i> released by CPHEEO, Ministry of Housing and Urban Affairs. Design stage • Review the MEP design basis report to confirm the proposed treatment approach for potable/domestic water and recycled water in accordance with ENS 2024 and CPHEEO

		requirements. • Verify that potable/domestic water is designed to comply with IS 10500:2012 for all uses involving human consumption and domestic activities. • Check the water balance and reuse mapping to identify proposed uses of treated wastewater such as toilet flushing, vehicle exterior washing, non-contact impoundments, and landscape irrigation. • Review the treatment process and quality-control provisions for recycled water to ensure suitability for the identified reuse applications under updated Table 7.19. • Verify segregation of potable water and recycled water systems in the design. Construction stage • Verify installation of all required water treatment, storage, and distribution systems for potable and recycled water as per approved design. • Check that recycled-water treatment infrastructure and associated reuse lines have been installed in accordance with intended end-use applications. • Verify physical segregation of potable and treated wastewater systems, including tanks and pipelines. • Review as-built drawings, equipment records, and site photographs to confirm conformity with approved design and readiness for water quality testing. Occupancy stage • Review potable/domestic water quality test reports from NABL-accredited laboratories and verify compliance with IS 10500:2012. • Review treated wastewater quality test reports from NABL-accredited laboratories and verify compliance with the applicable quality requirements for intended reuse applications under updated Table 7.19. • Check that treated wastewater is being used only for the reuse applications for which compliant quality has been demonstrated. • Review operational monitoring records, water-quality logs, and maintenance records to confirm ongoing compliance during building operation. • Verify continued segregation of potable and recycled water systems and review corrective action records where any non-compliance has been observed.
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Table 17 Compliance requirements as per Waste Management

4. Waste Management		
4a.	Declaration for safe handling and disposing C&D waste as per CPCB guidelines/ (C & D Waste Management Rules, 2016).	ENS 7.2.1 Construction waste management Detailed documentation list - Declaration for safe handling and disposing C&D waste as per CPCB guidelines/ (C & D Waste Management Rules, 2016). - Copy of the agreement/work order/tender document or declaration with an authorized waste management agency or contractor for handling construction and demolition (C&D) waste. The document shall be reviewed to confirm that it clearly outlines procedures for on-site segregation, safe handling, storage, collection, transportation, and disposal of C&D waste in accordance with Central Pollution Control Board (CPCB) guidelines and the Construction and Demolition Waste Management Rules, 2016. Design Stage - The submitted agreement shall be examined to ensure that it includes specific clauses demonstrating compliance with applicable statutory requirements and clearly defines the roles and responsibilities of stakeholders involved in C&D waste management. - In cases where C&D waste is directly handed over to municipal authorities or reused on-site, the verifier shall review municipal challans/receipts, disposal records, or documented evidence of reuse provided by the project team. These documents shall be assessed to confirm that the waste has been managed through authorized channels or appropriately reused within the site. Construction Stage - Check the implementation of declaration and other supporting document are implemented on site Occupancy stage - NA
4b.	An inventory of the waste generated during construction by either weight or volume, but not both shall be developed. The inventory shall classify the quantities of waste generated as per section 7.2.1.	Detailed documentation list - Detailed inventory of construction waste generated, including materials such as soil, sand, gravel, brick and masonry debris, concrete fragments, metals, wood, and packaging materials. The verifier shall assess whether the inventory clearly indicates the weight or volume of each waste type, total quantity generated, quantity diverted from landfill, and the method of diversion (reuse, recycling, or disposal through authorized agencies). Design Stage - NA

		Construction Stage - Examine the waste log sheets submitted by the project team to verify records of waste generation and management during construction. The verifier shall confirm that the log sheets document the quantity of each waste type generated, total waste generated, quantities reused on-site, materials sold to authorized recyclers, and waste handed over to municipal authorities or other authorized agencies. - Review copies of challans/receipts for waste materials sold or transferred to authorized recyclers or disposal facilities. The verifier shall confirm that the records demonstrate that construction waste has been appropriately diverted from landfill and managed through authorized channels in compliance with the Construction and Demolition Waste Management Rules, 2016. Occupancy Stage - NA
4c.	During Construction A waste management plan shall be developed which include: - Estimate the quantum of waste generated daily - Designate an area for collection of daily waste - Site Logistics plan including; designated collection, segregation and storage areas for construction waste as per categories as mentioned in Chapter 7: section 7.2.1.2. - Detailed implementation plan for reuse of waste on site as per section, Chapter 7: section 7.2.1.3. a. Detailed implementation plan for resale of recyclable waste to recyclers or municipal authorities as per Chapter 7: section 7.2.1.4	Documentation list During Construction A waste management plan shall be developed which include: - Estimate the quantum of waste generated daily - Designate an area for collection of daily waste - Site Logistics plan including; designated collection, segregation and storage areas for construction waste as per categories as mentioned in Chapter 7: section 7.2.1.2. - Detailed implementation plan for reuse of waste on site as per section, Chapter 7: section 7.2.1.3. a. Detailed implementation plan for resale of recyclable waste to recyclers or municipal authorities as per Chapter 7: section 7.2.1.4 Design Stage Review of documents submitted: - Review the Site Waste Management Plan (SWMP) prepared for the project. The verifier shall confirm that the plan includes: - Estimated daily waste generation during construction - Designated areas for collection, segregation, and storage of construction waste - Site logistics for handling different waste streams, including collection, transportation, and disposal pathways. - Examine the site layout drawings to verify the location of designated storage areas for construction materials and waste streams as required under Section 7.1.2 of ENS 2024. The layout should clearly indicate storage areas for materials such as steel, building blocks, stone, empty cement bags,

		packaging waste, and construction and demolition (C&D) debris. - Review the implementation strategy describing how construction waste will be segregated, reused, recycled, or handed over to authorized agencies during the construction phase. Construction Stage Review of documents submitted: ENS Clause 7.2.1.1 (7.3.2.1.) Segregation and Storage of Waste - Verify that designated waste storage areas identified in the site layout are implemented on-site. - Review supporting documentation and photographs, where available, to confirm that segregation of construction waste streams (e.g., steel, concrete debris, masonry waste, packaging waste, etc.) is being carried out in accordance with the Site Waste Management Plan. - Incremental points for waste segregation as centralised unit are available 100% recyclable waste segregated in 6 categories- 1 point 100% recyclable waste segregated in 8 categories- 2 point ENS Clause 7.2.1.2 (7.3.1.1) Minimization of Non-Hazardous Waste - Review copies of agreements/MoUs with authorized recyclers, transporters, or municipal authorities, along with supporting challans/receipts, to verify that at least 50% of non-hazardous waste generated during construction (by weight or volume) has been reused, repurposed, recycled, or salvaged. - Verify whether the project has achieved higher diversion levels of 75% and 95%, where applicable for incremental scoring for 2 and 3 points respectively. - Examine the implementation plan detailing on-site reuse of C&D waste materials and procedures for resale or handover of recyclable waste to authorized recyclers or municipal authorities. ENS Clause 7.2.1.3 Recycling of Packaging Waste - Review agreements/MoUs, challans, or receipts to confirm that 100% of packaging recyclable waste generated during construction has been handed over to manufacturers, authorized recyclers, or municipal authorities for appropriate management. ENS Clause 7.2.1.4 Diversion of Construction Waste from Landfill - Verify records demonstrating that 100% of construction waste generated during construction (by weight or volume) has been: - Reused or repurposed on-site, or - Diverted to authorized recycling facilities, or - Handed over to municipal authorities for final disposal.
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		- Review supporting documentation including waste logs, recycling records, transport manifests, and municipal challans/receipts to confirm diversion from landfill. - Confirm that the waste management practices comply with the Construction and Demolition Waste Management Rules, 2016. Post-Occupancy Stage Review of documents submitted: - Review the final waste management summary report submitted by the project team, summarizing: - Total construction waste generated - Quantity reused on-site - Quantity recycled or diverted from landfill - Quantity handed over to municipal authorities or authorized facilities. - Verify the consolidated records of challans, receipts, and waste diversion documentation to confirm compliance with the targets specified under the Site Waste Management Plan.
4d.	Post Occupancy: Site and Building floor plans, highlighted area for floor wise waste collection, with different color bins, organic waste composting location, type and catering capacity.	ENS Clause 7.2.2.2 Organic Waste Treatment documents submitted: Site and Building floor plans, highlighted area for floor wise waste collection, with different color bins, organic waste composting location, type and catering capacity. Design Stage - Detailed narrative describing the post-construction organic waste management strategy. The verifier shall assess whether the document clearly outlines procedures for waste collection, segregation, on-site treatment, storage, and final disposal of organic waste generated during the operational phase of the building. - Review the site plan indicating the plinth area and total built-up area of the project to verify the project size and determine the applicable compliance pathway for organic waste management systems. Construction Stage: N.A. Occupancy stage - Examine the site and building floor plans to confirm that: - Floor-wise waste collection areas are designated. - Locations of colour-coded waste bins are clearly indicated to facilitate segregation at source. - Locations of composting or organic waste treatment facilities and associated infrastructure are clearly identified. - Verify the level of waste segregation practices implemented within the building. Incremental points shall be assessed where 100% of recyclable waste is segregated into six and

		eight waste categories, respectively (for example: organic, sanitary, hazardous, plastic, paper, glass, metal, packaging, and e-waste). Projects with Built-up Area $\geq 5,000$ sq m • Review the technical specification sheets of the on-site organic waste treatment system to confirm the technology adopted and installed capacity of the system. • Verify that the installed system is designed to compost at least 50% of the projected post-occupancy organic waste generated on-site. Incremental points shall be evaluated where the system capacity demonstrates 75% and 95% treatment of organic waste, respectively. • Examine the sizing calculations for the composting system, ensuring that they are based on: - o Projected building occupancy - o Organic waste generation rates - o Catering or food service capacity, where applicable. Projects with Built-up Area $< 5,000$ sq m • Review copies of agreements/MoUs with the concerned local body or authorized waste management agencies, along with supporting challans or receipts, to verify that segregated organic waste is handed over for appropriate treatment and disposal. • Confirm that such arrangements are in place where municipal collection systems exist, or alternatively with authorized professional waste management agencies where municipal mechanisms are absent. On-site Implementation Verification • Review date-stamped contextual photographs of: - o Installed organic waste treatment systems - o Waste collection areas - o Segregation infrastructure and composting facilities • The photographs shall be assessed to verify actual on-site implementation and operational readiness of the organic waste management system.
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Table 18 Compliance requirements as per Indoor environmental quality

5. Indoor environmental quality		
5a.	Good for construction plan highlighted openings (doors, windows and ventilators), and enclosed parking with ventilation and exhaust systems	ENS 8.2.1 Ventilation potential Details of documents required - Construction plan showing door window schedule with effective opening percentage. - Schedule of regularly occupied area with effective WFR. - Drawing showing the enclosed parking areas with ventilation system. - Provide the specification sheet of glazing products used in the project. ENS Clause 8.2.1.1 The building shall meet the minimum criteria for the openable window-to-floor area ratio (WFR) to ensure an adequate potential for natural ventilation as per Table 9 under provision number 5.2.1.1. of this code. ENS Clause 8.2.4.1 (8.3.1.1) An opening and/or ventilator shall be provided, in addition to the window, for the installation of exhaust systems in the kitchen and bathroom/toilets. Incremental points are available if 50% regularly occupied spaces have cross ventilation – 2 points 75% - 3 points 90% – 4 points Calculation of cross ventilated area is provided in Annexure 5: Improved Air Cooling of ENS 2024. ENS Clause 8.2.5.1 The building shall meet the minimum criteria for visible light transmittance (VLT) to ensure adequate availability of daylight as per Table 9 under provision number 5.2.1.2 of this code. Design documents - Check the design document and calculation for WFR as per ENS requirement. - Check the calculation of cross ventilated area is provided in Annexure 5: Improved Air Cooling of ENS 2024. Construction stage - Review the implementation of openings is done as per door window schedule provided in design stage. - Check the VLT of glazing product used in the project from manufacturer cutsheets. Occupancy stage - Review and verify cross ventilation and VLT in all the space of the project.
5b.	Calculation of lux levels for common areas, exterior lighting and interior lighting (if applicable).	ENS 8.2.6 Lighting adequacy for common areas and exterior lighting Details of documents required - Statement of areas as per ENS 2024 along with simulation of illumination levels for artificial lighting. - Artificial lighting design document meeting lux levels as per ENS requirements.

		ENS Clause 8.2.6.1 Artificial lighting systems complying with the minimum recommended lux levels specified in Table 39 shall be installed. Design documents - Check the lighting design document for targeted illumination as per ENS. - Check lighting simulation for typical areas for illumination and the product specification used in design. Construction stage - Check the location of light points as per the design document. - Check the luminaires used in the projects are same as design documents and simulation. Occupancy stage Check the illumination level in the typical common areas, exterior lighting, and interior lighting as per ENS requirements.
5c.	Calculation of RETV and WFR for each typical block.	ENS 8.2.8 Thermal comfort Building design documents include plan elevation and section material specifications RETV calculation as per ENS 2024 WFR_{op} as per ENS 2024 U value/ Thermal Transmittance as per ENS 2024 ENS Clause 8.2.8.1 Buildings in all climate zones except cold climate shall comply with the following provisions of the Code: - Maximum residential envelope transmittance value (RETV) (except the roof) as per provision 5.2.1.4. - Minimum openable window-to-floor area ratio (WFR_{op}) as per provision 5.2.1.1. - Maximum thermal transmittance of roof (U_{roof}) as per provision 5.2.1.3. ENS Clause 8.2.8.2 Buildings in cold climates, shall comply with the following provisions of the Code: - Thermal transmittance value of the building envelope (U_{Envelope.Cold}) (except the roof) as per provision 5.2.1.5. - Maximum thermal transmittance of roof (U_{roof}) as per provision 5.2.1.3. Design Documents Check the following parameters/ reports in the project: - Building design documents include plan elevation and section material specifications - RETV calculation as per ENS 2024 - WFR_{op} as per ENS 2024 - U-value/thermal transmittance as per ENS 2024 Construction stage - Reviewing the construction specifications used in the site are as per the design/calculations Occupancy stage - Review the final construction envelope meets the ENS requirement.

5d.	Specifications of VOC content in paints, coatings, adhesives, and sealants (with copy of purchase invoice/BoQ/ tender documents)	ENS 8.2.2 Low-emitting materials 1) Design document/BOQs for interior finishes used in project 2) Product cutsheets for paints adhesives and sealants 3) Invoices of pains adhesives and sealants used in the project ENS Clause 8.2.2.1 Paints used on the interior side of the building envelope shall comply with the VOC content limits as per Table 38. Design documents Check the VOC limits of products planned to be used in the project in BOQs and tender documents Construction stage Check paint adhesive and sealants for VOC limits on site. Occupancy stage NA
5e.	Specifications of glass provided by the manufacturer (with copy of purchase invoice/ BoQ/tender documents).	ENS 8.2.5 Daylight availability Details of documents required • Calculation of WWR for the buildings • Specification sheet of glazing used in project • Supporting document like tender document, BOQ, invoices • Demarcation of regularly occupied areas meeting the daylighting requirement UDI of ECSBC and provide area statement with percentage calculation of daylit area for regularly occupied area. ENS Clause 8.2.5.1 (8.3.2.1) The building shall meet the minimum criteria for visible light transmittance (VLT) to ensure adequate availability of daylight as per Table 9 under provision number 5.2.1.2 of this code. Incremental points are available for daylight availability (useful daylight illuminance for 40% of regularly occupied area – 2 points, 50% – 3 points; 60% – 4 points. The building shall comply with the useful daylight illuminance requirement as prescribed by the ECSBC 2024 (for commercial buildings), Section 5.2.3-(a) ensure above-grade floor areas shall meet or exceed the useful daylight illuminance (UDI) area requirements listed in Table 56 for 90% of the potential daylit time in a year (refer to Chapter 9: Calculations and Formula). Incremental points can be achieved as per Table 42 of ENS. Design documents • Check the specification sheet of glazing used in the project • Check the minimum VLT requirement as per WWR of the project as per ENS provision 5.2.1.2 • Check the percentage of daylit area for incremental points with respect to the total regularly occupied area. Construction stage • Check tender document BoQs for procurement of selected glazing • Check on site the glazing used in the project is same as proposed • Check the daylit areas defined in the design document has opening same as defined in the design document

		Occupancy stage Check the invoices, purchase order for the glazing used in the project to meet the design.
5f.	Specifications of various lighting fixtures used (with copy of purchase invoice/BoQ/ tender documents)	8.2.7 Lighting quality: Colour rendering index Details of document required - Specification of all the lighting fixtures and lamps used in the project with details of CRI of lamps mentioned. - Lighting layout with schedule of lighting fixtures and lamps used in the project. - Tender document BoQs, purchase order, invoices of lighting fixtures and lamps ENS Clause 8.2.7.1 The colour rendering index (CRI) values for each zone within the building shall comply with requirements as per Table 40. Design documents - Check the lighting layouts and luminaire and lamp schedule of the project should meet the minimum lighting CRI index defined in the ENS document. Construction stage - Check the lighting fixtures being procured and installed on site are as per the design details Occupancy stage - Check the lighting fixtures installed on site are as per the design details meeting the CRI of the ENS.
5g.	Description of ventilation and exhaust system installed in the enclosed parking with showing ACH calculation	ENS 8.2.3 Air quality in car parking Details of document required - Design document for ventilation system in car parking meeting the NBC requirements. - Layout of exhaust fans for ventilation system in parking areas - Specification of exhaust fans/CO sensors - Tender document, BOQs, purchase orders invoices ENS Clause 8.2.3.1. For enclosed parking areas, a well-designed ventilation and exhaust system shall be installed that provides a minimum of 6 air changes per hour, as per the National Building Code (NBC), to effectively eliminate vehicle exhaust fumes and pollutants. Air change per hour = Q / V where, Q = airflow rate (m^3/h) V = volume of the space (m^3) Design stage - Check the design documents are meeting the NBC and ENS requirements

		Construction stage Check the design document and implementation of site for installation of exhaust system as per design is happening on the site. Including use of CO sensors are installed as per design. Occupancy stage Check implementation of exhaust system are installed as per design.
5h.	Good for construction floor plan highlighted enclosed parking with the placement of sensors.	ENS 8.3.3 Air Quality in underground parking Details of document required 1. Good for construction floor plan highlighted enclosed parking with placement marked for CO sensor on the drawings 2. Specification of exhaust fans/CO sensors ENS Clause 8.3.3.1 Incremental points are available for 8.3.3.1. Install a demand control ventilation system to limit CO levels in the underground parking area to ensure safety and air quality. The location of sensors should be followed as prescribed by the NBC 2016, Volume 2, Part 8, Section 3, Section 11.5.4. Incremental points can be achieved as per Table 43 (2 points). Design stage • Check the provision of CO sensor in the parking exhaust system in design document. Construction stage • Check the tender document , BOQs include the provision of CO sensors. Occupancy stage • Check the location of CO sensor is installed as per design document on site.

Questions

Section A: Objective Questions (MCQs) – 10 Nos

1. According to ENS 2024, which of the following building categories—despite being defined as residential occupancies under the National Building Code (NBC)—are specifically excluded from the scope of the residential code and must be treated as commercial buildings for compliance purposes?
 - A) Lodging and rooming houses
 - B) Dormitories
 - C) Hotels and similar accommodation facilities
 - D) All of the above
2. How does ENS 2024 define a "Private Residence" for the purpose of code compliance?
 - A) A building accommodating up to four families with no sleeping limit.
 - B) A structure accommodating one or two families with sleeping accommodation for not more than 20 persons.
 - C) Any structure used for residential purposes regardless of family count.
 - D) A building used exclusively by a single family with a load above 100 kW.
3. In a mixed-use building having residential and commercial use, if the commercial occupancy constitutes less than what percentage of the total above-grade floor area, the entire building may demonstrate compliance based on the residential classification?
 - A) 5%
 - B) 10%
 - C) 15%
 - D) 20%
4. Which of the following building categories is specifically EXCLUDED from the scope of ENS 2024 and must instead comply with the commercial building code (ECSBC)?
 - A) Apartment buildings
 - B) Group housing projects
 - C) Hotels and similar accommodation facilities
 - D) Mixed-use buildings with 5% commercial area
5. To achieve "ENS (Base Compliance)," which of the following is required?
 - A) Meeting 30% of the incremental points in each chapter.
 - B) Fulfilling all mandatory provisions prescribed in Chapters 4 to 8.
 - C) Achieving a minimum of 10 incremental points across the project.
 - D) Complying with only the building envelope requirements.
6. For a building to qualify for "ENS+ (Enhanced Compliance)," what is the minimum percentage of available incremental points it must achieve in each chapter?
 - A) 20%
 - B) 30%
 - C) 40%
 - D) 50%
7. "Super ENS (Advanced Compliance)" represents the highest level of performance and requires achieving at least what percentage of incremental points in each chapter?
 - A) 30%

- B) 50%
- C) 75%
- D) 100%

8. According to ENS, which technical section offers the highest maximum incremental points (40 points) in the ENS 2024 framework?

- A) Sustainable site management
- B) Building envelope
- C) Water conservation and management
- D) Indoor electrical end-use

9. Under the point-based system for ENS+, how many incremental points must be achieved specifically for the "Sustainable site management" section?

- A) 5 points
- B) 9 points
- C) 15 points
- D) 21 points

10. From which specific section of the Energy Conservation Act, 2001, does residential buildings are enabled to be notified for ECSBC?

- A) Section 2
- B) Section 13
- C) Section 14
- D) Section 15

Section B: Short Answer Questions – 5 Nos

1. What are the statutory load and demand thresholds for a residential building to fall under the purview of ENS 2024?
2. How does ENS 2024 define "Base Compliance" for a residential project?
3. Which three residential-type building categories are specifically excluded from ENS 2024 and must instead comply with commercial codes?
4. What is the criteria for demonstrating compliance in a mixed-use building where commercial occupancy is less than 10%?
5. What are the point requirements for achieving "Super ENS (Advanced Compliance)"?

Section C: Long Answer Questions – 2 Nos

1. Describe the scope and classification of residential buildings under the ENS 2024 framework, including the specific criteria for mixed-use structures.
2. Explain the tiered compliance system of ENS 2024 and how the point-based evaluation framework distinguishes between ENS, ENS+, and Super ENS levels.

Answer Key for MCQs

- | | |
|------|-------|
| 1. D | 6. B |
| 2. B | 7. B |
| 3. B | 8. B |
| 4. C | 9. B |
| 5. B | 10. C |

7. IMPLEMENTATION FRAMEWORK OF ECSBC AND ENS 2024

The ECSBC document defines the technical standards for energy performance in buildings, the ECSBC Rules which are defined by the states details out the legal procedures, authorities, and enforcement mechanisms necessary to implement those standards across the country. The Rules translate the Code from a technical document into a binding regulatory requirement. They provide state governments and urban local bodies (ULBs) with the statutory backing needed to mandate code compliance during building plan approval, construction, and occupancy.

The Rules also define the applicability and compliance procedures, including which building types and load thresholds are covered, the documents required at various approval stages, and the methods by which compliance may be demonstrated. By establishing uniform procedures, the Rules ensure consistent implementation across states and local bodies.

A further purpose of notifying the Rules is to clearly assign roles and responsibilities to enforcement agencies such as state-designated agencies, urban local bodies, and development authorities. The Rules set out how these agencies will review submissions, conduct inspections, verify compliance, and maintain records. They also provide the framework for recognizing accredited professionals who assist in technical evaluations.

The Rules additionally create the basis for penalties and enforcement actions, outlining what constitutes non-compliance, the corrective steps to be taken, and the penalties that may apply under the Energy Conservation Act. This ensures accountability and prevents the Code from being applied selectively or inconsistently.

To integrate ECSBC into everyday regulatory practice, the Rules enable its incorporation into local building bye-laws and Development Control Regulations. Since building approvals are processed at the local level, this integration ensures that ECSBC compliance becomes part of the standard building permit and occupancy process rather than an optional add-on.

Finally, the Rules provide the legal foundation for periodic updates and amendments to the Code. As technologies and standards evolve, the Rules allow the government to revise compliance procedures, introduce new performance levels, or strengthen sustainability requirements without requiring a new legislative process each time. The process of obtaining permissions from the authority having jurisdiction, Monitoring , reporting and compliance framework are presented in the flow charts.

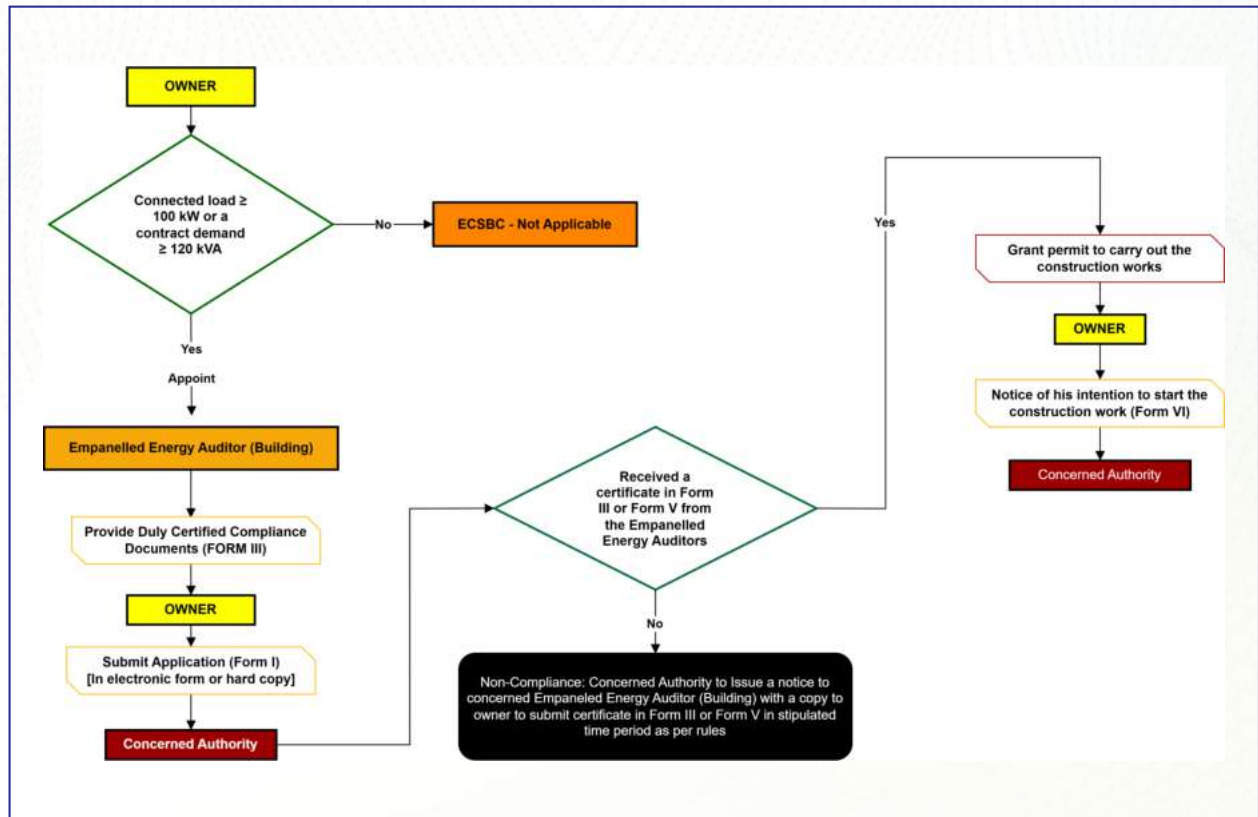


Figure 6 Procedure of erection of Code Compliant Building

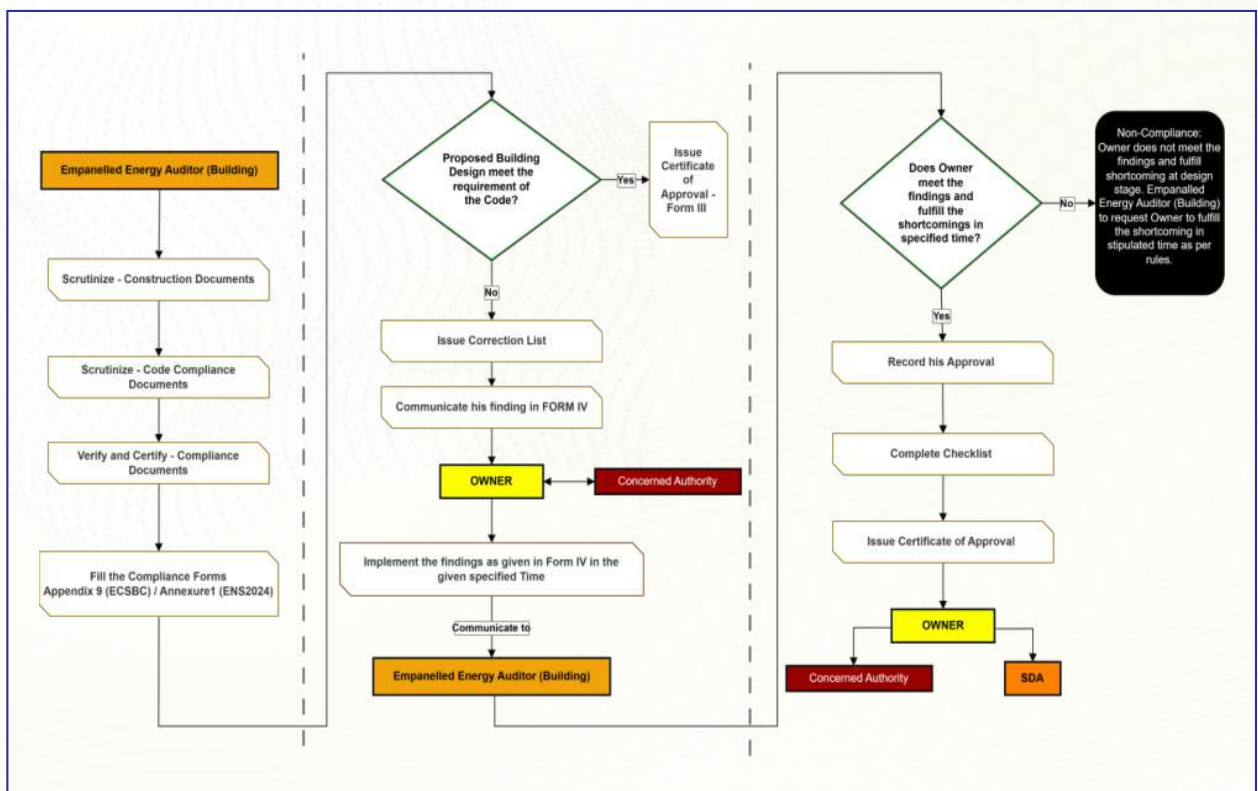


Figure 7 Design Stage - Procedure For Inspection

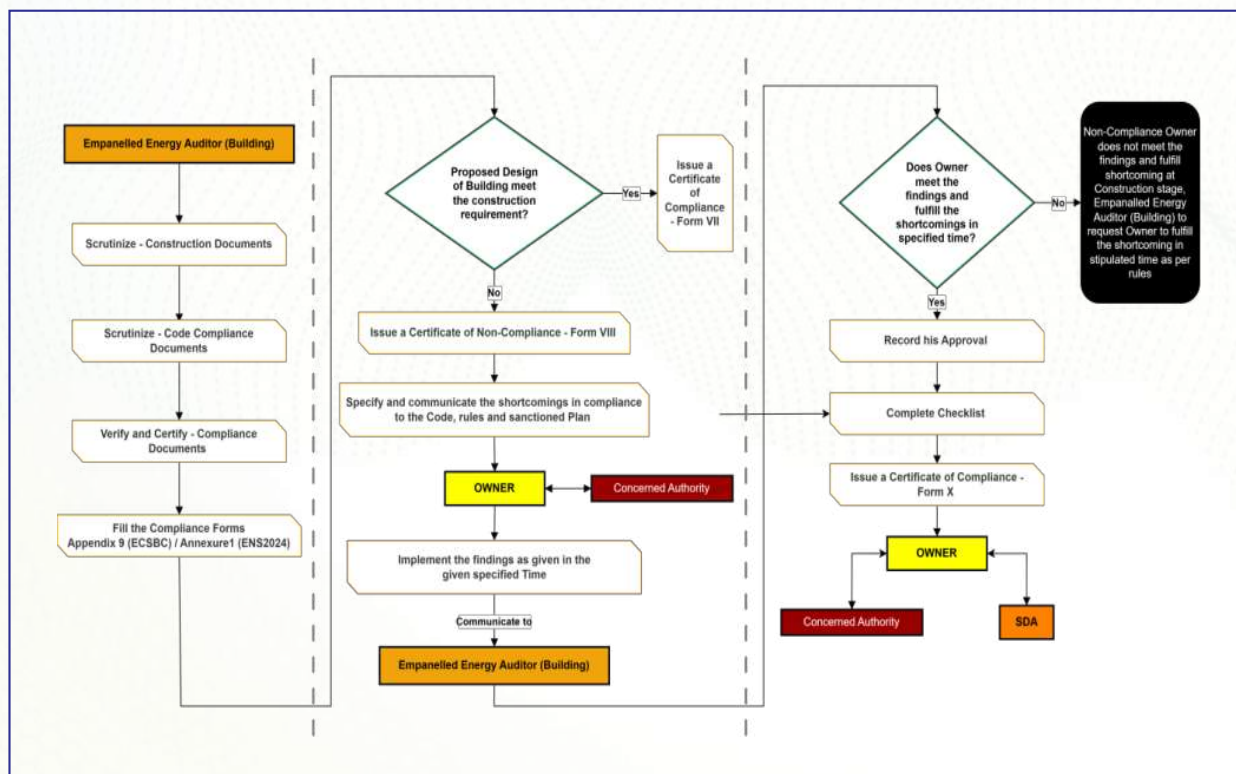


Figure 8 Construction Stage - Procedure For Inspection

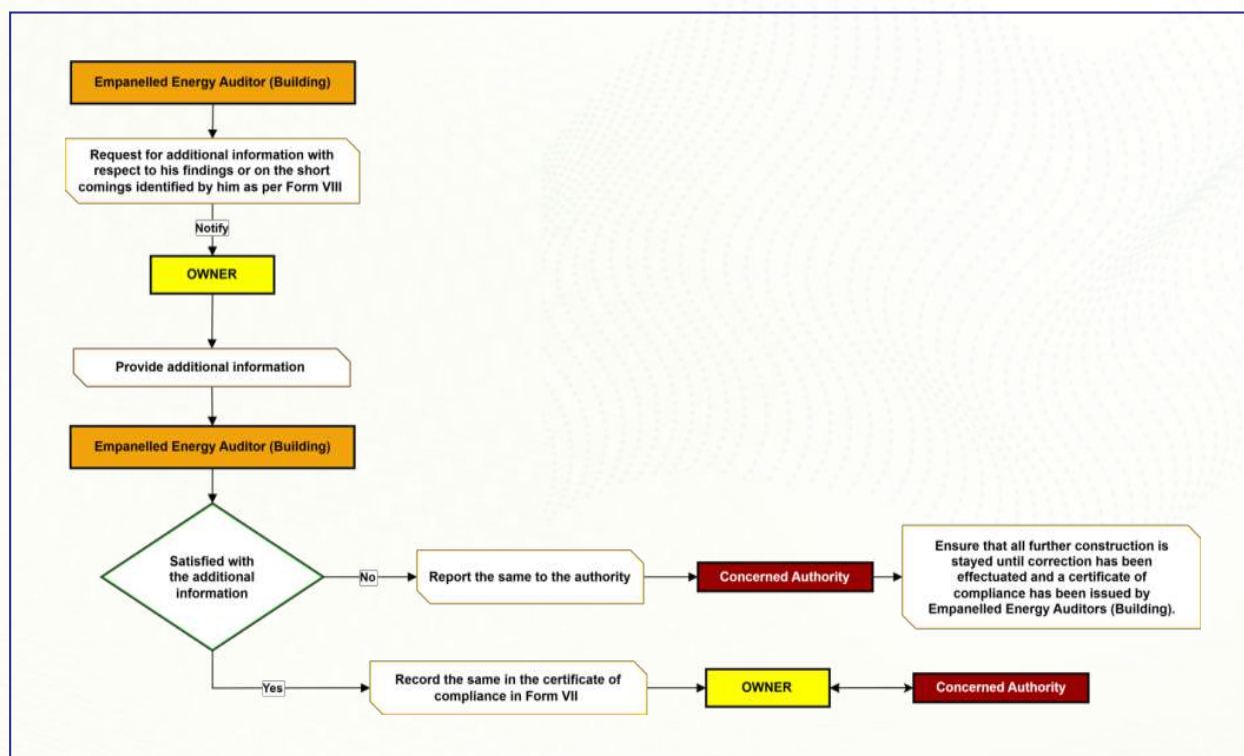


Figure 9 Construction Stage - Not Proceeding In Accordance With Sanctioned Plan

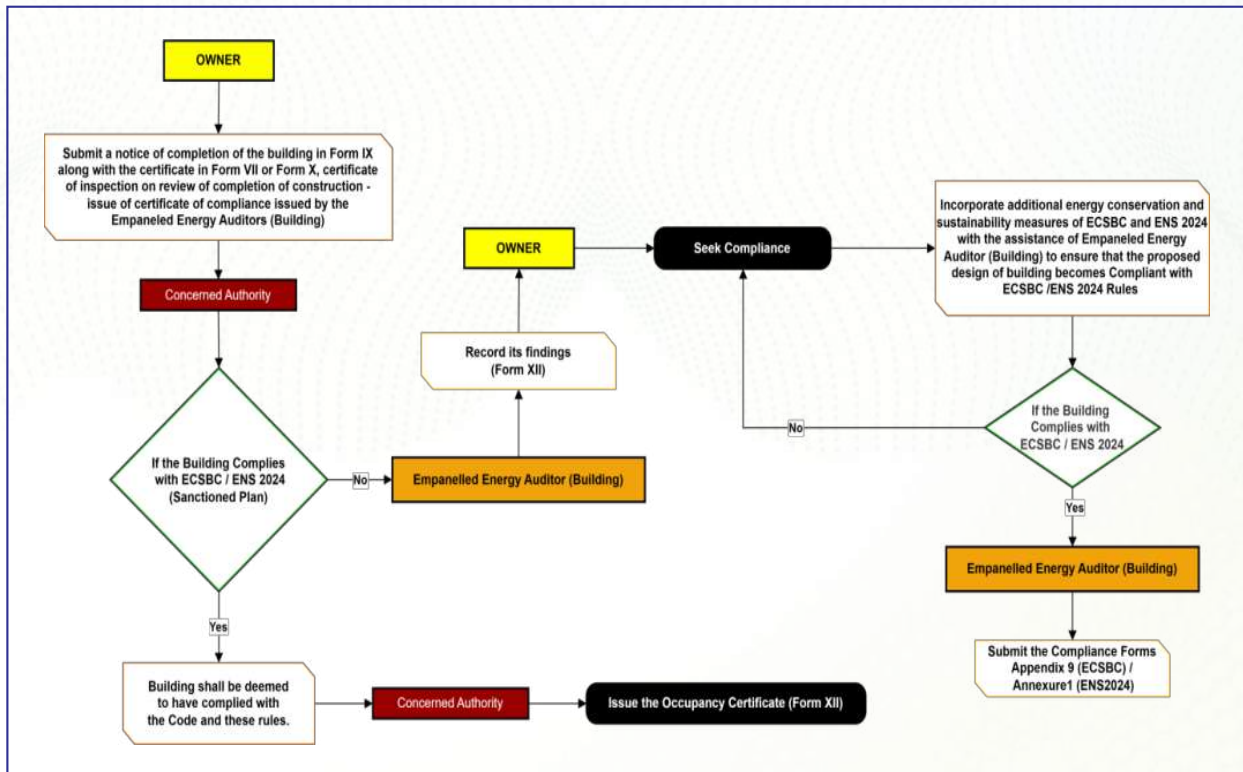


Figure 10 Completion of Building- Occupancy Certificate

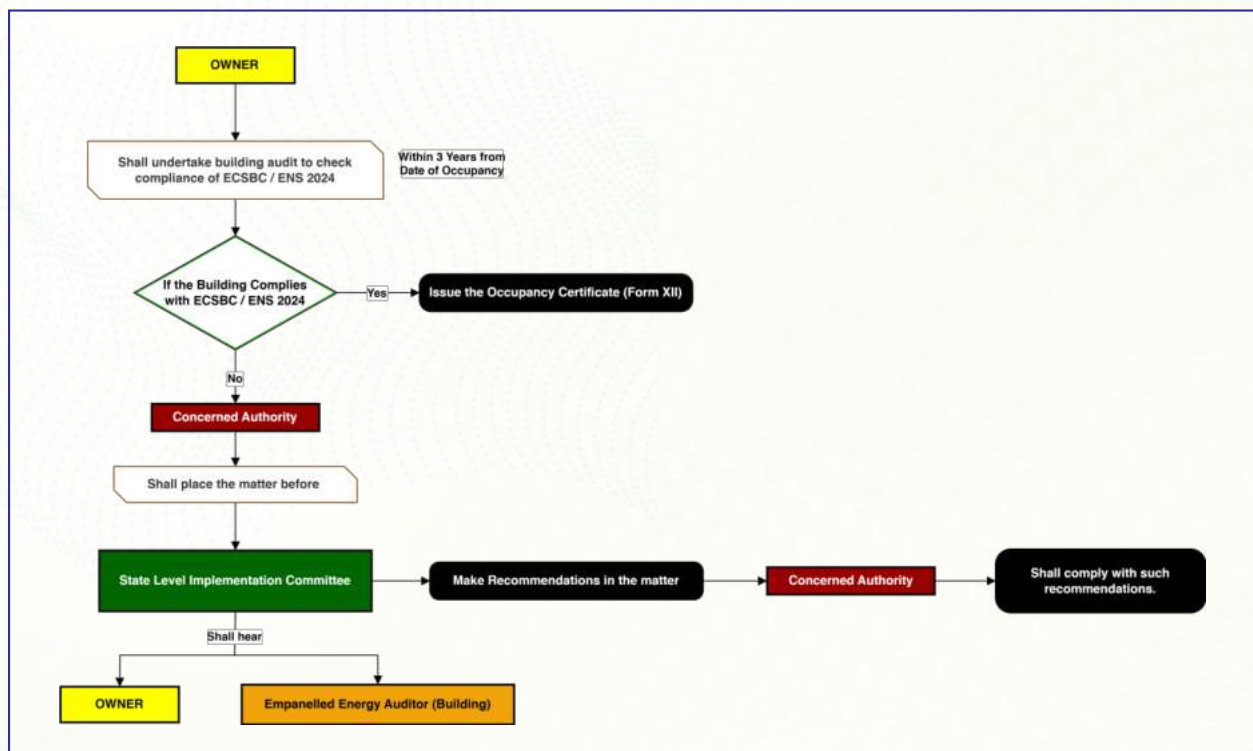


Figure 11 Provisional Occupancy Certificate

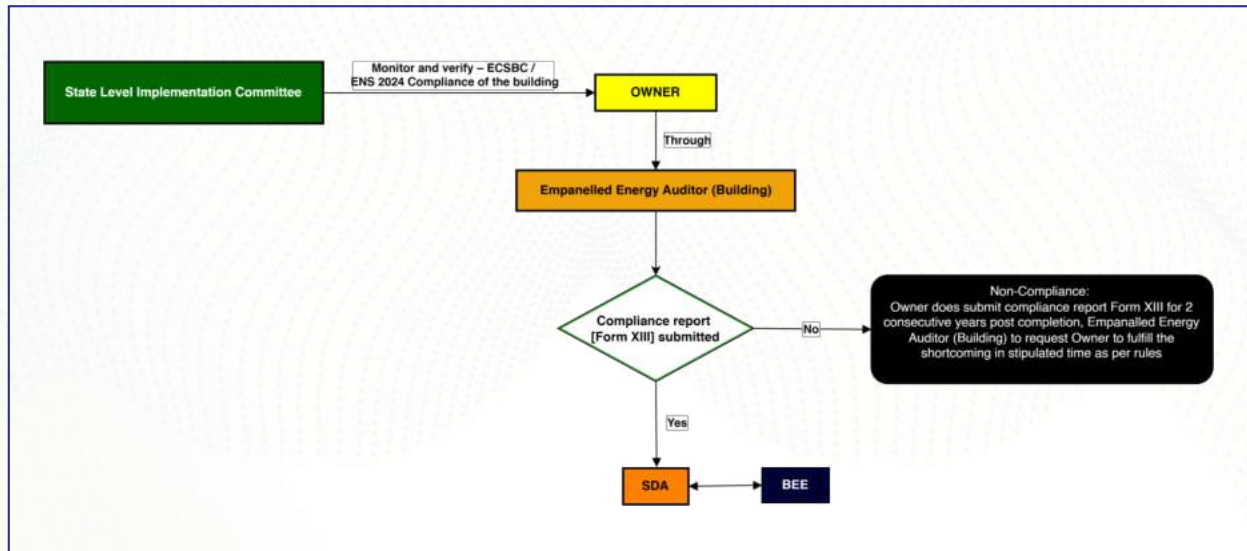


Figure 12 Post Completion Obligation

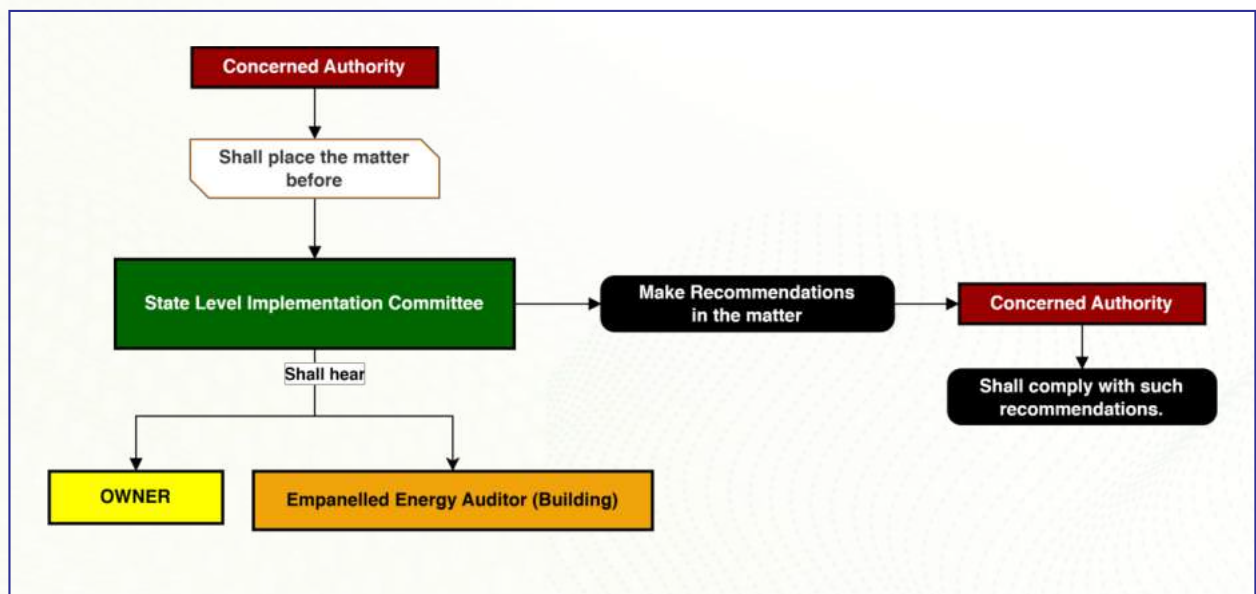


Figure 13 Procedure For Enforcement

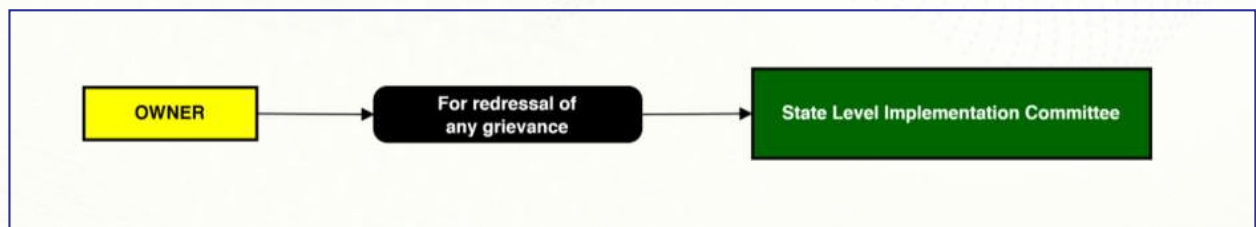


Figure 14 Procedure for Enforcement

The compliance framework of the ECSBC and the ENS 2024 are supported by a structured set of statutory forms developed and notified by the states that guide a project through initial design approval to post-occupancy performance monitoring stages. These forms establish a formal mechanism for documenting compliance with energy efficiency requirements, ensuring accountability of all stakeholders including building owners, developers, and empanelled energy auditors. They facilitate systematic verification at critical stages such as design submission, construction, completion, and operational performance, thereby enabling authorities having jurisdiction to enforce code provisions effectively. Forms defined in the table below integrated compliance and reporting tool to ensure that buildings not only meet the prescribed energy and sustainability standards at the design stage but also achieve and maintain the intended performance throughout their operational life.

Table 19 Compliance forms

Form number	Purpose/when used
Form I	Application (undertaking by owner) when seeking permission to erect/re-erect/alter/add to a building under ECSBC—i.e. the initial building-permit/plan-approval application under ECSBC Rules.
Form II	Undertaking (by owner/applicant) that the submitted design and construction documents comply with ECSBC/specify intended energy-conservation measures. This forms part of the initial application package.
Form III	Certificate by an empanelled energy auditor (building), confirming that the design stage compliance documents (as per Appendix 9 of ECSBC) are complete and compliant with the Code.
Form IV	Notice/communication of non-compliance by the auditor (or authority) if the design or construction documents do not meet ECSBC requirements. This allows the owner to rectify and re-submit.
Form V	Certificate of compliance at design/plan-approval stage (after corrections/verification)—indicates the design meets ECSBC requirements and construction may proceed under compliance.
Form VI	Notice by the owner to the authority indicating the intention to start construction. Used after plan approval and before actual work begins.
Form VII	Certificate of compliance by the empanelled energy auditor (building) after on-site construction/installation, affirming that construction has adhered to ECSBC-prescribed measures (envelope, HVAC, lighting, etc.).
Form VIII	Notice of non-compliance at construction stage (if deviations from approved plan or code requirements are found)—issued by auditor/authority for remediation.
Form IX	Owner's 'notice of completion of building'—submitted to authority when construction (including energy conservation measures) is complete and ready for final verification.
Form X	Final compliance certificate by empanelled energy auditor (building) after completion—certifying that the completed building meets ECSBC requirements and is ready for occupancy clearance.

Form XI	Report of energy performance index (EPI) ratio—if actual building energy performance (after occupancy) deviates from design/sanctioned values. Used for monitoring, corrective action, or enforcement as per Code.
Form XII	Application/request for occupancy certificate (or relevant occupancy/connection permit) —submitted by owner along with auditor's compliance certificate (Form X) to authority having jurisdiction.
Form XIII	Post-occupancy energy performance monitoring report—to be submitted by empanelled energy auditor (building) for a specified period (often first two years) to ensure building performs as per Code-sanctioned EPI, with provisions for remedial action if performance deviates.

The structured sequence of Forms I to XIII under the Energy Conservation Sustainable Building Code (ECSBC) India and the ENS ensures a comprehensive and continuous compliance pathway that extends beyond mere regulatory approval to actual performance validation. By integrating documentation, verification, and monitoring across all project stages, these forms promote a culture of accountability and performance-driven design and construction. Their systematic implementation not only strengthens regulatory enforcement but also supports the larger objective of achieving energy-efficient, sustainable, and environmentally responsible built environments. Ultimately, adherence to this framework enables buildings to deliver on their intended energy performance outcomes, contributing meaningfully to national energy conservation goals.

The following are the key roles and responsibilities of the stakeholders as per ECSBC rules:

Owner

1. Shall carry out the work for the said building until completion in accordance with the requirements of the ECSBC and ENS rules.
2. Shall engage empanelled/certified energy auditors (building) acting as third-party assessor for the project in development of building design, installation of energy conservation and sustainability measures and equipment to meet with the requirements of these rules and ensure following, namely:
 - 2.1 Finalize the compliance approach relevant for his building project based on the complexity of the building, budget and time constraints.
 - 2.2 Finalize the energy conservation and sustainability measures as per the code as amended from time to time having regard to the location of the proposed building.
 - 2.3 To integrate the energy conservation and sustainability measures in the building design in accordance with the provisions of ECSBC rules.
 - 2.4 That drawings, specifications, and compliance forms are prepared and energy conservation measures are reflected in the building design documents and proposed sustainability measures of the building and submitted to the authority having jurisdiction in compliance with the requirements of the rules accompanied by a certificate specifying the MEPI_{proposed} and MEPI_{baseline} and other compliance requirements of the building by the empanelled/ certified energy auditors (building) acting as third-party assessor for the project that the documents are as per the

- requirement of ECSBC rules.
- 2.5 Notice is given within the validity of sanction to the authority having jurisdiction of his intention to start the construction work at the building site.
 - 2.6 Commence the work within the period specified by the authority having jurisdiction from the date of such notice or seek extension of time for starting the construction work, wherever necessary.
 - 2.7 Ensure that the designed energy conservation and sustainability measures are deployed in the construction of the building and installation of its components and systems
3. Shall permit the empanelled/certified energy auditors (building) acting as third-party assessor for the project to enter the building or premises at the reasonable time for the purposes of inspection to ensure compliance of building works with rules and regulations under the ECACT.
 - a) Shall give written notice to the authority having jurisdiction intimating the completion of the construction work along with the certificated from the empanelled/certified energy auditors (building) acting as third-party assessor for the project to the effect that –
 - b) The construction of the building has been done in accordance with the sanction of the building permit.
 - c) All the energy conservation and sustainability measures have been installed and inspected, and they meet the requirements of the Code and ECSBC rules.
 - d) The building design meet with the provision of the ECSBC and ECSBC rules
 4. Shall give written notice to the authority having jurisdiction as well as to the state designated agency in case of termination of the services of empanelled/certified energy auditors (building) acting as third-party assessor for the project in its place.
 5. Shall obtain an occupancy permit from the authority having jurisdiction prior to any occupancy of the building or part thereof after completion of the building.
 6. Shall report the practical difficulties to the empanelled/certified energy auditors (building) acting as third-party assessor for the project, if any, in carrying out the provisions of these rules, who shall take necessary action in consultation with state designated agency and State Energy Conservation Building Code Implementation Committee.
 7. Shall on the receipt of the notice, if any, from the authority having jurisdiction, owner shall discontinue such usage within reasonable time as specified in such notice and in no case he shall disregard the provisions of these rules.
 9. Shall use or install any system or material or equipment on account of improving the energy efficiency and other sustainability requirement of the building as per ECSBC contrary to the system, material or equipment as indicated in the sanction plan after obtaining the necessary approval of the empanelled/certified energy auditors (building) acting as third-party assessor for the project.
 - a. Provided that it does not violate the spirit and intent of the provisions of ECSBC rules.
 - b. Provided further that such change shall not compromise with the building requirements, namely structural stability, safety, health or environmental provisions of Central and state laws applicable to the buildings covered under ECSBC rules.

Empanelled/Certified energy auditor (building) acting as third-party assessor

1. Shall verify and clarify –

- 1.1 The design of the building keeps in view the design criteria, energy and sustainability goals of the project, energy systems, performance verification plan and modelling approach.
- 1.2 The energy conservation and sustainability measures based on the design approach for the project under consideration
- 1.3 Construction documents and compliance documents, compliance forms and checklists specified to ensure that the building complies with the ECSBC and ECSBC rules. Following figure details how Empanelled/Certified energy auditor (building) would coordinate with owner and design team for collection of relevant information from the design and construction team.

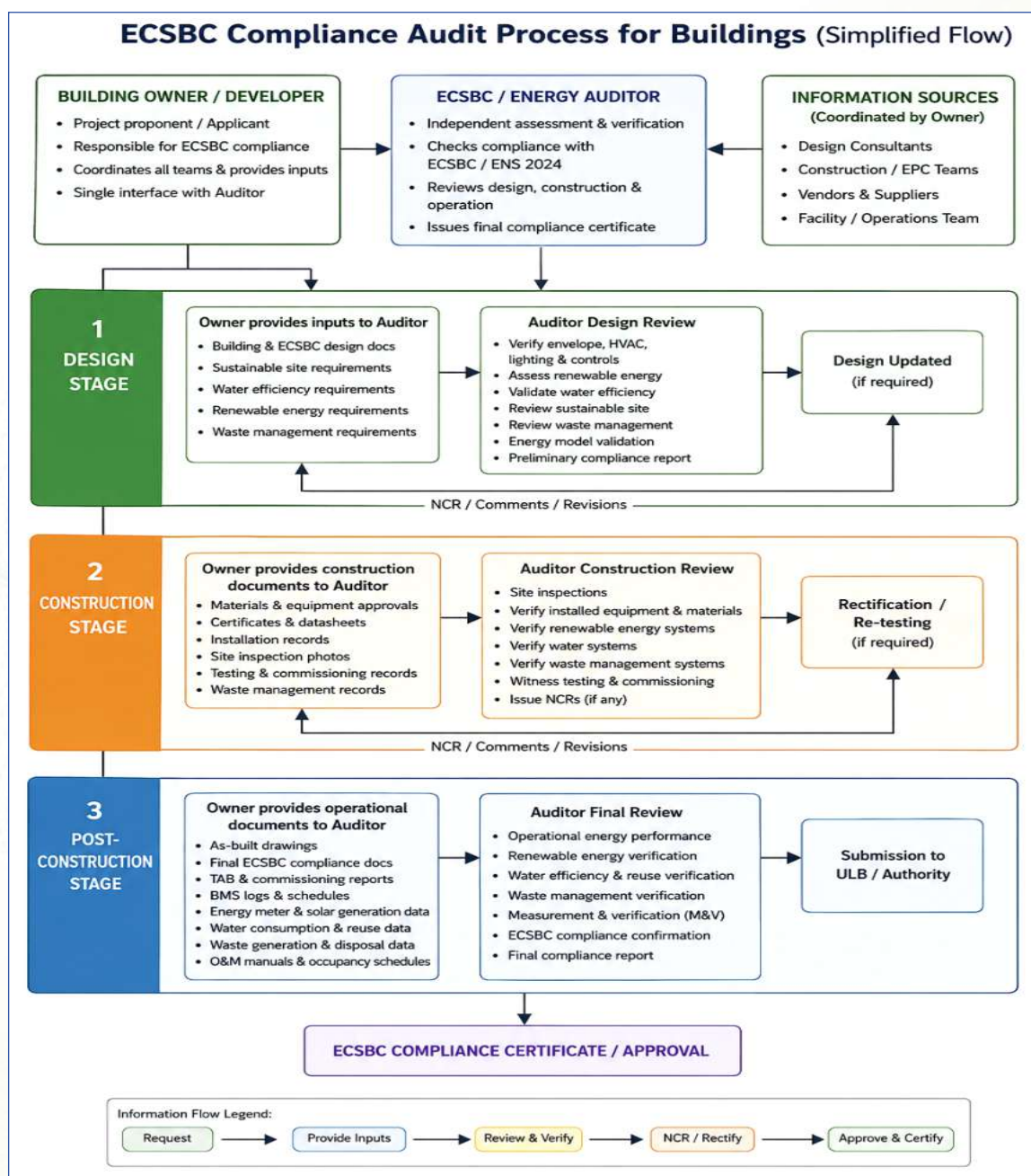


Figure 15 Flow Chart For Energy Auditor Building For Meeting Requirements of ECSBC/ENS at Design Stage, Construction Stage And Post Construction Stage

Note: The above requirements are indicative, for more details of respective compliance requirement Section 5 of this book for commercial buildings and section 6 for residential buildings can be referred.

1.4 Modelled Energy performance intensity of the proposed building.

2. Shall furnish a certificate under its seal and authorized signature to the effect that drawings, specification, construction documents, compliance documents and forms prepared covering building envelope, comfort system and controls, lighting and electrical. power systems, wherever applicable, and all other code related documentation prepared for submission to the authority having jurisdiction ensuring compliance with ECSBC rules.
3. Shall inspect the building works from the design stage to its commissioning stage of buildings including their uses under these rules and based on his certification, the authority having jurisdiction shall issue building permit, approve construction of building, issue completion certificate and occupancy certificate.
4. Shall ensure that none of the professionals or employees working under him/her is engaged in any work in connection with the construction or alteration of the building concerned covered under these rules to ensure that there is no conflict of interest with his/her official duties with the interests of the authority having jurisdiction.
5. Shall report to state-designated agencies on such unusual technical issues that may arise due to issue of building permit or construction of building or during occupancy stage.
6. Shall provide inputs to the National and State Energy Conservation and Sustainable Building Code Implementation Committees to facilitate for better implementation of the Code and rules.
7. Shall promote norms and standards specified in the Code.

State-Designated Agency

1. Shall coordinate, regulate, and enforce provisions of the ECSBC and there rules for efficient use of energy its conservation, and sustainability under the Act.
2. Shall ensure every commercial building or establishment having a connected load of 100 kW or above, or contract demand of 120 kVA or above, be constructed in compliance with ECSBC rules.
3. Shall monitor the performance of the empanelled/certified energy auditors (Building) to improve the quality, consistency and rate of compliance of these rules with a view to make the cadre of empanelled/certified auditors (Building) as effective instruments for promotion of energy efficiency and sustainability in the building sector in the state.
4. Shall create a data bank in state to measure the compliance rates of the code compliant buildings and accurately account for the energy savings resulting from the compliance of ECSBC rules.
5. Shall create a data bank on measured energy use per square meter of area of the building under different zones namely, hot and dry, warm and humid, temperate, composite and cold, separately for each category in the state.
6. Shall take necessary steps to make measured energy performance index as a measure to comply with these rules in the various categories of buildings and send its recommendations to the Bureau for the formulation of energy consumption norms and standards in respect of various categories of buildings constructed zone-wise in its state.
7. Shall arrange and conduct site visits, if considered necessary, to determine the accuracy of reporting by empanelled energy auditors (building) in the state.
8. Shall prepare a report on performance of empanelled energy auditors (building) listing out the projects complying with these rules, projects in violation of compliance with these rules

and the level of violation and provide summary of such violations for each year to BEE.

9. Shall coordinate with the authority having jurisdiction to amend their building bye-laws incorporating the provisions of these rules for the purpose of construction of buildings in compliance with the Code and these rules.
10. Shall provide necessary support to the authority having jurisdiction to conform to the concerning design construction including energy conservation and sustainability measures and occupancy for improving the performance of Code-compliant buildings and effectiveness in compliance of these rules.

State Level Implementation Committee

1. Shall promote energy efficiency standards through optimization of parameters in the various components and systems of the building in line with the provisions of these rules to enhance the building performance and provide every support to it to make it an effective instrument of promoting energy conservation, energy efficiency, and sustainability in the commercial building and establishments.
2. Shall forward its recommendation to the Bureau to assist the National Energy Conservation and Sustainable Building Code Implementation Committee to develop and revise energy consumption standards for buildings, in terms of energy performance index, zone wise—hot and dry, warm and humid, composite, temperate and cold climate zones, classification wise.
3. Shall create awareness about ECSBC and procedure for erection of Code-compliant building.
4. Shall promote construction of sustainable buildings ensuring quality and consistency in their constructions having regard to the climatic conditions and needs of the building projects.
5. Shall promote capacity building of building professionals, developers and contractors to promote energy-efficient designs of buildings in close co-ordination with authorities having jurisdiction.
6. Shall undertake performance review of annual work of all empanelled energy auditors (bBuilding) to check their credentials.
7. Shall prepare a summary of violations which shall be provided by state-designated agency to the Bureau and review such violations for the purpose of evaluating his professional skills.
8. Shall prepare a yearly report and furnish the same to the Bureau indicating inter alia the progress made in compliance of these rules in the state and the steps taken by the state-designated agency to improve the rate of compliance of Code in the state.
9. Shall create database through compilation of data of energy performance index and its ratio achieved by such building constructed after coming into force of these rules.

National Committee Constituted by BEE

1. Evaluating the recommendations of each State Committee on Energy Conservation in Building and finalizing national-level recommendations regarding energy-consumption norms and standards for Code-compliant buildings
2. Developing and revising energy-consumption standards for buildings - zone-wise (hot & dry, warm & humid, composite, temperate, and cold climate zones) and classification-wise based on the Energy Performance Index.
3. Providing necessary support to promote energy conservation and energy efficiency and sustainability in commercial and residential buildings

Questions

Section A: Objective Questions (MCQs) – 10 Nos

1. **Which legal instrument formally operationalizes the technical standards of the ECSBC into a binding regulatory requirement across India?**
 - A) The National Building Code 2016
 - B) The ECBC Rules 2018
 - C) The Energy Conservation Act 2001 (Original Text)
 - D) The Urban Development Guidelines
2. **Which statutory form is used by the owner as an undertaking to indicate that the submitted design and construction documents comply with the Code?**
 - A) Form I
 - B) Form II
 - C) Form III
 - D) Form V
3. **What is the purpose of Form IV in the compliance framework?**
 - A) Certificate of compliance at the design stage
 - B) Notice of intention to start construction
 - C) Communication of non-compliance by the auditor or authority at the design stage
 - D) Request for an occupancy certificate
4. **Which form serves as the "Certificate of compliance" issued by an empanelled energy auditor after on-site construction is finished?**
 - A) Form VII
 - B) Form IX
 - C) Form X
 - D) Form XII
5. **Which entity is responsible for creating a state-level data bank to measure compliance rates and account for energy savings?**
 - A) The Urban Local Body (ULB)
 - B) The Bureau of Energy Efficiency (BEE)
 - C) The State-Designated Agency (SDA)
 - D) The Technical Grievances Redressal Committee
6. **Form XIII is specifically designated for which stage of the building lifecycle?**
 - A) Pre-construction design approval
 - B) Mid-construction inspection
 - C) Building completion and occupancy request
 - D) Post-occupancy energy performance monitoring
7. **According to the rules, who must the owner engage as a third-party assessor to verify the building's energy and sustainability goals?**
 - A) A licensed municipal architect
 - B) An empanelled or certified energy auditor (building)
 - C) A representative from the Ministry of Power
 - D) A state-level electrical inspector

8. Which committee is tasked with hearing grievances filed by building owners relating to building permits or the determination of MEPI?
 - A) National Energy Conservation Building Code Implementation Committee
 - B) State Energy Conservation and Sustainable Building Code Implementation Committee
 - C) Technical Grievances Redressal Committee
 - D) BEE Executive Committee
9. When a building's actual energy performance deviates from design values after occupancy, which report is used for monitoring and potential enforcement?
 - A) Form X
 - B) Form XI
 - C) Form VI
 - D) Form VIII
10. The National Energy Conservation Building Code Implementation Committee is responsible for finalizing national energy consumption norms based on recommendations from:
 - A) International energy agencies
 - B) Individual building owners
 - C) State Energy Conservation and Sustainable Building Code Implementation Committees
 - D) Only the Bureau of Energy Efficiency

Section B: Short Answer Questions – 5 Nos

1. How do the ECBC Rules 2018 assist Urban Local Bodies (ULBs) in enforcing energy standards?
2. What is the role of an empanelled energy auditor (building) during the design stage?
3. Explain the significance of Form X and Form XII in the occupancy process.
4. What are the primary duties of a State-Designated Agency (SDA) regarding energy auditors?
5. Why does the framework include provisions for periodic updates and amendments to the Code?

Section C: Long Answer Questions – 2 Nos

1. Describe the systematic compliance pathway established by Statutory Forms I through XIII.
2. Explicate the roles of the State-Designated Agency (SDA) and the State Implementation Committee in the implementation of the ECSBC.

Answer Key for MCQs

- | | |
|------|-------|
| 1. B | 6. D |
| 2. B | 7. B |
| 3. C | 8. C |
| 4. A | 9. B |
| 5. C | 10. C |

8. ENERGY TERMINOLOGY AND OTHERS

8.1. General

This section defines specific terms, abbreviations, and acronyms for the purposes of ECSBC and ENS. These definitions apply to all sections. Any terms not defined here should be interpreted according to their commonly accepted meanings in the context in which they appear.

A

Above grade area (AGA): AGA is the cumulative floor area of all the floor levels of a building that are above the ground level. Ground level shall be as defined in building site plan. A floor level is above grade if one-third of the total external surface area of only the said floor level is above the ground level.

Accredited energy auditor building: Means an energy auditor accredited in accordance with the provisions of Clause (p) of Sub-section (2) of Section 13. [An accredited energy auditor in building means an energy auditor who carries out a comprehensive evaluation and analysis of a building's current energy use, including heating and cooling equipment, other appliances, and utility bill data.]

Accredited independent laboratory: Testing laboratory not affiliated with producer or consumer of goods or products tested at the laboratory and accredited by national or international organisations for technical competence.

Addition: An extension or increase in floor area or height of a building outside of the existing building envelope.

Affordable housing projects: Affordable houses are dwelling units (DUs) with carpet area less than 60 sq. m. 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% of the FAR/FSI for dwelling units of carpet area not more than 60 sq. m will be considered as affordable housing projects. This definition could be changed time to time by the Ministry of Housing and 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.

Air changes per hour (ACH): The ACH is a measurement that quantifies the number of times the air within a space is completely replaced with fresh air within a one-hour time period. It indicates the effectiveness of ventilation or air exchange in a given space.

Air-conditioning and condensing units serving computer rooms: Air-conditioning equipment that provides cooling by maintaining space temperature and humidity within a narrow range. Major application is in data centres where dissipating heat generated by equipment takes precedence over comfort cooling for occupants.

Alternate water source: Non-potable source of water that includes grey water, on-site treated water, harvested rainwater, and reclaimed (recycled) water from sewage treatment plant.

Alteration: Any change, rearrangement, replacement, or addition to a building or its systems

and equipment; any modification in construction or building equipment.

Area weighted average (AWA) method: The AWA method is based on the concept of weighted arithmetic mean where instead of each data point contributing equally to the final mean; each data point contributes more 'weight' than others based on the size of the area the said data point is applicable to. To calculate the area weighted average mean, a summation of each data point multiplied with its respective area is divided with the total area.

$$AWA = \frac{\Sigma(\text{Data point} \times \text{area})}{\text{Total area}}$$

Astronomical time control: An automatic time control that makes an adjustment for the length of the day as it varies over the year.

Automatic control device: A device capable of automatically turning loads off and on without manual intervention.

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

Backflow: The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any sources other than its intended source Back- Siphonage, Back- Pressure Backflow etc.

Balancing, air system: Adjusting airflow rates through air distribution system devices, such as fans and diffusers, by manually adjusting the position of dampers, splitters vanes, extractors, etc., or by using automatic control devices, such as constant air volume or variable air volume boxes.

Balancing, hydronic system: Adjusting water flow rates through hydronic distribution system devices, such as pumps and coils, by manually adjusting the position valves, or by using automatic control devices, such as automatic flow control valves.

Ballast: Unit inserted between the supply and one or more discharge lamps which by means of inductance, capacitance or resistance, single or in combination, serves mainly to limit the current of the lamp(s) to the required value. It may also include means for transforming from the supply voltage and arrangements which help to provide starting voltage and preheating current, prevent cold starting, reduce stroboscopic effect, correct the power factor and suppress radio interference.

Bar: 1 bar pressure is equivalent to 1 kg/cm² or 10 m of water column.

Baseline building: A building that has the same building floor area, gross wall area, and gross roof area as the proposed building and it conforms to all the mandatory requirements of ECSBC-compliant building.

Boiler: A self-contained low-pressure appliance for supplying steam or hot water.

Brownfield site: Real property or the expansion, redevelopment, or reuse of which may be complicated by the presence or possible presence of a hazardous substance, pollutant, or

contaminant.

Building or building complex or complex: A structure wholly or partially enclosed within exterior walls, or within exterior and party walls, and a roof, affording shelter to persons, animals, or property. Building complex means a building or group of buildings constructed in a contiguous area for business, commercial, institutional, healthcare, hospitality purposes or assembly buildings under the single ownership of individuals or group of individuals or under the name of a co-operative group society or on lease and sold as shops or office space or space for other commercial purposes, having a connected load of 100 kW or contract demand of 120 kVA and above.

Building base: Includes building structure, building envelope, common areas, circulation areas, parking, basements, services area, plant room and its supporting areas, and open project site area.

Building, core, and shell: Buildings where the developer or owner will only provide the base building and its services.

Building (existing): A building or portion thereof that was previously occupied or approved for occupancy by the authority having jurisdiction.

Building envelope: The exterior plus the semi-exterior portions of a building. For the purposes of determining building envelope requirements, the classifications are defined as follows:

Building envelope (exterior): The elements of a building that separate conditioned spaces from the exterior.

Building envelope (semi-exterior): The elements of a building that separate conditioned space from unconditioned space or that enclose semi-heated spaces through which thermal energy may be transferred to or from the exterior, or to or from unconditioned spaces, or to or from conditioned spaces

Building envelope dwelling units (ENS): The elements of a building that separate the habitable spaces of dwelling units from the exterior and are exposed to the ambient (i.e., exposed directly to external air and opening into balconies). It does not include walls facing open corridors and enclosed shafts as well as walls of common services such as lifts and staircase (see Figure 1: Walls included in the definition of building envelope. Dotted lines show the walls included in the definition of building envelope in this code).



Figure 16 Walls included in the definition of building envelope

Building grounds lighting: Lighting provided through a building's electrical service for parking lot, site, roadway, pedestrian pathway, loading dock, and security applications.

Building material: Any element of the building envelope through which heat flows and that heat is included in the component U-factor calculations other than air films and insulation.

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 (BUA): Sum of the covered areas of all floors of a building, other than the roof, and areas covered by external walls and parapet on these floors.

Bio digester: Biogas digester uses natural anaerobic decomposition of organic matter under controlled conditions to convert organic waste into manure.

Black water: Wastewater from toilet, bidet, urinals, kitchen sink, bed pan sink or similar contaminated sources.

24-hour business building: Business building operated and occupied for more than 12 hours on each weekday. Intensity of occupancy may vary.

C

Carbon credit certificate: Means the certificate issued by the Central Government or any agency authorized by it (in accordance with the provisions of the Energy Conservation Act), under Section 14AA.

Carbon credit trading scheme: Means the scheme for reduction of carbon emissions notified by the Central Government under Clause (w) of Section 14.

Cardinal direction: Cardinal directions or cardinal points are the four main directional points of a compass: north, south, east, and west.

Carpet area: Carpet area is the net usable floor area of a dwelling unit, excluding the area covered by the external walls, areas under services shafts, exclusive balcony or verandah area and exclusive open terrace area, but includes the area covered by the internal partition walls of the dwelling unit.

Centralized control: Single hardware/software for observing and controlling operations of a group of equipment and devices with similar or different functions

Circuit breaker: A safety device that automatically stops flow of current in electrical circuits. It protects the circuit from current surge.

Class of construction: Classification that determines the construction materials for the building envelope, roof, wall, floor, slab-on-grade floor, opaque door, vertical fenestration, skylight.

Coefficient of performance (CoP) – cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions

Coefficient of performance (COP) – heating: The ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system, including the compressor and, if applicable, auxiliary heat, under designated operating conditions

Colour rendering index (CRI): The CRI is a quantitative measure of the ability of a light source to accurately reveal the true colours of objects compared to a reference light source. It is a scale ranging from 0 to 100, with higher values indicating better colour rendering.

Common area: Areas within a commercial building that are available for use by all tenants in a building (i.e. lobbies, corridors, restrooms, etc.) in residential buildings, 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 m².

Commercial building: A building or a part of building or building complex which are used or intended to be used for commercial purposes and classified as per the time of the day the building is operational and sub classified, as per the functional requirements of its design, construction, and use as per following details:

Group I – 24 hours building covering Type A Hospitality, Type B Healthcare, and Type C Assembly, Type D Business and

Group II – Regular building covering Type D Business, Type E Educational, and Type F shopping complexes.

Compliance documents: The forms specified in ECSBC Rules and Regulations to record and check compliance with these rules. These include but are not limited to MEPI and PES compliance report, but also other required supporting documents on building envelope mechanical systems lighting system water management and waste management, site parameters and indoor environmental quality checks, permit checklists and certificates from certified auditor for existing or proposed buildings.

Connected load: The sum of the rated wattage of all equipment, appliances, and devices to be installed in the building or part of building or building complexes, in terms of kilowatt (kW) that will be allocated to all applicants for electric power consumption in respect of the proposed building or building complexes on their completion.

Contaminant: Any substance, that is potentially hazardous to human health or the environment and is present in the environment at concentrations above its natural or background concentration.

Contamination: An impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids, or waste. Also defined as high hazard.

Contract demand: The maximum demand in kilovolt-ampere (kVA) (within a consumer's sanctioned load) agreed to be supplied by the electricity provider or utility in the agreement executed between the user and the utility or electricity provider.

Construction documents: Drawings or documents, containing information pertaining to building construction processes and approvals, building materials and equipment specification, architectural details etc. required by the authority having jurisdiction.

Construction waste: Construction waste is any substance, matter, or thing that is produced as a result of construction work.

Controls or control device: Manually operated or automatic device or software to regulate the operation of building equipment

Cool roof: Roof with top layer of material that has high-solar reflectance and high-thermal emittance properties. Cool roof surfaces are characterized by light colours so that heat can be rejected back to the environment.

Cumulative design modelled energy performance index (MEPI): The MEPI for a building having two or more different functional uses and calculated based on the area weighted average (AWA) method.

D

Daylight area: The daylight illuminated floor area under horizontal fenestration (skylight) or adjacent to vertical fenestration (window), described as follows:

Horizontal fenestration: The area under a skylight, monitor, or sawtooth configuration with an effective aperture greater than 0.001 (0.1%). The daylight area is calculated as the horizontal dimension in each direction equal to the top aperture dimension in that direction plus either the floor-to-ceiling height (H) for skylights, or $1.5H$ for monitors, or H or $2H$ for the sawtooth configuration, or the distance to the nearest 1 metre or higher opaque partition, or one-half the distance to an adjacent skylight or vertical glazing, whichever is least, as shown in the figure below.

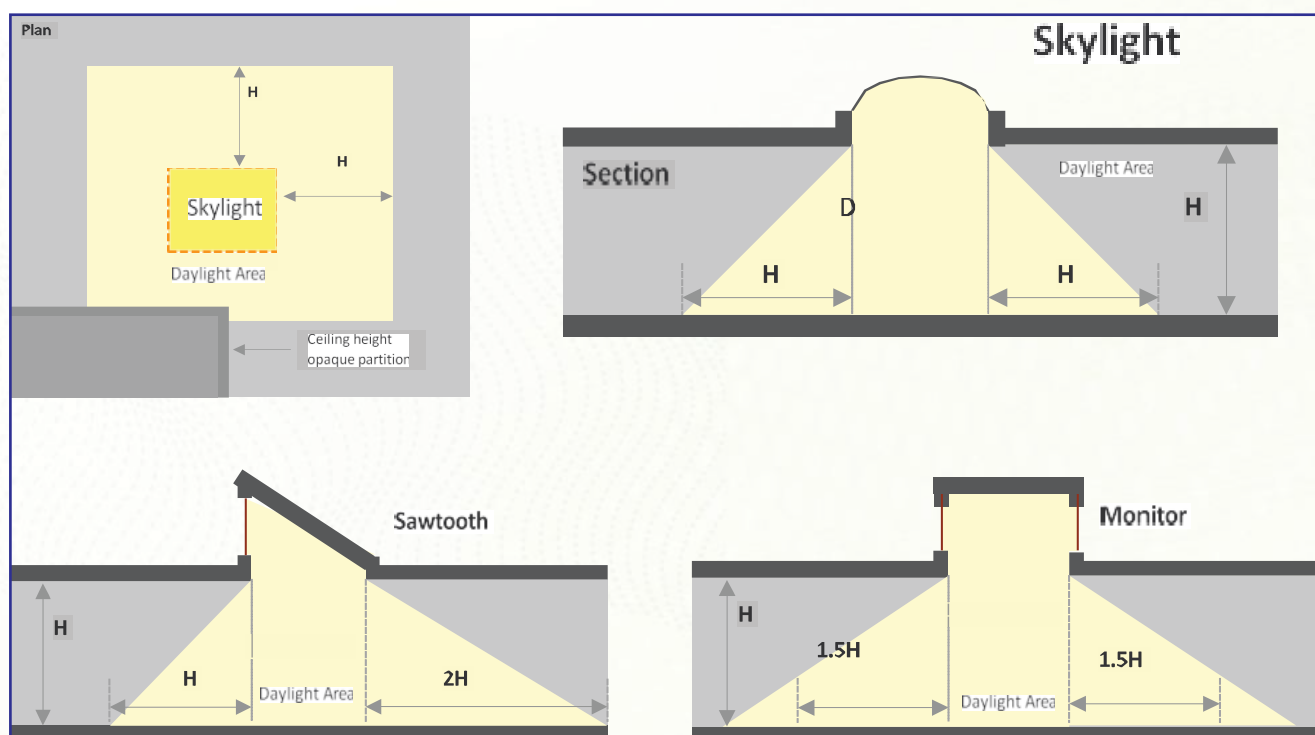


Figure 8 Plan and sections

Vertical fenestration: The floor area adjacent to side apertures (vertical fenestration in walls) with an effective aperture greater than 0.06 (6%). The daylight area extends into the space perpendicular to the side aperture, a distance equal to daylight extension factor (DEF) multiplied by the head height of the side aperture or till higher opaque partition, whichever is less. In the direction parallel to the window, the daylight area extends a horizontal dimension equal to the

width of the window plus either 1 meter on each side of the aperture, or the distance to an opaque partition, or one-half the distance to an adjacent skylight or window, whichever is least.

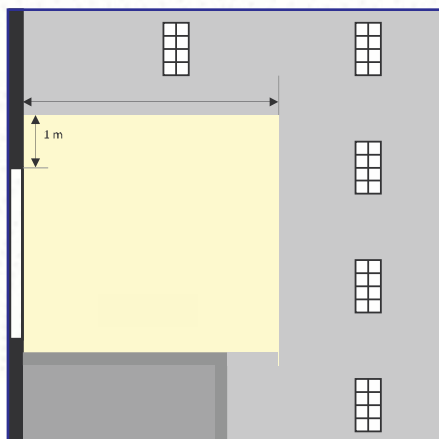


Figure 3: Vertical fenestration

Daylight extension factor (DEF): Factor to manually calculate the daylight area on floor plates. It is to be multiplied by the head height of windows. It is dependent on orientation and glazing VLT, shading devices adjacent to it and building location.

Daytime business building: Business building operated typically only during daytime on weekdays up to 12 hours each day.

Daylight window: Fenestration 2.2 metres above floor level, with an interior light shelf at bottom of this fenestration.

Dead band: The range of values within which a sensed variable can vary without initiating a change in the controlled process.

Demand: Maximum rate of electricity (kW) consumption recorded for a building or facility during a selected time frame.

Demand control ventilation (DCV): A ventilation system capability that provides automatic reduction of outdoor air intake below design rates when the actual occupancy of spaces served by the system is less than design occupancy.

Demand factor: It is the ratio of the sum of the maximum demand of a system (or part of a system) to the total connected load on the system (or part of the system) under consideration. Demand factor is always less than one.

Design capacity: Output capacity of a mechanical or electrical system or equipment at design conditions.

Design conditions: Specified indoor environmental conditions, such as temperature, humidity and light intensity, required to be produced and maintained by a system under which the system must operate.

Designated agency: Means any agency designated under Clause (d) of Section 15 [any agency designated by the state government to coordinate, regulate and enforce the provisions of the Energy Conservation Act within the state.]

Designated consumer: Means any consumer specified under Clause (e) of Section 14 [any consumer specified by the Central Government, in consultation with the Bureau, under Clause (e) of Section 14 of the Energy Conservation Act, 2001, having regard to the intensity or quantity of energy consumed and the amount of investment required for switching over to energy-

efficient equipment and capacity of industry to invest in it and availability of the energy-efficient machinery and equipment required by the industry, and it includes users of energy in energy-intensive industries and other establishments as specified in the Schedule to the Act;]

Distribution system: Network or system comprising controlling devices or equipment and distribution channels (cables, coils, ducts, pipes, etc.) for delivery of electrical power, or cooled or heated water or air in buildings.

Domestic sewage: The liquid and water-borne wastes derived from the ordinary living processes, free from industrial wastes, and of such character as to permit satisfactory disposal, without special treatment, into the public sewer or by means of a private sewage disposal system.

Domestic water: Potable water provided for domestic purposes such as drinking, cooking and supply to fixtures such as kitchen sink, washbasins, shower, clothes washer, and dishwasher.

Door: All operable opening areas that are not more than one half glass, in the building envelope, including swinging and roll-up doors, fire doors, and access hatches.

Door area: Total area of the door measured using the rough opening and including the door slab and the frame.

Drinking water: Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

Dwelling unit: An Independent housing unit with separate facilities for living, cooking, and sanitary requirement.

E

Economizer (air): A duct and damper arrangement with automatic controls that allow a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather.

Economizer (water): A system by which the supply air of a cooling system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling.

Effective aperture: Visible light transmittance x window-to-wall ratio ($EA = VLT \times WWR$).

Efficacy: The lumens produced by a lamp-plus ballast system divided by the total watts of input power (including the ballast), expressed in lumens per watt.

Efficiency: Performance at a specified rating condition.

Efficiency (thermal): Ratio of work output to heat input.

Efficiency (combustion): Efficiency with which fuel is burned during the combustion process in equipment.

Emittance: The ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

Energy: Power derived from renewable or non-renewable resources to provide heating, cooling, and light to a building or operate any building equipment and appliances. It has various forms such as thermal (heat), mechanical (work), electrical, and chemical that may be transformed from one into another. Customary unit of measurement is watts (W).

Energy audit: Means the verification, monitoring, and analysis of use of energy including

submission of technical report containing recommendations for improving energy efficiency with cost–benefit analysis and an action plan to reduce energy consumption.

Energy efficiency ratio (EER): The ratio of net cooling capacity in watt to total rate of electric input in watts under design operating conditions.

Energy recovery system: Equipment to recover energy from building or space exhaust air and use it to treat (pre-heat or pre-cool) outdoor air taken inside the building or space by ventilation systems.

ENS 2024 building: Any building in which all covered spaces comply with the requirements of chapter 3 of the Eco- Niwas Samhita 2024.

ENS 2024 point: It is the algebraic sum of the points that are obtained by meeting the requirements of Eco-Niwas Samhita 2024.

Envelope area: Envelope area (excluding roof) of dwelling units is the overall area of the building envelope (see definition 'building envelope'). It is the gross external wall area (includes the area of the walls and the openings such as windows and doors), with measurement taken horizontally from outside surface to outside surface and measured vertically from the top of the floor to the top of the roof.

Envelope performance factor (EPF): Value for the building envelope performance compliance option calculated using the procedures specified in Section 5.3.5. For the purposes of determining building envelope requirements the classifications are defined as follows:

- (a) Baseline building EPF: Envelope performance factor calculated for the baseline building using standardized requirements for walls, vertical fenestrations, and roofs
- (b) Proposed building EPF: The building envelope performance factor for the proposed building using proposed values for walls, vertical fenestrations, and roofs

Equipment: Mechanical, electrical, or static devices for operating a building, including but not limited to those required for providing cooling, heating, ventilation, lighting, service hot water, vertical circulation.

Equipment (existing): Equipment previously installed in an existing building.

Equivalent SHGC: SHGC for a fenestration with a permanent external shading projection. It is calculated using the projection factor (PF) of the permanent external shading projection and shading equivalent factor (SEF) listed in Section 5.3.3-(1).

Exemption: Any exception allowed to compliance with ECSBC requirements.

Fan system power: Sum of the nominal power demand (nameplate W or HP) of motors of all fans that are required to operate at design conditions to supply air from the heating or cooling source to the conditioned space(s) and return it to the point where it can be exhausted to outside the building.

Fenestration: All areas (including the frames) in the building envelope that let in light, including windows, plastic panels, clerestories, skylights, glass doors that are more than one-half glass, and glass block walls.

- (a) Skylight: A fenestration surface having a slope of less than 60 degrees from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration.
- (b) Vertical fenestration: All fenestration other than skylights. Trombe wall assemblies,

where glazing is installed within 300 mm of a mass wall, are considered walls, not fenestration.

Fenestration area: Total area of the fenestration measured using the rough opening and including the glazing, sash, and frame. For doors where the glazed vision area is less than 50% of the door area, the fenestration area is the glazed vision area. For all other doors, the fenestration area is the door area.

Finished floor level: Level of floor achieved after finishing materials have been added to the subfloor or rough floor or concrete floor slab.

Floor area: The net enclosed area expressed in m² of a floor in the building including circulation spaces like lobby or corridors, service areas and semi-open spaces such as verandah or balcony.

Fossil fuel: Fuel derived from a hydrocarbon deposit such as petroleum, coal, or natural gas derived from living matter of a previous geologic time

Fresh water: Water obtained from municipal, public utility, bore well, open well and bought out water for domestic use.

Fuel: A material that may be used to produce heat or generate power by combustion.

Fuel utilization efficiency (FUE): A thermal efficiency measure of combustion equipment like furnaces, boilers, and water heaters.

Gathering hall (type of assembly): Any building, its lobbies, rooms, and other spaces connected thereto, primarily intended for assembly of people, but which has no theatrical stage or permanent theatrical and/or cinematographic accessories and has gathering space for greater or equal to 100 persons, for example, stand-alone dance halls, stand-alone night clubs, halls for incidental picture shows, dramatic, theatrical or educational presentation, lectures or other similar purposes having no theatrical stage except a raised platform and used without permanent seating arrangement; art galleries, community halls, marriage halls, places of worship, museums, stand-alone lecture halls, passenger terminals and heritage and archaeological monuments, pool and billiard parlour, bowling alleys, community halls, courtrooms, gymnasiums, indoor swimming pools, indoor tennis court, any indoor stadium for sports and culture, auditoriums.

Grade: Finished ground level adjoining a building at all exterior walls.

Grey water: Untreated wastewater that has not come into contact with toilet waste, kitchen sink waste, or similarly contaminated sources. Grey water includes wastewater from bathtubs, showers, lavatories, clothes washers, laundry tubs, dishwashers and domestic RO reject water.

Guest room: Any room or rooms used or intended to be used by a guest for sleeping purposes.

Habitable spaces: Space in a building or structure intended or used for working, meeting, living, sleeping, eating, or cooking. Bathrooms, water closet compartments, closets, halls, storage or utility space, and similar areas are not considered habitable spaces.

Heat island effect: The thermal absorption by hardscape, such as dark, non-reflective pavement and buildings, and its subsequent radiation to surrounding areas. Other contributing factors may include vehicle exhaust, air conditioners, and street equipment. Tall buildings and narrow streets reduce airflow and exacerbate the effect.

High-rise buildings: A building above 4 storeys, and/or a building exceeding 15 metres or more in height (without stilt) and 17.5 metres (including stilt).

Hospitals and sanatoria (healthcare): Any building or a group of buildings under single management, used for housing persons suffering from physical limitations because of health or age and those incapables of self-preservation, for example, any hospitals, infirmaries, sanatoria, and nursing homes.

HVAC system: Equipment, distribution systems, and terminal devices that provide, either collectively or individually, the processes of heating, ventilating, or air conditioning to a building or parts of a building.

Hyper markets (Type F of shopping complex): Large retail establishments that are a combination of supermarket and department stores. They are considered as a one-stop shop for all needs of the customer.

Indoor air quality: The nature of indoor air that affect the health and well-being of building component.

Indoor environment quality: The condition or state of indoor environment.

Infiltration: Uncontrolled inward air leakage through cracks and crevices in external surfaces of buildings, around windows and doors due to pressure differences across these caused by factors such as wind or indoor and outside temperature differences (stack effect), and imbalance between supply and exhaust air systems

Installed interior lighting power: Power in watts of all permanently installed general, task, and furniture lighting systems and luminaries.

Integrated energy efficiency ratio (IEER): It 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.

Integrated part-load value (IPLV): Weighted average efficiency of chillers measured when they are operating at part load conditions (less than design or 100% conditions). It is more realistic measurement of chillers efficiency during its operational life.

Inventory: A complete list of items such as property, goods in stock, or the contents of a building

Labelled: equipment or materials to which a symbol or other identifying mark has been attached by the manufacturer indicating compliance with specified standard or performance in a specified manner.

Lighted floor area (gross): Gross area of lighted floor spaces

Lighting (decorative): Lighting that is ornamental or installed for aesthetic effect. Decorative lighting shall not include general lighting.

Lighting (emergency): Battery-backed lighting that provides illumination only when there is a power outage and general lighting luminaries are unable to function.

Lighting (general): Lighting that provides a substantially uniform level of illumination throughout an area. General lighting shall not include decorative lighting or lighting that provides a dissimilar level of illumination to serve a specialized application or feature within such area.

Lighting system: A group of luminaires circuited or controlled to perform a specific function.

Lighting power allowance:

- (a) **Interior lighting power allowance:** The maximum lighting power in watts allowed for interior of a building.
- (b) **Exterior lighting power allowance:** The maximum lighting power in watts allowed for the exterior of a building.

Lighting power density (LPD): Maximum lighting power per unit area of a space as per its function or building as per its classification.

Low-energy comfort systems: Space conditioning or ventilation systems that are less energy intensive than vapour compression-based space condition systems. These primarily employ alternate heat transfer methods or materials (adiabatic cooling, radiation, desiccant, etc.), or renewable sources of energy (solar energy, geo-thermal) so that minimal electrical energy input is required to deliver heating or cooling to spaces.

Low-rise buildings: A building equal or below 4 storeys, and/or a building up to 15 metres in height (without stilt) and up to 17.5 metres (including stilt).

Luminous efficacy (LE): Total luminous flux emitted from a luminaire upon input power, expressed in lumens per watt.

Luminaire: Equipment which distributes, filters directs the light transmitted from one or more lamps and which includes all the parts necessary for supporting, fixing and protecting the lamps, but not the lamps themselves, and where necessary, circuit auxiliaries together with the means for connecting them to the supply.

Note: A luminaire with integral non-replaceable lamps is regarded as a luminaire, except that the tests are not applied to the integral lamp or integral self-ballasted lamp.

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.

Man-made daylight obstruction: Any permanent man-made object (equipment, adjacent building) that obstructs sunlight or solar radiation from falling on a portion or whole of a building's external surface at any point of time during a year is called as a man-made sunlight obstructor.

Manual (non-automatic): Requiring personal intervention for control. Non-automatic does not necessarily imply a manual controller, only that personal intervention is necessary.

Manufacturing processes: Processes through which raw material is converted into finished goods for commercial sale using machines, labour, chemical, or biological processes, etc.

Manufacturer: Company or person or group of persons who produce and assemble goods or purchases goods manufactured by a third party in accordance with their specifications.

Mean temperature: Average of the minimum daily temperature and maximum daily temperature.

Mechanical cooling: Reducing the temperature of a gas or liquid by using vapour compression, absorption, and desiccant dehumidification combined with evaporative cooling, or another energy-driven thermodynamic cycle. Indirect or direct evaporative cooling alone is not considered mechanical cooling.

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

Modelled energy performance intensity (MEPI): MEPI of a building is estimated annual energy consumption in kilowatt-hours per square metre area of the building (excluding unconditioned basement area, unconditioned refuge area, and stilt parking area) and calculated using a simulation program.

Metered faucet: A self-closing factory calibrated faucet that dispenses a predetermined volume of water for each cycle.

Metering: Practice of installing meters in buildings to acquire data for energy consumption and other operational characteristics of individual equipment or several equipment grouped on basis of their function (lighting, appliances, chillers, etc.). Metering is done in buildings to monitor their energy performance.

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

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

National Building Code (NBC): Model building code that provides guidelines for design and construction of buildings.

Natural daylight obstruction: Any natural object, like tree, hill, etc. that obstructs sunlight from falling on part or whole of a building's external surface at any point of time during a year and casts a shadow on the building surface.

Naturally ventilated building: A building that does not use mechanical equipment to supply air to and exhaust air from indoor spaces. It is primarily ventilated by drawing and expelling air through operable openings in the building envelope.

Net exposed roof area: Net exposed roof area = Total roof area – equipment area

Non-cardinal directions: Any direction which is not a cardinal direction, i.e. perfect north, south, east, or west, is termed as non-cardinal direction.

Non-opaque building envelope components: Non-opaque building envelope components include transparent/translucent panels in windows, doors, ventilators, etc.

No star hotel (type of hospitality): Any building or group of buildings under the same management, in which separate sleeping accommodation on commercial basis, with or without dining facilities or cooking facilities, is provided for individuals. This includes lodging rooms, inns, clubs, motels, guest houses and excludes residential apartments rented on a lease agreement of four months or more. These shall also 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 adjoining rooms under joint occupancy and single management, for example, school and college dormitories, students, and other hostels and military barracks.

Occupant/Occupancy sensor: A device that detects the presence or absence of people within an area and causes lighting, equipment, or appliances to be dimmed, or switched on or off accordingly.

On-site electricity generation systems: Systems located at the building site that generate electricity, including but not limited to, generators, combined heat and power systems, fuel cells, and on-site renewable energy systems.

On-site renewable energy: Energy from renewable resources harvested at the building site.

Opaque assembly or opaque construction: Surface of the building roof or walls other than fenestration and building service openings such as vents and grills.

Opaque building envelope components: Opaque building envelope components include walls, opaque panels in doors, windows, ventilators, etc.

Opaque external wall: External wall composed of materials which are not transparent or translucent, usually contains the structural part of the building, and support the glazed façade. This type may be composed of one or more materials.

Open gallery mall (type of shopping complex): A large retail complex containing a variety of stores and often restaurants and other business establishments housed in a series of connected or adjacent buildings or in a single large building. The circulation area and atrium of the open gallery mall is an unconditioned space and is open to sky.

Openable area of dwelling unit: The total openable area expressed in m² 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).

Openable window-to-floor ratio (WFR_{op}): The WFR_{op} is the ratio of the total openable area to the total carpet area of dwelling units. The total openable area of a dwelling unit is the addition of openable area of all windows and ventilators, opening directly to the external air, an open balcony, 'verandah', corridor or shaft; and the openable area of the doors opening directly into an open balcony.

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

Operative temperature: A uniform temperature of a radially black enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the actual non-uniform environment.

It is combined effect of the mean radiant temperature and air temperature calculated as average of the two. It is also known as dry resultant temperature or resultant temperature.

Organic waste: Any material that is easily compostable and comes from either a plant or an animal including but not limited to, kitchen waste (food scraps, fruit and vegetable peels, tea leaves, and coffee grounds etc.), garden waste (pruning/ cutting waste, shredded leaves, mulches, flowers etc.).

Organic waste converters (OWC): Machines that are used to convert organic waste such as vegetable waste, meat waste, bakery waste, leaves, fruits and fruit skins, and flowers into valuable compost that can be used for organic farming activities.

Orientation: The direction a building facade faces, i.e., the direction of a vector perpendicular to and pointing away from the surface of the facade. For vertical fenestration, the two categories are north- oriented and all other.

Orientation factor (ω): It is a measure of the amount of direct and diffused solar radiation that is received on the vertical surface in a specific orientation. This factor accounts for and

gives weightage to the fact that the solar radiation falling on different orientations of walls is not same.

Outdoor (outside) air: Air taken from the outside the building and has not been previously circulated through the building.

Out-patient healthcare (type of healthcare): Any building or a group of buildings under single management, which is used only for treating persons requiring treatment or diagnosis of disease but not requiring overnight or longer accommodation in the building during treatment or diagnosis.

Overcurrent: Any current in excess of the rated current of the equipment of the ampacity of the conductor. It may result from overload, short circuit, or ground fault.

Overall efficiency: Efficiency of motor and pump considered together.

Owner: A person, group of persons, company, trust, institute, registered body, state or Central Government and its attached or subordinate departments, undertakings and like agencies or organisation in whose name the property stands registered in the revenue records for the construction of a building or building complex.

Packaging construction waste: Including but not limited to cement bags, wooden crates and pallets, cardboard boxes, plastic wrapping and shrink wrap, foam and bubble wrap, Strapping bands and steel wires, Polyethylene film or plastic sheeting, plastic or metal drums/buckets/containers, corrugated plastic sheets, specialized packaging, etc.

Party wall: A firewall on an interior lot line used or adapted for joint service between two buildings.

Paved areas: Paved area is an area that is paved with concrete, asphalt, stone, brick, gravel, or other wearing surface.

Percentage of energy saving (PES): Percentage of energy saving of proposed building in reference to baseline building.

Permanently installed: Equipment that is fixed in place and is not portable or movable.

pH: pH is a figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acid and higher values more alkaline. The pH is equal to $-\log_{10} c$, where c is the hydrogen ion concentration in moles per litre.

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

Plenum: A compartment or chamber to which one or more ducts are connected that forms a part of the air distribution system, and that is not used for occupancy or storage.

Plug loads: Energy used by products that are powered by means of an AC plug. This term excludes building energy that is attributed to major end uses specified in the code (like HVAC, lighting, water heating, etc.).

Plumbing appliance: Devices or equipment that are intended to perform a special plumbing function. Its operation and/or control may be dependent upon one or more energized components, such as motors, controls, heating elements, or pressure or temperature-sensing elements. Such device or equipment shall be permitted to operate automatically or manually by the user or operator.

Plumbing appurtenance: A device or assembly that is an adjunct to the basic piping system and plumbing fixtures. An appurtenance demands no additional water supply, nor does it add any discharge load to a fixture or the drainage system. It performs some useful function in the operation, maintenance, servicing, economy, or safety of the plumbing system.

Plumbing fixture: An approved-type receptacle or device that is supplied with water or that receives liquid wastes and discharges such wastes into the drainage system to which it may be directly or indirectly connected.

Plumbing system: Includes water, building supply, and distribution pipes; all plumbing fixtures, fittings, appliances and appurtenances; all drainage and vent pipes; and all building drains and building sewers, including on-site water and sewage treatment.

Pool: Any structure, basin, or tank containing an artificial body of water for swimming, diving, or recreational bathing. The terms include, but no limited to, swimming pool, whirlpool, spa, hot tub.

Post occupancy: The buyer of a property agrees to allow the seller of the property to stay in the property past the settlement date.

Potable water: Water that is satisfactory for drinking, culinary, and domestic purposes and that meets the requirements of the health authority having jurisdiction.

P&I diagram: Piping and instrument diagram is a detail diagram which shows all the piping together with the equipment's, instruments, and control devices.

Potential daylight time: Amount of time in a day when there is daylight to light a space adequately without using artificial lighting.

Primary inter-cardinal direction: Any of the four points of the compass, midway between the cardinal points; northeast, southeast, southwest, or northwest are called primary inter-cardinal direction.

Process load: Building loads resulting from the consumption or release of energy due to industrial processes or processes other than those for providing space conditioning, lighting, ventilation, or service hot water heating.

Projection factor (overhang): It is the ratio of the horizontal depth of the external shading projection to the sum of the height of the fenestration and the distance from the top of the fenestration to the bottom of the farthest point of the external shading projection, in consistent units.

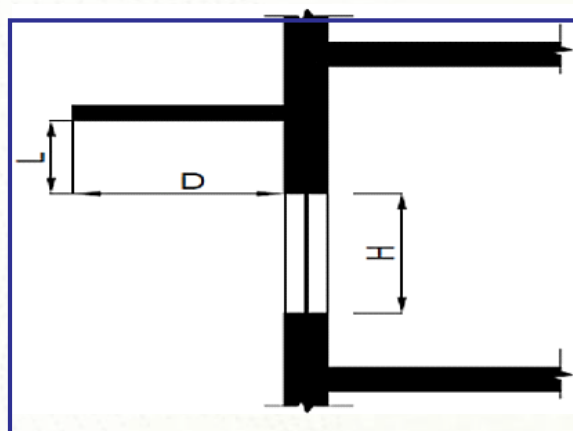


Figure 4: Projection factor right fin $(PFR) = D/(H+L)$

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

Projection factor (side fin): It is the ratio of the horizontal depth of the external shading projection to the distance from the window jamb to the farthest point of the external shading projection, in consistent

Projection factor Left Fin $(PF \text{ left}) = C/(A+W)$

Projection factor Right Fin $(PF \text{ right}) = C/(B+W)$

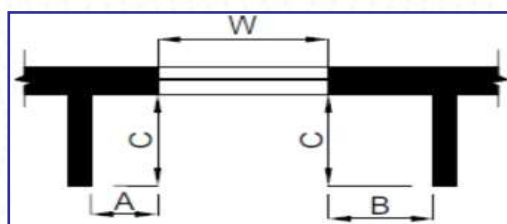


Figure 5: Projection factor of vertical shading device

Projection factor (overhang and side fin): Average of ratio projection factor for overhang only and projection factor of side fin only.

Proposed building: Is consistent with the actual design of the building and complies with all the mandatory requirements of ECSBC.

Proposed design: A computer model of the proposed building, consistent with its actual design, which complies with all the mandatory requirements of ECSBC.

R-value (thermal resistance): The reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. Units of R value are $\text{m}^2 \cdot \text{k} / \text{W}$.

Readily accessible: Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc. In public facilities, accessibility may be limited to certified personnel through locking covers or by placing equipment in locked rooms.

Recirculating system: A domestic or service hot water distribution system that includes a close circulation circuit designed to maintain usage temperatures in hot water pipes near terminal devices (e.g., lavatory faucets, shower heads) in order to reduce the time required to obtain hot water when the terminal device valve is opened. The motive force for circulation is either natural (due to water density variations with temperature) or mechanical (recirculation pump).

Reclaimed (recycled) water: Non-potable water generated, as a result of tertiary treatment of domestic black/grey water that meets requirements of the authority having jurisdiction for its intended uses.

Regularly occupied spaces (residential): Regularly occupied spaces include living room, bedrooms, dining room, kitchen, etc.

Remediation: The doing of any works, or carrying out of any operations or taking of any steps in relation to a polluted site for the purpose of (a) identifying or investigating or preventing or minimizing or remedying or mitigating the adverse effects by reason of which polluted site is such site; (b) restoring the quality of environment, flora and fauna at the site to an acceptable level; and includes making of subsequent inspections from time to time for the purpose of keeping under review the condition of the site in question, in the manner prescribed.

Renewable energy generating zone: A contiguous or semi-contiguous area, either on rooftop or elsewhere within site boundary, dedicated for installation of renewable energy systems.

Renewable energy resources: Energy from solar, wind, biomass or hydro, or extracted from hot fluid or steam heated within the earth.

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, the 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.

Residential envelope heat transmittance (RETV): The RETV is the net heat gain rate (over the cooling period) through the building envelope of dwelling units (excluding roof) divided by the area of the building envelope (excluding roof) of dwelling units. Its unit is W/m^2 .

Solar Heat gain coefficient (SHGC):²⁷ The SHGC is the fraction of incident solar radiation admitted through non-opaque components, both directly transmitted, and absorbed and subsequently released inward through conduction, convection, and radiation (Figure 6).

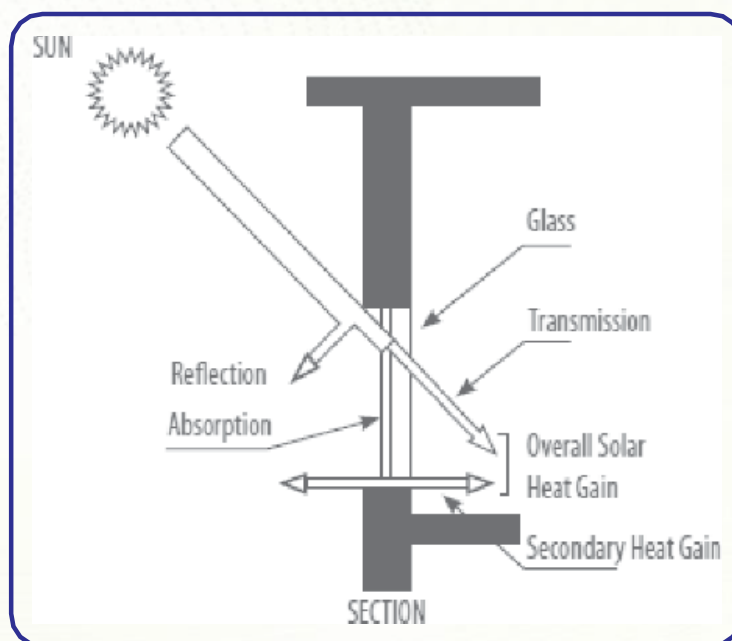


Figure 6: Solar heat gain through a non-opaque component

Resort (type of hospitality): Commercial establishments that provide relaxation and recreation over and above the accommodation, meals, and other basic amenities. The characteristics of resort are:

- i. Includes one or more recreation(s) facility like spa, swimming pool, or any sport.
- ii. Is located in the midst of natural and picturesque surroundings outside the city.
- iii. Comprises two or more blocks of buildings within the same site less than or equal to three floors (including the ground floor).

Reset: Automatic adjustment of the controller set-point to a higher or lower value.

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

Roof: The upper portion of the building envelope, including opaque areas and fenestration, that is horizontal or tilted at an angle of less than 60° from horizontal. This includes podium roof as well which are exposed to direct sun rays.

Roof area (gross): The area of the roof measured from the exterior faces of walls or from the centerline of party walls.

Roof gardens: In the case of roofs with roof gardens on earth fill for plantation or lawn, the thermal resistance of the earth fill can be taken into the calculation of the thermal transmittance (U value) of the roof. Some of the heat absorbed by the earth fill is also released into the atmosphere due to evapotranspiration of irrigation water from the roof garden, thus giving additional benefit.

Sedimentation basin: A sediment basin is a temporary pond built on a construction site to capture eroded or disturbed soil that is washed off during rainstorms, and protect the water quality of a nearby stream, river, lake, or bay. The sediment-laden soil settles in the pond before the runoff is discharged.

Service: The equipment for delivering energy from the supply or distribution system to the premises served.

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

Service water heating equipment: Equipment for heating water for domestic or commercial purposes other than space heating and process requirements.

Set-point: The desired temperature (°C) of the heated or cooled space that must be maintained by mechanical heating or cooling equipment.

Sewage: Wastewater containing human excreta (faeces and urine) as well as sources of black water and grey water.

Shading coefficient (SC): Measure of thermal performance of glazing. It is the ratio of solar heat gain through glazing due to solar radiation at normal incidence to that occurring through 3 mm thick clear, double-strength glass. Shading coefficient, as used herein, does not include interior, exterior, or integral shading devices.

Shading equivalent factor: Coefficient for calculating effective SHGC of fenestrations shaded by permanent overhangs or side fins. It is calculated by multiplying the external shading factor (ESF) with the SHGC of unshaded non-opaque component.

Shopping mall (shopping complex): A large retail complex containing a variety of stores and often restaurants and other business establishments housed in a series of connected or adjacent buildings or in a single large building. The circulation area and atrium of the mall is an

enclosed space covered completely by a permanent or temporary structure.

Simulation program: Software in which virtual building models can be developed to simulate the energy performance of building systems and daylighting analysis.

Single-zone system: An HVAC system serving a single HVAC zone.

Site-recovered energy: Waste energy recovered at the building site that is used to offset consumption of purchased fuel or electrical energy supplies.

Slab-on-grade floor: Floor slab of the building that is in contact with ground and that is either above grade or is less than or equal to 300 mm below the final elevation of the nearest exterior grade.

Solar energy source: Source of thermal, chemical, or electrical energy derived from direction conversion of incident solar radiation at the building site.

Solar heat gain coefficient (SHGC): The ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

Solar reflectance: Ratio of the solar radiation reflected by a surface to the solar radiation incident upon it.

Solar reflective index: A measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. It is defined such that a standard black surface (initial solar reflectance 0.05, initial thermal emittance 0.90) has an initial SRI of 0, and a standard white surface (initial solar reflectance 0.80, initial thermal emittance 0.90) has an initial SRI of 100. To calculate the SRI for a given material, obtain its solar reflectance and thermal emittance via the Cool Roof Rating Council Standard (CRRRC-1). SRI is calculated according to ASTM E 1980. Calculation of the aged SRI is based on the aged, tested values of solar reflectance and thermal emittance.

Space: An enclosed area within a building. The classifications of spaces are as follows for purpose of determining building envelope requirements:

- (a) Conditioned space: A cooled space, heated space, or directly conditioned space.
- (b) Semi-heated space: An enclosed space within a building that is heated by a heating system whose output capacity is greater or equal to 10.7 W/m^2 but is not a conditioned space.
- (c) Non-conditioned space: An enclosed space within a building that is not conditioned space or a semi-heated space. Crawlspace, attics, and parking garages with natural or mechanical ventilation are not considered enclosed spaces.

Sullage: Wastewater without faecal matter, commonly known as grey water.

Sustainable buildings: A building that meets the specified building performance requirement while minimizing disturbance to and improving the function of local, regional, and global ecosystem both during and after its construction and specified service life.

Star hotels/motels: Any building or group of buildings under single management and accredited as a starred hotel by the Hotel and Restaurant Approval and Classification Committee, Ministry of Tourism, in which sleeping accommodation, with or without dining facilities is provided.

Stand-alone retail (shopping complex): A large retail store owned or sublet to a single

management which may offer customers a variety of products under self-branding or products of different brands. The single management shall have a complete ownership of all the spaces of the building and no space within the building is further sold or sublet to a different management.

Storey: Portion of a building that is between one finished floor level and the next higher finished floor level or building roof. Basement and cellar shall not be considered a storey.

Summer solar insolation: Measure of solar radiation energy received on a given surface area from the month of March to October within the same calendar year. Units of measurement are watts per square metre (W/m^2) or kilowatt-hours per square metre per day ($\text{kWh}/(\text{m}^2/\text{day})$) (or hours/day).

Super market (shopping complex): Supermarkets are large self-service grocery stores that offer customers a variety of foods and household supplies. The merchandize is organized into an organized aisle format, where each aisle has only similar goods placed together.

System: A combination of equipment and auxiliary devices (e.g., controls, accessories, interconnecting means, and terminal elements) by which energy is transformed so it performs a specific function such as HVAC, service water heating, or lighting.

System efficiency: The system efficiency is the ratio of annual kWh electricity consumption of equipment of water cooled chilled water plant (i.e. chillers, chilled and condenser water pumps, cooling tower) to chiller thermal kWh used in a building.

System (existing): A system or systems previously installed in an existing building.

Tenant lease agreement: The formal legal document entered into between a landlord and a tenant to reflect the terms of the negotiations between them; that is, the lease terms have been negotiated and agreed upon, and the agreement has been reduced to writing. It constitutes the entire agreement between the parties and sets forth their basic legal rights.

Tenant leased area: Area of a building that is leased to tenant(s) as per the tenant lease agreement.

Terminal device: A device through which heated or cooled air is supplied to a space to maintain its temperature. It usually contains dampers and heating and cooling coils. Or a device by which energy form a system is finally delivered, e.g., registers, diffusers, lighting fixtures, faucets, etc.

Tactile warning blocks: Tactile warning blocks indicate an approaching potential hazard or a change in direction of the walkway, and serve as a warning of the approaching danger to persons with visual impairments, preparing them to tread cautiously and expect obstacles along the travel path, traffic intersections, doorways, etc.

Theatre or motion picture hall (type of assembly): Any building primarily meant for theatrical or operatic performances, and which has a stage, proscenium curtain, fixed or portable scenery or scenery loft, lights, mechanical appliances or other theatrical accessories and equipment for example, theatres, motion picture houses, auditoria, concert halls, television and radio studios admitting an audience and which are provided with fixed seats.

Thermal block: A collection of one or more HVAC zones grouped together for simulation purposes. Spaces need not be contiguous to be combined within a single thermal block.

Thermal comfort conditions: The condition of mind which express stratification with the thermal environment and is assessed by subjective evaluation.

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

Thermal emittance: Thermal emittance is the relative ability of a material to reradiate absorbed heat as invisible infrared radiation. Emittance, measured from 0 to 1, is defined as the ratio of the radiant flux emitted by a body to that emitted by a black body at the same temperature and under the same conditions.

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 $W/m^2 \cdot K$.

Thermostat: Device containing a temperature sensor used to automatically maintain temperature at a desirable fixed or adjustable set point in a space.

Tinted: As applied to fenestration, bronze, green, or grey colouring that is integral with the glazing material. Tinting does not include surface applied films such as reflective coatings, applied either in the field or during the manufacturing process.

Topsoil: Topsoil is the upper layer of a soil profile, usually darker in colour (because of its higher organic matter content) and more fertile than subsoil, and which is a product of natural, biological and environmental processes.

Transformer: A static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power

Transformer losses: Electrical losses in a transformer that reduces its efficiency.

Transport buildings (assembly): Any building or structure used for the purpose of transportation and transit like airports, railway stations, bus stations, and underground and elevated mass rapid transit system example, underground or elevated railways.

Unconditioned buildings: Building in which more than 90% of spaces are unconditioned spaces.

Unconditioned space: Mechanically or naturally ventilated space that is not cooled or heated by mechanical equipment.

Universities and all others coaching/training institutions (educational): A building or a group of buildings, under single management, used for imparting education to students numbering more than 100 or public or private training institution built to provide training/coaching etc.

Used water: Black or grey water from fixtures or appliances.

Useful daylight illuminance: Percentage of annual daytime hours that a given point on a work plane height of 0.8 m above finished floor level receives daylight between 100 lux to 2,000 lux.

U-factor (thermal transmittance): Heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side. Unit of U value is $W/m^2 \cdot K$.

Variable air volume (VAV) system: HVAC system that controls the dry-bulb temperature within a space by varying the volumetric flow of heated or cooled air supplied to the space.

Vegetative roofs: Also known as green roofs, they are thin layers of living vegetation installed on top of conventional flat or sloping roofs.

Ventilation: The process of supplying or removing air by natural or mechanical means to or from any space. Such air is not required to have been conditioned.

Video conferencing: Any space where one- or two- way audio and video communication is supported between two or more sites. Both audio (aural) and video (visual) communication are supported in real time. The transfer and display of information and data such as documents and multimedia program materials may also be available functions in a videoconference space.

Visible light transmittance (VLT): VLT is the ratio of the total transmitted light to the total incident light. It is a measure of the transmitted light in the visible portion of the spectrum through a material.

Vermicomposting: It is a process in which earthworms are used to convert organic materials into humus-like material known as vermicompost.

Vision windows: Windows or area of large windows that are primarily for both daylight and exterior views. Typically, their placement in the wall is between 1 metre and 2.2 metres above the floor level.

Volatile organic compounds (VOCs): The VOCs are a group of organic chemicals that easily evaporate at room temperature. They are commonly found in various products such as paints, solvents, cleaning agents, adhesives, and building materials.

Waste management: Waste management refers to the activities and actions required to manage waste from its start till its disposal. This includes collection, transport, treatment and disposal of waste together with monitoring and regulation.

Wall: That portion of the building envelope, including opaque area and fenestration, that is vertical or tilted at an angle of 60° from horizontal or greater. This includes above- and below-grade walls, between floor spandrels, peripheral edges of floors, and foundation walls.

- a) Wall, above grade: a wall that is not below grade.
- b) Wall, below grade: that portion of a wall in the building envelope that is entirely below the finish grade and in contact with the ground.

Wall area (gross): The overall area of a wall including openings such as windows and doors measured horizontally from outside surface to outside surface and measured vertically from the top of the floor to the top of the roof. If roof insulation is installed at the ceiling level rather than the roof, then the vertical measurement is made to the top of the ceiling. The gross wall area includes the area between the ceiling and the floor for multi-storey buildings.

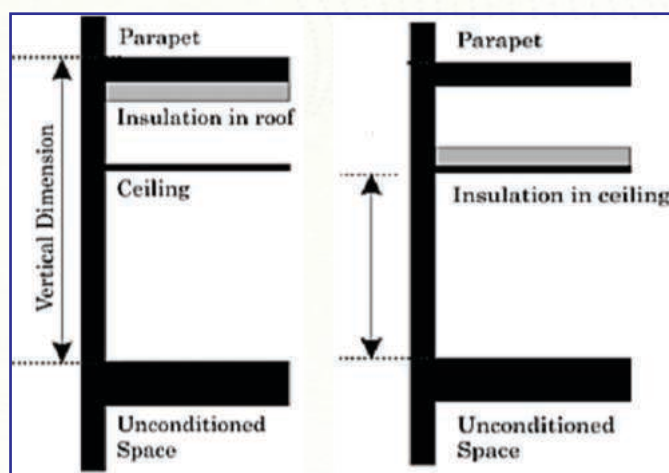


Figure 6: Delineation of Wall area for calculation of gross wall area with respect to insulation layer.

Water heater: Vessel in which water is heated and withdrawn for use external to the system.

Wastewater: Used water from plumbing fixtures or similar equipment which may be a source of black or grey water.

Wet area: Areas such as bathroom, toilet, kitchen, and laundry where water is utilized at fixtures and appliances.

White light source: Electrically operated product intended to emit, or, in the case of a non-incandescent light source, intended to be possibly tuned to emit, light, or both, with the following optical characteristics:

Chromaticity coordinates x and y in the range

$0.270 < x < 0.530$ and

$2.3172x^2 + 2.3653x - 0.2199 < y < -2.3172x^2$

$+ 2.3653x - 0.1595$

Window-to-wall ratio (WWR): The WWR is the ratio of the non-opaque building envelope components area to the envelope area (excluding roof) of dwelling units.

Zone (HVAC): A space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g., temperature) can be maintained throughout using a single sensor (e.g., thermostat or temperature sensor).

Zone (critical): A zone serving a process where reset of the zone temperature set-point during a demand shed event might disrupt the process, including but not limited to data centres, telecom and private branch exchange (PBX) rooms, and laboratories.

Zone (non-critical): A zone that is not a critical zone.

Zone (Plumbing): A group of 8–10 adjacent floors categorized as zone for a pumping system.



Table 20 Conversion of units

SI unit	IP unit
1 cmh	0.588 cfm
1 Pa	0.0040 inch of water gauge
1 m	3.28 ft
1 m	39.37 in
1 mm	0.039 in
1 l/s	2.12 cfm
1 m ²	10.76 ft ²
1 W/m ²	0.0929 W/ ft ²
1 W/ lin m	3.28 W/ ft
1 W/m ² .K	0.1761 Btu/ h-ft ² -°F
1 W/ l-s ⁻¹	0.063 W/ gpm
1 m ² .K/W	5.678 ft ² -h-°F/ Btu
1 °C	((°C X 9/5) + 32) °F
1 kW _r	0.284 TR
1 kW	1.34 hp
1 kW	3412.142 Btu/h

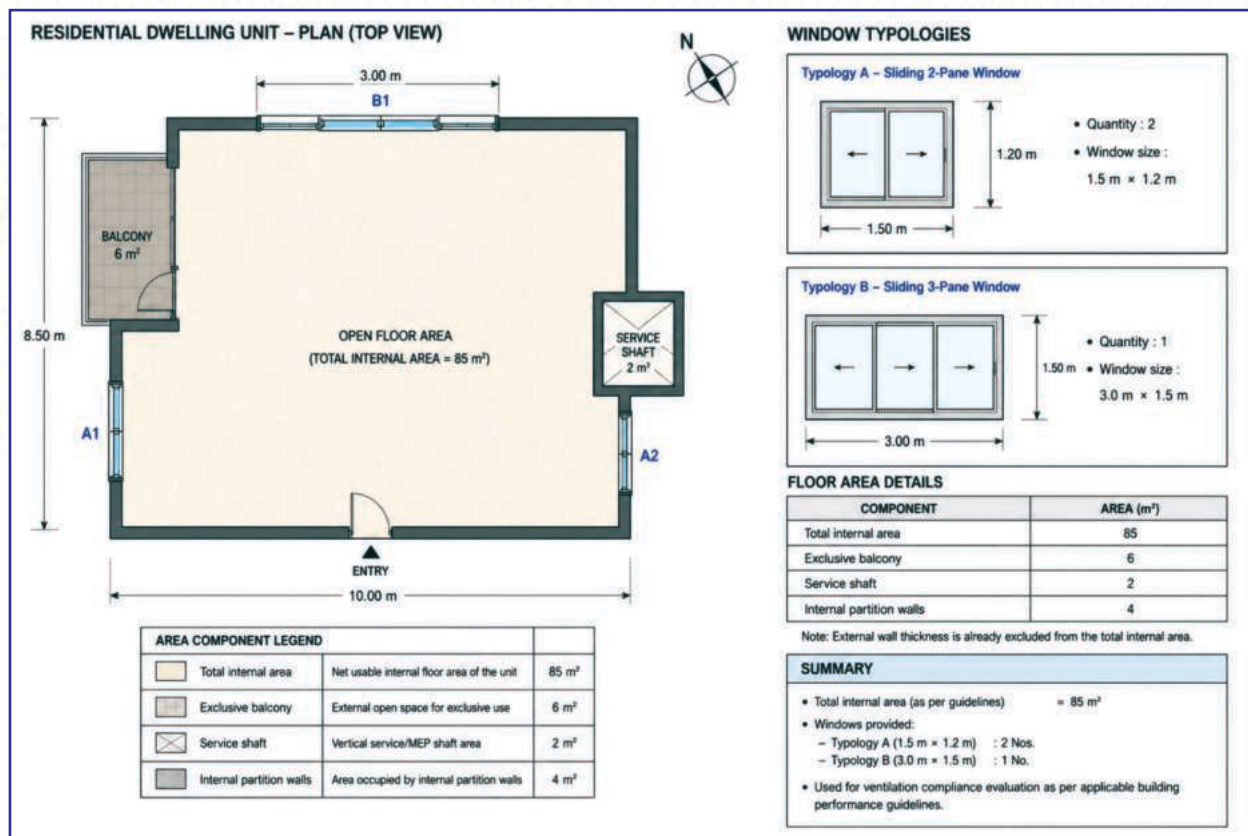
PRACTICE NUMERICALS

Openable Window-to-Floor Area Ratio (WFR_{OP})— Practice Problem

Practice Question: Residential Ventilation Compliance

Question 1: A residential dwelling unit is being evaluated for ventilation compliance under the applicable building performance guidelines.

The dwelling unit has the following characteristics:



Floor Area Details

Component	Area
Total internal area	85m ²
Exclusive balcony	6m ²
Service shaft	2m ²
Internal partition walls	4m ²

Note: External wall thickness is already excluded from the total internal area.

Window Details

Typology A – Sliding 2-Pane Windows

- Quantity: 2
- Window size: 1.5 m x 1.2m

Typology B – Sliding 3-Pane Window

- Quantity: 1
- Window size: 3.0 m x 1.5m

Task

Calculate the Openable Window-to-Floor Area Ratio (WFR_{op}) for the dwelling unit.

Solution: This exercise demonstrates the calculation methodology for the Openable Window-to-Floor Area Ratio (WFR_{op}) for a residential dwelling unit, including:

- Determination of carpet area
- Identification of typology-based openable window area
- Calculation of total effective openable area
- Final compliance ratio computation

Step-by-Step Solution

Step 1 – Calculate Carpet Area (A_{carpet})

As per the prescribed methodology, carpet area excludes:

- Exclusive balconies/verandahs
- Service shafts

but includes:

- Internal partition walls

Thus,

$$\begin{aligned} A_{\text{carpet}} &= \text{Total Internal area} + \text{internal partition walls area} \\ A_{\text{carpet}} &= 85 + 4 \\ A_{\text{carpet}} &= 89\text{m}^2 \end{aligned}$$

Therefore,

$$A_{\text{carpet}} = 89\text{m}^2$$

Step 2 – Calculate Openable Window Area ($A_{\text{openableDU}}$)

(a) Sliding 2-Pane Windows

Each window area:

$$1.5 \times 1.2 = 1.8\text{m}^2$$

Openable area per window:

$$1.8 \times 0.50 = 0.9\text{m}^2$$

For two windows:

$$2 \times 0.9 = 1.8\text{m}^2$$

Therefore,

$$A_{\text{openable,2pane}} = 1.8\text{m}^2$$

(b) Sliding 3-Pane Window

Window area:

$$3.0 \times 1.5 = 4.5 \text{ m}^2$$

Effective openable area:

$$4.5 \times 0.67 = 3.015 \text{ m}^2$$

Therefore,

$$A_{\text{openable,3pane}} = 3.015^2$$

Step 3 – Total Openable Area

$$A_{\text{openableDU}} = 1.8 + 3.015$$

$$A_{\text{openableDU}} = 4.815 \text{ m}^2$$

Therefore,

$$A_{\text{openable,3pane}} = 4.815 \text{ m}^2$$

Step 4 – Calculate Openable Window-to-Floor Area Ratio

The ratio is defined as:

$$\text{WFR}_{\text{op}} = \frac{A_{\text{openable}}}{A_{\text{carpet}}}$$

Substituting the values:

$$\text{WFR}_{\text{op}} = \frac{4.815}{89}$$

$$\text{WFR}_{\text{op}} = 0.0541$$

$$\text{WFR}_{\text{op}} = 5.41\%$$

Final Answer

$$\text{WFR}_{\text{op}} = 0.0541 \text{ or } 5.41\%$$

Key Learning Points

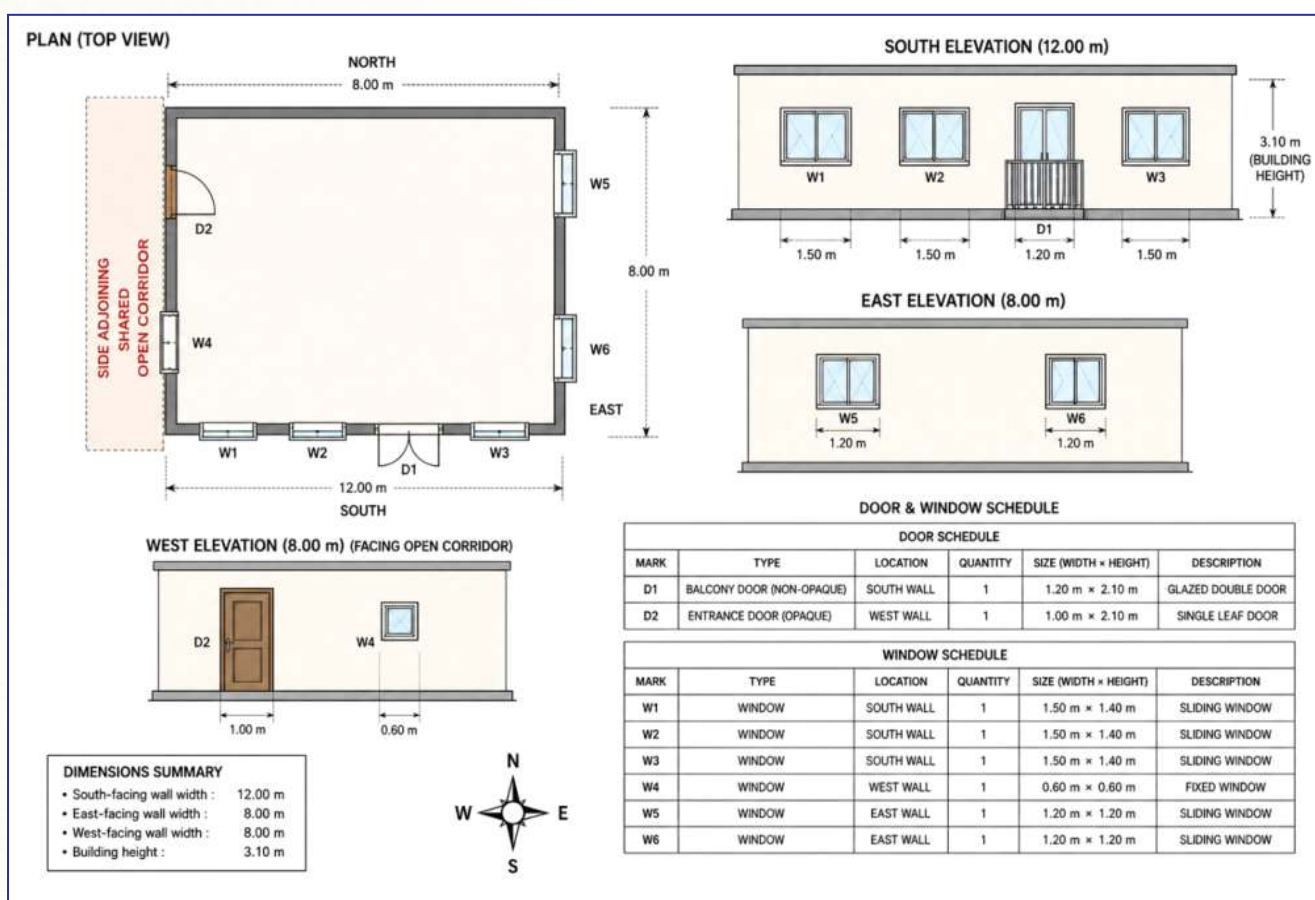
- Carpet area excludes balconies and service shafts but includes internal partition walls.
- Openable area depends on window typology and corresponding default opening percentage.
- Effective ventilation potential is assessed using the ratio of openable area to carpet area.
- Sliding window configurations significantly affect the final openable area contribution.

Window-to-Wall Ratio (WWR) – Practice Problem

Practice Question: Calculating Window-to-Wall Ratio (WWR)

Question 2: An architect is evaluating the Window-to-Wall Ratio (WWR) for a residential dwelling unit located at the end of a building block. The unit has three external-facing sides and one side adjoining a shared open corridor.

1. Building Dimensions and Measurement



External Wall Dimensions

Wall Orientation

South-facing wall

East-facing wall

Width

12 m

8 m

West-facing wall (facing open corridor) 8 m

Building Height

3.1 m

2. Openings (Fenestration and Doors)

South Wall

Windows

- Quantity: 3
- Size of each window:

1.5 m x 1.4 m

Non-Opaque Balcony Door

- Quantity: 1
- Size:

1.2 m x 2.1 m

East Wall

Windows

- Quantity: 2
- Size of each window:

1.2 m x 1.2 m

West Wall (Facing Open Corridor)

Opaque Entrance Door

- Quantity: 1
- Size:

1.0m x 2.1 m

Window

- Quantity: 1
- Size:

0.6m x 0.6 m

Task

Calculate the Window-to-Wall Ratio (WWR) for the dwelling unit.

Solution : This exercise demonstrates the methodology for calculating the Window-to-Wall Ratio (WWR) for a residential dwelling unit, including:

- Determination of gross envelope area
- Identification of non-opaque components
- Treatment of exclusions such as open corridors
- Calculation of effective WWR

Step-by-Step Solution**Step 1 – Identify Exclusions**

As per the prescribed methodology:

- Walls facing open corridors are excluded from WWR calculations.
- Openings on walls facing open corridors are also excluded.

Therefore:

- Exclude the entire west-facing wall
- Exclude the entrance door and window on the west wall

Step 2 – Calculate Total Envelope Area (A_{envelope})

The envelope area is calculated using the gross wall area, including openings.

South Wall Area

$$12 \times 3.1 = 37.2 \text{ m}^2$$

East Wall Area

$$8 \times 3.1 = 24.8 \text{ m}^2$$

North Wall Area

$$12 \times 3.1 = 37.2 \text{ m}^2$$

Total Envelope Area

$$A_{\text{envelope}} = 37.2 + 24.8 + 37.2$$

$$A_{\text{envelope}} = 99.2 \text{ m}^2$$

Therefore:

$$A_{\text{envelope}} = 99.2 \text{ m}^2$$

Step 3 – Calculate Total Non-Opaque Area (A_{envelope})**(a) South Wall Windows**

Area of one window:

$$1.5 \times 1.4 = 2.1 \text{m}^2$$

For three windows:

$$3 \times 2.1 = 6.3 \text{m}^2$$

For three windows:

$$3 \times 2.1 = 6.3 \text{m}^2$$

(b) South Wall Non-Opaque Door

$$1.2 \times 2.1 = 2.52 \text{m}^2$$

Since the door is fully glazed, the entire area is considered non-opaque.

(c) East Wall Windows

Area of one window:

$$1.2 \times 1.2 = 1.44 \text{m}^2$$

For two windows:

$$2 \times 1.44 = 2.88 \text{m}^2$$

Total Non-Opaque Area

$$A_{\text{non-opaque}} = 6.3 + 2.52 + 2.88$$

$$A_{\text{non-opaque}} = 11.7 \text{m}^2$$

Therefore,

$$A_{\text{non-opaque}} = 11.7 \text{m}^2$$

Step 4 – Calculate Window-to-Wall Ratio (WWR)

The Window-to-Wall Ratio is defined as:

Substituting the calculated values:

$$\text{WWR} = \frac{A_{\text{non-opaque}}}{A_{\text{envelope}}}$$

Final Answer

$$\begin{aligned}\text{WWR} &= \frac{11.7}{99.2} \\ \text{WWR} &= 0.1179 \\ \text{WWR} &= 11.79\%\end{aligned}$$

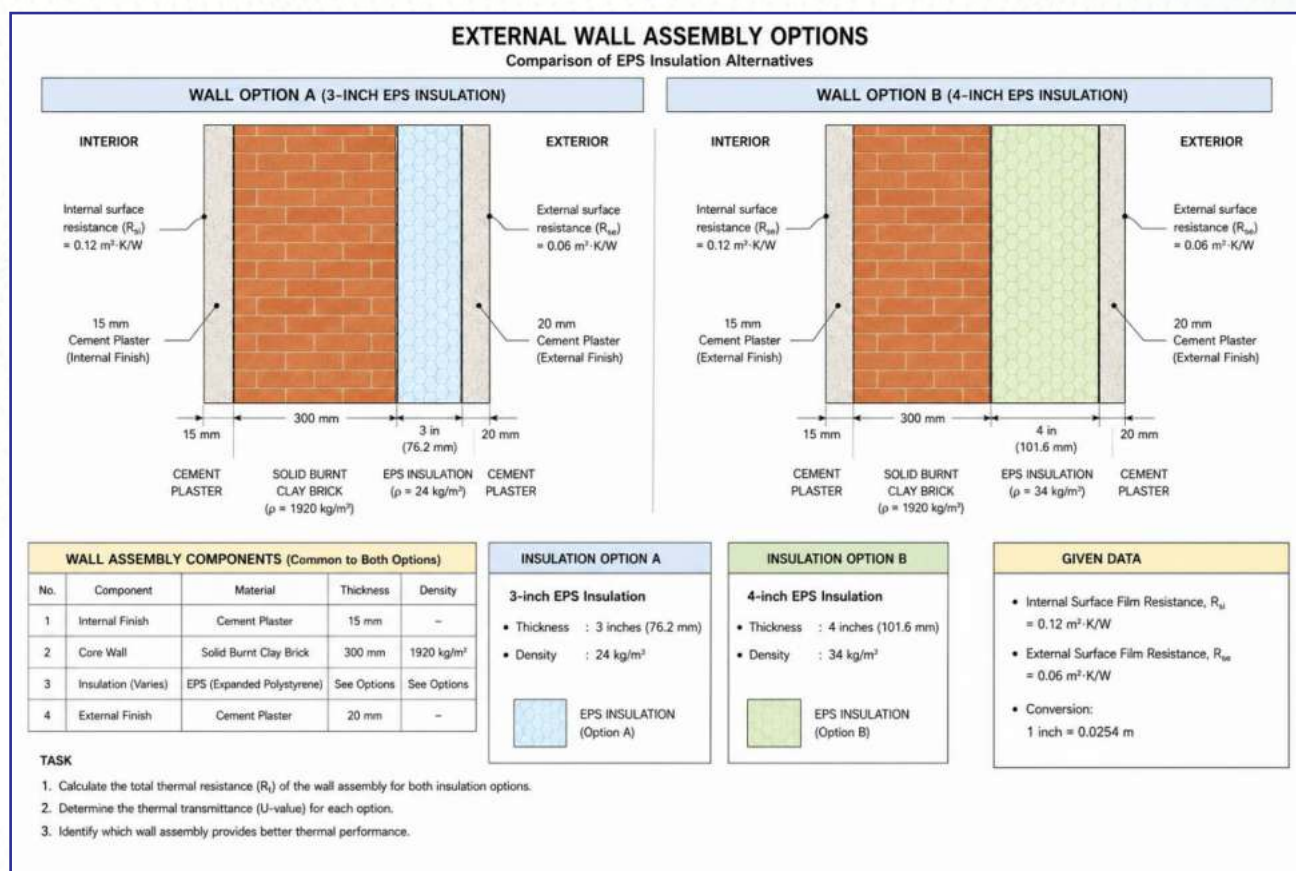
WWR = 0.1179 or 11.79%

Key Learning Points

- WWR calculations are based on gross envelope area, including openings.
- Non-opaque components include transparent and translucent glazing areas.
- Walls and openings facing open corridors are excluded from calculations.
- Opaque doors do not contribute to non-opaque area.
- Accurate measurement conventions are critical for compliance calculations.

Practice Question: Wall Thermal Performance with Plaster and Insulation

Question 3: You are evaluating the thermal performance of an external wall assembly for a residential building located in a Composite Climate zone. The wall consists of masonry construction with cement plaster finishes and an additional layer of thermal insulation. Two insulation alternatives using Expanded Polystyrene (EPS) are being compared to determine which option provides superior thermal efficiency.



Wall Assembly

- **Internal Finish:** 15 mm Cement Plaster
- **Core Wall:** 300 mm Solid Burnt Clay Brick (density = 1920 kg/m³)
- **External Finish:** 20 mm Cement Plaster

Insulation Alternatives

- **Option A:** 3-inch EPS insulation (density = 24 kg/m³)
- **Option B:** 4-inch EPS insulation (density = 34 kg/m³)

Given Data

- Internal Surface Film Resistance, R_{si} = 0.12 m²·K/W
- External Surface Film Resistance, R_{se} = 0.06 m²·K/W
- Conversion:

$$1 \text{ inch} = 0.0254 \text{ m}$$

Task

1. Calculate the total thermal resistance (R_t) of the wall assembly for both insulation options.
2. Determine the thermal transmittance (U-value) for each option.
3. Identify which wall assembly provides better thermal performance.

Step-by-Step Solution**Step 1: Determine Thermal Conductivity Values**

From the material property table:

Material	Thermal Conductivity k
Cement Plaster	0.721 W/m·K
Solid Burnt Clay Brick (1920 kg/m ³)	0.80 W/m·K
Expanded Polystyrene (EPS)	0.035 W/m·K

Step 2: Calculate Thermal Resistance of Each Layer

Thermal resistance is calculated using:

$$R = \frac{t}{k}$$

where:

- R = thermal resistance (m²·K/W)
- t = thickness (m)
- k = thermal conductivity (W/m·K)

1. Internal Cement Plaster

Thickness = 15 mm = 0.015 m

$$R = \frac{0.015}{0.721} = 0.0208 \text{ m}^2\cdot\text{K/W}$$

2. Brick Wall

Thickness = 300 mm = 0.30 m

$$R = \frac{0.30}{0.80} = 0.375 \text{ m}^2\cdot\text{K/W}$$

3. External Cement Plaster

Thickness = 20 mm = 0.020 m

$$R = \frac{0.020}{0.721} = 0.0277 \text{ m}^2 \cdot \text{K/W}$$

Step 3: Calculate Insulation Resistance**Option A — 3-inch EPS**

Convert thickness:

$$3 \times 0.0254 = 0.0762 \text{ m}$$

$$R = \frac{0.0762}{0.035} = 2.177 \text{ m}^2 \cdot \text{K/W}$$

Option B — 4-inch EPS

Convert thickness:

$$4 \times 0.0254 = 0.1016 \text{ m}$$

$$R = \frac{0.1016}{0.035} = 2.903 \text{ m}^2 \cdot \text{K/W}$$

Step 4: Calculate Total Thermal Resistance

The total resistance of the wall assembly is:

$$R_t = R_{si} + R_{se} + \sum R_i$$

Option A

$$R_t = 0.12 + 0.06 + 0.0208 + 0.375 + 0.0277 + 2.177$$

$$R_t = 2.7805 \text{ m}^2 \cdot \text{K/W}$$

Option B

$$R_t = 0.12 + 0.06 + 0.0208 + 0.375 + 0.0277 + 2.903$$

$$R_t = 3.5065 \text{ m}^2 \cdot \text{K/W}$$

Step 5: Calculate Thermal Transmittance (U-Value)

The U-value is determined using:

$$U = \frac{1}{R_t}$$

Option A

$$U = \frac{1}{2.7805} = 0.3596 \text{ W/m}^2\cdot\text{K}$$

Rounded to one decimal place:

$$U \approx 0.4 \text{ W/m}^2\cdot\text{K}$$

Option B

$$U = \frac{1}{3.5065} = 0.2851 \text{ W/m}^2\cdot\text{K}$$

Rounded to one decimal place:

$$U \approx 0.3 \text{ W/m}^2\cdot\text{K}$$

Final Results

Parameter	Option A (3 in EPS)	Option B (4 in EPS)
Total Resistance R_t	2.7805 $\text{m}^2\cdot\text{K/W}$	3.5065 $\text{m}^2\cdot\text{K/W}$
U-Value	0.4 $\text{W/m}^2\cdot\text{K}$	0.3 $\text{W/m}^2\cdot\text{K}$

Conclusion

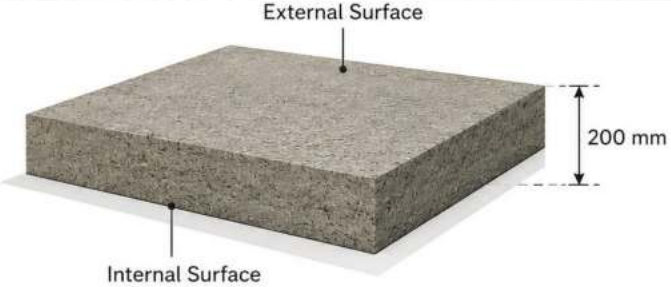
Option B provides better thermal performance. The 4-inch EPS insulation increases the overall thermal resistance of the wall assembly and results in a lower U-value compared to Option A.

In building envelope design, a lower U-value indicates reduced heat transfer through the wall, leading to improved insulation performance, lower cooling and heating loads, and enhanced energy efficiency. Therefore, despite both options using EPS insulation, the thicker insulation layer in Option B makes it the more effective solution for thermal control in a residential building located in a Composite Climate zone.

Roof Thermal Transmittance (U-Value) – Practice Problem

Question 4: An architect is designing a roof assembly for a residential building in a Cold Climate region. The roof consists of a single homogeneous layer of lime concrete.

Given Specifications

MATERIAL AND THICKNESS		
Material	Thickness	
Lime Concrete	200 mm	

SURFACE FILM RESISTANCES	
Parameter	Value
Internal surface resistance (R_{si})	0.10 m ² K/W
External surface resistance (R_{se})	0.04 m ² K/W

Roof Construction

Material	Thickness
Lime Concrete	200 mm

Surface Film Resistances

Parameter	Value
Internal surface resistance (R_{si})	0.10 m ² K/W
External surface resistance (R_{se})	0.04 m ² K/W

Task

1. Identify the thermal conductivity (k) of lime concrete.
2. Calculate the thermal resistance of the lime concrete layer.
3. Determine the total thermal resistance (R_t) of the roof assembly.
4. Calculate the thermal transmittance (U-value) of the roof.

Solution: This exercise demonstrates the methodology for calculating the thermal transmittance (U-value) of a roof assembly using:

- Material thermal conductivity
- Layer thermal resistance
- Surface film resistances
- Total thermal resistance of the roof system

Formulae Used

Thermal Resistance of a Layer

$$R = \frac{t}{k}$$

Where:

- R= Thermal resistance (m²K/W)
- t= Thickness of material (m)
- k= Thermal conductivity (W/mK)

Total Thermal Resistance

$$R_t = R_{si} + R_{se} + \sum R_i$$

Thermal Transmittance

$$U = \frac{1}{R_t}$$

Step-by-Step Solution

Step 1 – Identify Thermal Conductivity (k)

From the material property table:

Material	Thermal Conductivity
Lime Concrete	0.730 W/mk

Therefore,

k = 0.730 W/mK

Step 2 – Calculate Thermal Resistance of Lime Concrete Layer

Convert Thickness to Meters

$$200 \text{ mm} = 0.2 \text{ m}$$

Apply Resistance Formula

$$R_{\text{lime_concrete}} = \frac{0.2}{0.730}$$

$$R_{\text{lime_concrete}} \approx 0.274 \text{ m}^2 \text{ K/W}$$

Therefore,

$$R_{\text{lime_concrete}} = 0.274 \text{ m}^2 \text{ K/W}$$

Step 3 – Calculate Total Thermal Resistance (R_t)

$$R_t = 0.10 + 0.04 + 0.274$$

$$R_t = 0.414 \text{ m}^2 \text{ K/W}$$

Therefore,

$$R_t = 0.414 \text{ m}^2 \text{ K/W}$$

Step 4 – Calculate Thermal Transmittance (U-Value)

$$U = \frac{1}{0.414}$$

$$U \approx 2.415 \text{ W/m}^2 \text{ K}$$

Rounded to one decimal place:

$$U \approx 2.4 \text{ W/m}^2 \text{ K}$$

Final Answer

Parameter	Result
Thermal resistance of lime concrete	0.274 m ² K/W
Total thermal resistance (R_t)	0.414 m ² K/W
Roof thermal transmittance (U-value)	2.4 W/m ² K

Key Learning Points

- Thermal resistance depends on both material thickness and thermal conductivity.
- Surface film resistances must be included in total thermal calculations.
- Roof U-value is calculated as the inverse of total thermal resistance.
- Lower U-values indicate improved thermal insulation and reduced heat transfer.
- Correct unit conversion is essential for accurate thermal performance analysis.

Residential Envelope Transmittance Value (RETV) – Practice Problem

Question 5 : An architect is evaluating the envelope thermal performance of an 900 m² luxury residential apartment with side 30m x 30m , located in a Composite Climate region (e.g., Delhi) with two exposed facades facing South and East. with window wall ratio of 20% equally distributed on exposed facades. Wall to ceiling height is 3.1 m. provide recommendation for ENS compliance of RETV if needed.

1. Building Geometry and Assumptions

Apartment Floor Area

900 m²

External Envelope Dimensions

South Facade

Length: 30 m²

East Facade

Length: 30 m

Building Height

3.1 m

Step 1 – Calculate Total Envelope Area

The total envelope area includes the gross external wall area.

South Wall Area

$30 \times 3.1 = 93 \text{ m}^2$

East Wall Area

$30 \times 3.1 = 93 \text{ m}^2$

Total Envelope Area

$$A_{\text{envelope}} = 93 + 93$$

$$A_{\text{envelope}} = 186 \text{ m}^2$$

2. Window-to-Wall Ratio (WWR)

$$\text{WWR:} \quad 20\%$$

Step 2 – Determine Non-Opaque and Opaque Areas**Non-Opaque Area (Windows)**

$$A_{\text{non-opaque}} = 186 \times 0.20$$

$$A_{\text{non-opaque}} = 37.2 \text{ m}^2$$

Therefore,

$$A_{\text{non-opaque}} = 37.2 \text{ m}^2$$

Opaque Area (Walls)

$$A_{\text{opaque}} = 186 - 37.2$$

$$A_{\text{opaque}} = 148.8 \text{ m}^2$$

Therefore,

$$A_{\text{opaque}} = 148.8 \text{ m}^2$$

3. Thermal Properties

Parameter	Value
Opaque wall U-value	1.8 W/m ² K
Glass U-value	5.7 W/m ² K
Equivalent SHGC	0.25

4. RETV Formula

The Residential Envelope Transmittance Value is calculated as:

$$\text{RETV} = \frac{Q_{\text{opaque}} + Q_{\text{non-opaque}} + Q_{\text{solar}}}{A_{\text{non-opaque}}}$$

Where:

- Q_{opaque} = Heat gain through opaque envelope
- $Q_{\text{non-opaque}}$ = Heat gain through glazing conduction
- Q_{solar} = Solar heat gain through glazing

5. Climate Coefficients (Composite Climate)

Coefficient	Value
a	6.06
b	1.85
c	68.99

6. Orientation Factors (ω)

Orientation	Factor
South	1.089
East	1.155

Step 3 – Divide Areas Equally by Orientation

Since the apartment has two equal facades:

Opaque Area per Orientation

$$148.8/2=74.4 \text{ m}^2$$

Non-Opaque Area per Orientation

$$37.2/2=18.6 \text{ m}^2$$

Step 4 – Calculate Opaque Conduction Heat Gain (Term 1)

The opaque conduction equation is:

$$Q_{\text{opaque}} = a \times (A_{\text{opaque}} \times U_{\text{opaque}} \times \omega)$$

South Facade

$$6.06 \times 74.4 \times 1.8 \times 1.089 \\ = 883.9$$

East Facade

$$6.06 \times 74.4 \times 1.8 \times 1.155 \\ = 937.5$$

Total Opaque Heat Gain

$$Q_{\text{opaque}} = 883.9 + 937.5$$

$$Q_{\text{opaque}} = 1821.4$$

Therefore,

$$Q_{\text{opaque}} = 1821.4 \text{ W}$$

Step 5 – Calculate Non-Opaque Conduction Heat Gain (Term 2)

The non-opaque conduction equation is:

$$Q_{\text{non-opaque}} = b \times (A_{\text{glass}} \times U_{\text{glass}} \times \omega)$$

South Facade

$$1.85 \times 18.6 \times 5.7 \times 1.089$$

$$= 213.6$$

East Facade

$$1.85 \times 18.6 \times 5.7 \times 1.155$$

$$= 226.5$$

Total Non-Opaque Heat Gain

$$Q_{\text{non-opaque}} = 213.6 + 226.5$$

$$Q_{\text{non-opaque}} = 440.1$$

Therefore,

$$Q_{\text{non-opaque}} = 440.1 \text{ W}$$

Step 6 – Calculate Solar Heat Gain (Term 3)

The solar gain equation is:

$$Q_{\text{solar}} = c \times (A_{\text{glass}} \times \text{SHGC}_{\text{eq}} \times \omega)$$

South Facade

$$68.99 \times 18.6 \times 0.25 \times 1.089 \\ = 349.4$$

East Facade

$$68.99 \times 18.6 \times 0.25 \times 1.155 \\ = 370.5$$

Total Solar Heat Gain

$$Q_{\text{solar}} = 349.4 + 370.5 \\ Q_{\text{solar}} = 719.9$$

Therefore,

$$Q_{\text{solar}} = 719.9 \text{ W}$$

Step 7 – Calculate Total Heat Gain

$$Q_{\text{total}} = 1821.4 + 440.1 + 719.9 \\ Q_{\text{total}} = 2981.4 \text{ W}$$

Therefore,

$$Q_{\text{total}} = 2981.4 \text{ W}$$

Step 8 – Calculate RETV

$$\text{RETV} = \frac{2981.4}{186} \\ \text{RETV} = 16.03 \text{ W/m}^2$$

Rounded to the nearest integer:

$$\text{RETV} = 16 \text{ W/m}^2$$

Final Result

Parameter	Value
Total Envelope Area	186 m ²
Total Heat Gain	2981.4 W
Calculated RETV	16.03 W/m ²
Rounded RETV	16 W/m ²

Compliance Assessment

The calculated RETV exceeds the prescribed maximum limit of:

$$15 \text{ W/m}^2$$

Therefore:

The proposed design does not comply with the RETV requirement

Recommendations for Compliance Improvement

To reduce RETV and achieve compliance, the following strategies may be adopted:

- Improve wall insulation to reduce opaque U-value
- Use high-performance glazing with lower U-value
- Reduce SHGC using spectrally selective glazing
- Reduce overall WWR
- Incorporate external shading devices

Key Learning Points

- RETV evaluates total heat gain through the building envelope excluding the roof.
- Both conductive and solar heat gains contribute to RETV.
- Orientation factors significantly influence heat gain calculations.
- Lower U-values and lower SHGC values improve envelope performance.
- RETV compliance can be achieved through optimized glazing and insulation design.

Equivalent Solar Heat Gain Coefficient (SHGC_{eq}) – Practice Problem

Question 6: A residential building in New Delhi includes a south-facing glazed window with permanent external shading devices consisting of an overhang and side fins.

The objective is to calculate the Equivalent Solar Heat Gain Coefficient (SHGC_{eq}) to account for the impact of shading on solar heat gain.

Given Data

Location

Parameter	Value
City	New Delhi
Latitude	28.6°N
Latitude Category	≥23.5°N

Window Orientation

South Facing

Window Solar Property

Parameter	Value
Unshaded SHGC ($\text{SHGC}_{\text{unshaded}}$)	0.55

Shading Geometry**Overhang Dimensions**

Parameter	Value
Horizontal projection (H_{overhang})	1.0 m
Vertical distance from sill of the window	2.0 m

Side Fin Dimensions (Both Sides)

Parameter	Value
Horizontal projection (H_{fin})	0.6 m

Parameter	Value
Distance to farthest shading point (V_{fin})	1.2 m

Task

1. Calculate projection factors for the overhang and side fins.
2. Determine the External Shading Factors (ESF).
3. Calculate the total shading factor.
4. Determine the Equivalent Solar Heat Gain Coefficient (SHGC_{eq}).

Solution : This exercise demonstrates the methodology for calculating the Equivalent Solar Heat Gain Coefficient (SHGC_{eq}) for a shaded residential window.

The example illustrates:

- Projection factor calculations.
- Determination of External Shading Factors (ESF).
- Combination of overhang and side-fin effects.
- Final calculation of equivalent SHGC for RETV analysis.

Formulae Used**Projection Factor**

$$PF = \frac{H}{V}$$

Where:

- PF= Projection factor
- H= Horizontal projection depth
- V= Relevant vertical or horizontal distance

Combined Side-Fin Shading Factor

$$ESF_{\text{sidefin}} = 1 - (1 - ESF_{\text{right}}) + (1 - ESF_{\text{left}})$$

Total External Shading Factor

$$ESF_{\text{total}} = ESF_{\text{overhang}} \times ESF_{\text{sidefin}}$$

Equivalent SHGC

$$SHGC_{\text{eq}} = SHGC_{\text{unshaded}} \times ESF_{\text{total}}$$

Step-by-Step Solution**Step 1 – Calculate Projection Factors (PF)****(a) Overhang Projection Factor**

$$PF_{\text{overhang}} = \frac{1.0}{2.0}$$

$$PF_{\text{overhang}} = 0.50$$

Therefore,

$PF_{\text{overhang}} = 0.50$

(b) Right Side Fin Projection Factor

$$PF_{\text{right}} = \frac{0.6}{1.2}$$

$$PF_{\text{right}} = 0.50$$

Therefore,

$$PF_{\text{right}} = 0.50$$

(c) Left Side Fin Projection Factor

$$PF_{\text{left}} = \frac{0.6}{1.2}$$

$$PF_{\text{left}} = 0.50$$

Therefore,

$$PF_{\text{left}} = 0.50$$

Step 2 – Determine External Shading Factors (ESF)

Using the prescribed ESF tables for:

- Latitude category: $\geq 23.5^\circ$ N
- South-facing orientation
- Projection factor range: 0.50–0.59

Overhang ESF

$$ESF_{\text{overhang}} = 0.626$$

Therefore,

$$ESF_{\text{overhang}} = 0.626$$

Right Side Fin ESF

$$ESF_{\text{right}} = 0.887$$

Therefore,

$$ESF_{\text{right}} = 0.887$$

Left Side Fin ESF

$$ESF_{\text{left}} = 0.886$$

Therefore,

$$ESF_{\text{left}} = 0.886$$

Step 3 – Calculate Combined Side-Fin Shading Factor

$$ESF_{\text{sidefin}} = 1 - (1 - 0.887) + (1 - 0.886)$$

$$ESF_{\text{sidefin}} = 1 - 0.113 + 0.114$$

$$ESF_{\text{sidefin}} = 0.773$$

Therefore,

$$ESF_{\text{sidefin}} = 0.773$$

Step 4 – Calculate Total External Shading Factor

$$ESF_{\text{total}} = 0.626 \times 0.773$$

$$ESF_{\text{total}} \approx 0.484$$

Therefore,

$$ESF_{\text{total}} = 0.484$$

Step 5 – Calculate Equivalent SHGC

$$SHGC_{\text{eq}} = 0.55 \times 0.484$$

$$SHGC_{\text{eq}} = 0.266$$

Therefore,

$$SHGC_{\text{eq}} = 0.266$$

Final Result

Parameter	Result
Overhang Projection Factor	0.50
Side Fin Projection Factor	0.50
Total External Shading Factor	0.484
Equivalent SHGC	0.266

Conclusion

The permanent external shading devices significantly reduce the effective solar heat gain through the window.

$$SHGC_{\text{eq}} = 0.266$$

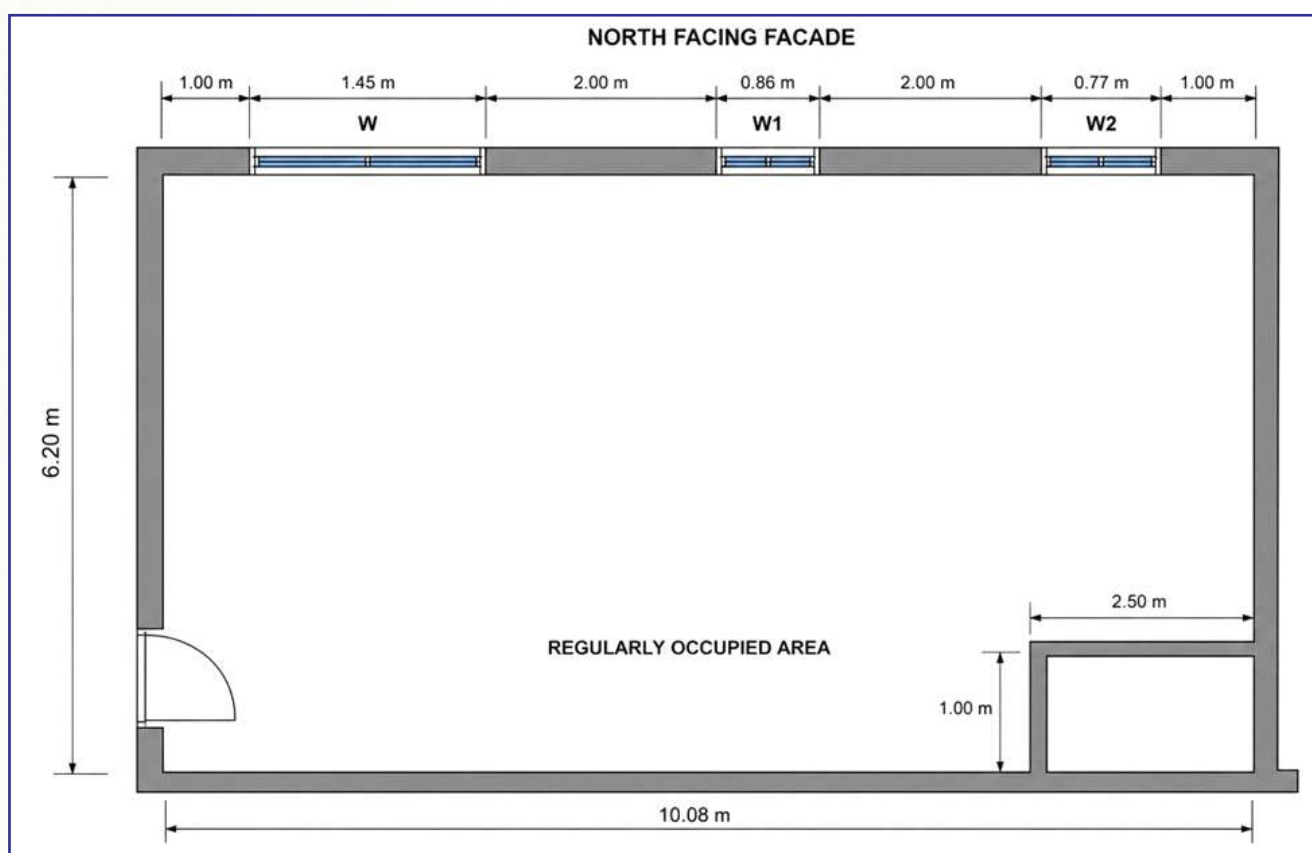
This adjusted value should be used in RETV calculations instead of the unshaded SHGC value.

Key Learning Points

- External shading reduces solar heat gain through glazing.
- Projection factors are used to quantify shading geometry.
- Overhangs and side fins each contribute to shading effectiveness.
- Equivalent SHGC accounts for permanent shading devices in envelope calculations.
- Lower $SHGC_{eq}$ values improve thermal performance and reduce RETV.

Practice Question: Manual Daylight Compliance Calculation

Question 7 A residential room in Delhi is being evaluated for daylight compliance using the prescribed manual method based on Daylight Extent Factors (DEF). The room contains three north-facing windows as illustrated in the reference figure without any shading device.



OPENINGS SCHEDULE				
MARK	TYPE	WIDTH (m)	HEIGHT (m)	SILL HEIGHT (m)
W	WINDOW	1.45	1.20	1.00
W1	WINDOW	0.86	1.20	1.00
W2	WINDOW	0.77	1.20	1.00
NOTE: SILL HEIGHT MEASURED FROM FINISHED FLOOR LEVEL (FFL).				

1. Project Inputs

Window Properties

Parameter	Value
Visible Light Transmittance (VLT)	0.6
VLT Category	VLT $\geq$ 0.3

Orientation

Windows North Facing

For:

Daylight Extent Factors (DEF) for Manually Calculating Daylight.

Shading	Latitude	WindowType	VLT<0.3				VLT≥0.3			
			North	South	East	West	North	South	East	West
No shading or PF < 0.4	≥15°N	All windowtypes	2.5	2.0	0.7	0.5	2.8	2.2	1.1	0.7
	< 15°N		2.4	2.0	0.8	0.6	2.7	2.2	1.5	0.8
Shading withPF ≥ 0.4	All latitudes	All window types without lightshelf*	2.8	2.3	1.5	1.1	3.0	2.5	1.8	1.5
		Window with lightshelf*	3.0	2.5	1.8	1.6	3.5	3.0	2.1	1.8
* To qualify as a light shelf the internal projection shall meet the requirements specified under Exceptions to SHGC requirements in Table 5.9 to Table 5.11.										

Daylight Extent Factor (DEF) referred from ECSBC Prescribed DEF for no shading for latitude > 15 deg N = 2.8

Step 1 – Calculation of window height.

In a direction perpendicular to the fenestration, multiply daylight extent factor (DEF) by the head height of the fenestration

Head height of windows is window height plus Sill height.

$$1.2 + 1 = 2.2 \text{ m.}$$

Step 2 – Calculation of daylit area parallel to fenestration.

direction parallel to the fenestration, daylit area extends a horizontal dimension equal to the width of the fenestration plus either 1 meter on each side of the aperture, as per the reference drawing, this covers the entire wall width.

Step 3. Calculation of Daylight Extent

Daylight Extent is multiplication of window height and Daylight Extent Factor.

Window Height = 2.2

Day Light Extent factor = 2.8

Daylight Extent perpendicular to wall with windows is $2.2 \times 2.8 = 6.16 \text{ m}$

Step 4. Calculation of total regularly occupied area

Length x width of room – (obstructed area on south east corner)

$6.2 \times 10.08 - (1.0 \times 2.5)$

$62.496 - (2.5)$

$= 59.996 \text{ m}^2$

$\sim 60 \text{ m}^2$

Step 5. Calculation of daylit area

Total daylit area without internal obstruction

$= \text{Daylight Extent} \times \text{Room width} = 6.16 \times 10.08 = 62.09 \text{ m}^2$

Internal Obstruction Area

$2.5 \times 1 = 2.5 \text{ m}^2$

Total day lit area $= 62.09 - 2.5 = 59.59$

Step 6. Percentage of regularly occupied area that is day lit.

Regularly Occupied area $= 60 \text{ m}^2$

Total day lit area $= 59.59 \text{ m}^2$

% of daylit area $= 59.59/60 \times 100 = 99.32\%$

percentage of above grade floor area meeting the UDI requirement for 90% of the potential daylit time in a year as per Manual method of daylight area calculation is 99.32 %

Key Learning Points

- DEF-based calculations provide a simplified alternative to daylight simulation.
- Daylight penetration depends on window height, orientation, shading, and VLT.
- Overlapping daylight zones / obstruction must be deducted from total compliant area.

Post-Occupancy Waste Generation Estimation – Practice Problem

Question 8: A residential housing complex is being evaluated for post-occupancy waste management infrastructure.

The project team must estimate:

- Total daily waste generation
- Organic and inorganic waste quantities
- Vermi-composting capacity
- Centralized inorganic waste storage requirements

Given Data

Parameter	Value
Total dwelling units (DU)	60
Occupancy rate	4.5 occupants per DU
Waste generation rate	0.6 kg/person/day
Organic waste fraction	40%
Inorganic waste fraction	60%

Solution : This exercise demonstrates the methodology for estimating post-occupancy municipal solid waste generation for a residential housing project using National Building Code (NBC) guidelines.

The example illustrates:

- Occupancy estimation
- Daily waste generation calculations
- Organic and inorganic waste segregation
- Organic waste treatment sizing
- Inorganic waste storage requirements

Step 1 – Calculate Total Occupancy

Total occupancy is determined using:

$$\text{Total Occupants} = \text{Number of DUs} \times \text{Occupants per DU}$$

Substituting the values:

$$\text{Total Occupants} = 60 \times 4.5$$

$$\text{Total Occupants} = 270$$

Therefore,

270 occupants

Step 2 – Calculate Total Daily Waste Generation

Daily waste generation is calculated as:

$$\text{Total Daily Waste} = \text{Total Occupants} \times \text{Waste Generation Rate}$$

Substituting the values:

$$\text{Total Daily Waste} = 270 \times 0.6$$

$$\text{Total Daily Waste} = 162 \text{ kg/day}$$

Therefore,

$$162 \text{ kg/day}$$

Step 3 – Segregate Organic and Inorganic Waste

(a) Organic Waste:

$$\text{Organic Waste} = 162 \times 0.40$$

$$\text{Organic Waste} = 64.8 \text{ kg/day}$$

Substituting the values:

$$\text{Total Daily Waste} = 270 \times 0.6$$

$$\text{Total Daily Waste} = 162 \text{ kg/day}$$

Therefore,

$$64.8 \text{ kg/day}$$

(b) Inorganic Waste

$$\text{Inorganic Waste} = 162 \times 0.60$$

$$\text{Inorganic Waste} = 97.2 \text{ kg/day}$$

Therefore,

$$97.2 \text{ kg/day}$$

Step 4 – Estimate Organic Waste Treatment Requirement**Vermi-Composting System**

The project uses vermi-composting with a:

60-day retention period

Step 4 – 4A – Calculate Total Organic Waste for Retention Period

$$\text{Total Organic Waste} = 64.8 \times 60$$

$$\text{Total Organic Waste} = 3888 \text{ kg}$$

Therefore,

$$3888 \text{ kg}$$

Step 4B – Calculate Vermi Bed Volume Requirement

Using the prescribed thumb rule:

$$1 \text{ kg of organic waste} = 0.002 \text{ m}^3$$

The required volume is:

$$\text{Vermi Bed Volume} = \text{Organic Waste} \times 0.002$$

Substituting the values:

$$3888 \times 0.002$$

$$= 7.776 \text{ m}^3$$

Rounded:

$$7.78 \text{ m}^3$$

Step 5 – Estimate Inorganic Waste Storage Requirement

The project must store at least:

$$2 \text{ days of inorganic waste}$$

before municipal collection.

Step 5A – Convert Daily Inorganic Waste to Volume

Using the conversion factor:

$$0.0033 \text{ m}^3/\text{kg}$$

Daily inorganic waste volume:

$$97.2 \times 0.0033$$

$$= 0.32076 \text{ m}^3/\text{day}$$

Rounded:

$$(0.324 \text{ m}^3/\text{day})$$

Step 5B – Calculate 2-Day Storage Volume

$$0.324 \times 2$$

$$= 0.648 \text{ m}^3$$

Converting to litres:

$$= 0.648 \text{ m}^3 \times 648 \text{ L}$$

Therefore,

$$648 \text{ L}$$

Step 5C – Determine Number of Storage Bins

Assuming standard:

$$240 \text{ L bins}$$

Required number of bins:

$$648/240 = 2.7$$

Rounded upward:

3 bins

However, the referenced guideline recommends:

4 bins

to allow adequate circulation and operational flexibility.

Final Result Recommended bins Summary

Parameter	Result
Total occupants	270
Total daily waste generation	162 kg/day
Organic waste	64.8 kg/day
Inorganic waste	97.2 kg/day
Organic waste over 60 days	3888 kg
Vermi bed volume required	7.78 m ³
Inorganic waste storage	648 L
Minimum 240-L bins required	3
Recommended bins	4

Conclusion

The residential project generates:

162 kg/day

of municipal solid waste, requiring:

- A vermi-composting system of approximately:

7.78 m³

- Centralized inorganic storage capacity of:

648 L

with a recommended provision of:

4 standardized bins

for efficient waste management operations.

Key Learning Points

- Occupancy estimation forms the basis of waste generation calculations.
- NBC guidelines provide standard per-capita waste generation rates.
- Organic and inorganic waste streams must be calculated separately.
- Composting systems require retention-period-based sizing.
- Centralized storage sizing must account for collection frequency.
- Practical bin provision may exceed theoretical minimum calculations for operational efficiency.

Construction Waste Diversion Estimation – Practice Problem

Question 9: A residential development project with a total built-up area of:

$$4,500 \text{ m}^2$$

is being evaluated for construction waste management compliance.

Task : The project sustainability consultant must estimate the total waste generated and prepare a diversion strategy to minimize landfill disposal.

1. Waste Generation Data

Construction Waste Generation Rate

$$45 \text{ kg/m}^2$$

This value falls within the prescribed range for new construction projects.

2. Waste Composition and Material Properties

Waste Category	Percentage	Density
Soil, Sand, and Gravel	25%	1600 kg/m ³
Brick and Masonry	30%	1900 kg/m ³
Concrete	30%	1200 kg/m ³
Metals	7%	7850 kg/m ³
Packaging / Others	6%	–
Hazardous Waste (Bitumen)	2%	1040 kg/m ³

3. Diversion Strategy

Reused or Repurposed On-Site

- Soil, sand, and gravel
- Brick and masonry
- Concrete

These materials will be reused for:

- Landscaping
- Filling
- Road sub-base applications

Recycled Off-Site

- Metals
- Packaging waste

These materials will be sent to authorized recycling vendors.

Hazardous Waste Handling

Hazardous waste will be transferred to municipal authorities for safe disposal.

Task

1. Calculate total construction waste generated.
2. Determine waste quantities for each category.
3. Calculate the volume of concrete and metal waste.
4. Determine the percentage of waste diverted from landfill.

Solution: This exercise demonstrates the methodology for estimating construction waste generation and landfill diversion for a residential development project.

The example illustrates:

- Total construction waste estimation
- Waste categorization by material type
- Volume estimation using material densities
- Diversion and recycling calculations
- Final landfill diversion percentage determination

Step-by-Step Solution

Step 1 – Calculate Total Construction Waste Quantity

Total waste generation is calculated as:

$$\text{Total Waste} = \text{Built - up Area} \times \text{Waste Generation Rate}$$

$$\text{Total Waste} = 4500 \times 45$$

$$\text{Total Waste} = 202500 \text{ kg}$$

Therefore,

$$\boxed{202500 \text{ kg}}$$

Step 2 – Calculate Individual Waste Quantities

(a) Soil, Sand, and Gravel

$$202500 \times 0.25$$

$$= 50625 \text{ kg}$$

Therefore,

$$\boxed{50625 \text{ kg}}$$

(b) Brick and Masonry

$$202500 \times 0.30$$

$$= 60750 \text{ kg}$$

Therefore,

$$\boxed{60750 \text{ kg}}$$

(c) Concrete

$$202500 \times 0.30$$

$$= 60750 \text{ kg}$$

Therefore,

$$\boxed{60750 \text{ kg}}$$

(d) Metals

$$202500 \times 0.07$$

$$= 14175 \text{ kg}$$

Therefore,

$$\boxed{14175 \text{ kg}}$$

(e) Packaging / Others

$$202500 \times 0.06$$

$$= 12150 \text{ kg}$$

Therefore,

$$\boxed{12150 \text{ kg}}$$

(f) Hazardous Waste

$$202500 \times 0.02$$

$$= 4050 \text{ kg}$$

Therefore,

$$\boxed{4050 \text{ kg}}$$

Step 3 – Calculate Waste Volumes

The volume calculation formula is:

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

m
V

$$\rho = \frac{m}{V} = 2.4 \text{ kg/L}$$

(a) Concrete Waste Volume

$$\begin{aligned} \text{Volume}_{\text{concrete}} &= \frac{60750}{1200} \\ &= 50.625 \text{ m}^3 \end{aligned}$$

Therefore,

$$50.625 \text{ m}^3$$

(b) Metal Waste Volume

$$\begin{aligned} \text{Volume}_{\text{metal}} &= \frac{14175}{7850} \\ &\approx 1.806 \text{ m}^3 \end{aligned}$$

Therefore,

$$1.806 \text{ m}^3$$

Step 4 – Calculate Waste Diversion Quantity

Waste is considered diverted when it is:

- Reused on-site
- Repurposed
- Recycled

Diverted Waste Categories

Category	Quantity
Soil / Sand / Gravel	50,625 kg
Brick & Masonry	60,750 kg
Concrete	60,750 kg
Metals	14,175 kg
Packaging	12,150 kg

Total Diverted Waste

$$\begin{aligned} &50625+60750+60750+14175+12150 \\ &=198450 \text{ kg} \end{aligned}$$

Therefore,

$$198450 \text{ kg}$$

Step 5 – Calculate Diversion Percentage

The diversion percentage is calculated as:

$$\text{Diversion \%} = \left(\frac{\text{Diverted Waste}}{\text{Total Waste}} \right) \times 100$$

Substituting the values:

$$\text{Diversion \%} = \left(\frac{198450}{202500} \right) \times 100$$

$$\text{Diversion \%} = 98\%$$

Therefore,

98%

Final Results Summary

Parameter	Result
Total construction waste	202,500 kg
Concrete waste volume	50.625 m ³
Metal waste volume	1.806 m ³
Total diverted waste	198,450 kg
Diversion percentage	98%

Conclusion

The project achieves an overall construction waste diversion rate of:

98%

Only the hazardous waste fraction:

2%

requires disposal through authorized municipal handling systems.

The proposed strategy significantly minimizes landfill dependency through:

- On-site reuse
- Material recovery
- Recycling practices

Key Learning Points

- Construction waste estimation is based on built-up area and generation rates.
- Material-wise segregation is essential for effective diversion planning.
- Waste volume calculations require density-based conversion.
- Reuse and recycling significantly reduce landfill disposal.
- Hazardous waste requires specialized disposal procedures.
- High diversion rates improve sustainability compliance performance.

ECSBC Compliance Check Using Whole Building Performance Method: Practice Problem

Question 10: A commercial office building with occupancy 9am to 5pm is proposed in a **Composite Climate Zone** and is being evaluated for compliance under the **Energy Conservation and Sustainable Building Code (ECSBC)** using the **Whole Building Performance (WBP) Method**.

Building Description

Parameter	Details
Building Use	Office Building
Basement	1 Basement Floor (Parking and Services)
Stilt Floor	1 Stilt Floor (Parking)
Occupied Floors Above	Ground + 5 Upper Floors
Typical Floor Area	1400 m ²
Window Wall Ratio	35%
Air-Conditioned Areas	Office spaces on Ground and Upper Floors
Basement Use	Parking, electrical room, pump room
Stilt Use	Open parking
All Mandatory compliances of ECSBC are met	

The energy simulation results for the building are summarized below:

Case	Annual Energy Consumption
Base Case Building	1,260,000 kWh/year
Proposed Case Building	1 Basement Floor (Parking and Services)
Stilt Floor	1,080,000 kWh/year

Task

1. Calculate the MEPI and PES achieved by the proposed building compared to the base case.
2. Determine whether the building complies with ECSBC requirements.
3. If the building does not comply with super ECSBC, calculate the maximum allowable annual energy consumption for the proposed case to meet Super ECSBC compliance.
4. What approach can be followed for Standardized compliance method for meeting super ECSBC compliance, explain what is the theatrical difference is there from ICM

Sample Answer: ECSBC Compliance Check Using Whole Building Performance Method**Step 1: Determine the Conditioned Floor Area**

Total conditioned floors = 6 floors

Given:

- Typical Floor Plate Area = 1,400 m² per floor

Therefore,

$$\text{Total Conditioned Floor Area} = 6 \times 1400 = 8400 \text{ m}^2$$

Thus, the total conditioned floor area is:

$$8,400 \text{ m}^2$$

Step 2 Calculation of MEPI and PES**(a) MEPI Calculation**

MEPI (Modified Energy Performance Index) is calculated as:

$$\text{MEPI} = \frac{\text{Annual Energy Consumption}}{\text{Conditioned Floor Area}}$$

Proposed Building MEPI

Given:

- Proposed Building Energy Consumption = 1,080,000 kWh/year
- Conditioned Floor Area = 8,400 m²

Therefore,

$$\text{MEPI}_{\text{proposed}} = \frac{1080000}{8400} = 128.57 \text{ kWh/m}^2/\text{year}$$

Base Case MEPI

$$\text{MEPI}_{\text{base}} = \frac{1260000}{8400} = 150 \text{ kWh/m}^2/\text{year}$$

The proposed building **COMPLIES** with ECSBC as $\text{MEPI}_{\text{proposed}} < \text{MEPI}_{\text{baseline}}$, and all Mandatory requirement of ECSBC are MET

Question asked, If the building does not comply, calculate the maximum allowable annual energy consumption for the proposed case to meet ECSBC compliance. Since the project already MEET the ECSBC compliance, no further requirements are required to be met

(b) Percentage Energy Savings (PES)

The Percentage Energy Savings is calculated as:

$$\text{PES} = \frac{\text{Base Case Energy} - \text{Proposed Case Energy}}{\text{Base Case Energy}} \times 100$$

Substituting the values:

$$\text{PES} = \frac{1260000 - 1080000}{1260000} \times 100 = 14.29\%$$

Thus, the proposed building achieves:

Percentage Energy Savings = 14.29%

2. ECSBC plus and super ECSBC Compliance Check

Under ECSBC Whole Building Performance Method:

- Achieved energy savings = 14.29%

As per Table 12.6 (composite climate the PES for ECSBC + and Super ECSBC are

Building Type	ECSBC+	Super-ECSBC
Office (Regular Use)	14%	22%

Since the PES is > 14% ECSBC plus requirements are MET, **however Additional Mandatory Requirements for ECSBC + and Super ECSBC from section 4.3 , 8.3, 9.3 and 10.3 shall be required to be met in accordance with ECSBC compliance under Integrative compliance method**

3. Maximum Allowable Proposed Energy Consumption for super ECSBC Compliance

To comply with ECSBC, the proposed building must achieve at least 22% energy savings.

Maximum allowable proposed energy consumption:

$$\text{Maximum Allowable Energy} = 1,260,000 \times (1 - 0.22)$$

Therefore,

$$\text{Maximum Allowable Energy} = 1,260,000 \times (1 - 0.22) = 1,260,000 \times 0.78 = 982,800 \text{ kWh/year}$$

Maximum Allowable Energy Consumption for super ECSBC

= 982,800 kWh/year

however Additional Mandatory Requirements for ECSBC + and Super ECSBC from section 4.3 , 8.3, 9.3 and 10.3 shall be required to be met in accordance with ECSBC compliance under **Integrative Compliance Method**

For meeting compliance with **Standardized Compliance Method** for meeting super ECSBC compliance all the requirements from Table 3.3 shall be met.

Mandatory Requirements for ECSBC, ECSBC + and Super ECSBC	Additional Mandator Requirement for ECSBC + and Super ECSBC	Standardized Requirements for ECSBC, ECSBC + and Super ECSBC
Section 4.2	Section 4.3	
Section 5.2		Section 5.3
Section 6.2		Section 6.3
Section 7.2		Section 7.3
Section 8.2		Section 8.3
Section 9.2	Section 9.3	
Section 10.2	Section 10.3	
Section 11.2	Section 11.3	

The main difference from of Standardized compliance method(SCM) from ICM is that , instead of simulation using performance standards of each section from 5.2-8.2 for creating baseline case and calculating MEPI, the project following SCM shall meet all the mandatory and prescriptive requirement of each component independently for section 5.3 – 8.3 in addition to other sections mandatory and additional mandatory requirement.

Key Learning Points

- Non airconditioned area from basement and stilt to be excluded from MEPI calculation
- Apart from MEPI calculation additional mandatory requirements to be met for ECSBC plus
- Considering SCM all standardized requirements to be met for Super ECSBC.

ECSBC Compliance Check Using Whole Building Performance Method: Practice Problem

Question 11 The following tables present the annual energy end-use summary for a commercial office with regular 9-5 operation project located in a composite climate zone, evaluated under the Bureau of Energy Efficiency Energy Conservation and Sustainable Building Code (ECSBC) baseline scenarios for four building orientations: 0°, 90°, 180°, and 270°.

The project has an approximate gross floor area of 138,232 ft² and a net conditioned floor area of approximately 86,158 ft². Non-conditioned spaces are located in the basement and refuge areas.

ECSBC Baseline Case – Annual Energy End-Use Summary

Alternative	Lights	Equipment	Heating	Cooling	Tower/Heat Reject	Pumps/Aux.	Fans	Total
ECSBC Base Case	3,91,235	3,24,646	1,05,331	11,71,474	7,638	2,011	76,573	20,78,908
90deg	3,91,235	3,24,646	1,10,150	11,62,134	7,520	1,979	74,845	20,72,509
180deg	3,91,235	3,24,646	1,04,938	12,13,832	7,535	1,982	76,803	21,20,971
270deg	3,91,235	3,24,646	1,03,013	11,55,700	7,507	1,973	76,745	20,60,819

The following table presents the modeled annual energy end-use summary for the proposed design case.

Proposed Case – Annual Energy End-Use Summary

Alternative	Lights	Equipment	Heating	Cooling	Tower/Heat Reject	Pumps/Aux.	Fans	Total
Proposed Case	6,40,394	3,24,646	1,720	9,65,668	0	0	22,538	19,54,966

Evaluate the building for ECSBC compliance using ICM and calculate the savings required over and above the baseline case in order to meet the Super ECSBC.

Solution:

1. Calculation for ECSBC compliance

the proposed case energy consumption is compared against the average energy consumption of the baseline building simulated for all four orientations (0°, 90°, 180°, and 270°), in accordance with the ECSBC performance method approach. The average baseline performance is used as the reference for evaluating compliance rather than selecting the worst-performing orientation.

Alternative	Lights	Equipment	Heating	Cooling	Tower/Heat Reject	Pumps/Aux.	Fans	Total
Ashrae Base Case	3,91,235	3,24,646	1,05,331	11,71,474	7,638	2,011	76,573	20,78,908
90deg	3,91,235	3,24,646	1,10,150	11,62,134	7,520	1,979	74,845	20,72,509
180deg	3,91,235	3,24,646	1,04,938	12,13,832	7,535	1,982	76,803	21,20,971
270deg	3,91,235	3,24,646	1,03,013	11,55,700	7,507	1,973	76,745	20,60,819
Average								2083301.8

$$\text{MEPI} = \frac{\text{Total Annual Energy Consumption (kwh/year)}}{\text{Net built - up Area [M}^2\text{]}}$$

Here, the net built-up area (m^2) is the total built-up area (m^2) excluding the following areas:

- d) Unconditioned basement area (m^2)
- e) Unconditioned refuge area (m^2)
- f) Stilt Parking Area (m^2)

Calculation Net built-up areas $m^2 = 86158/10.76 = 8007.25 m^2$

$$\begin{aligned} MEPI_{\text{baseline}} &= 2083301.8 / 8007.25 \\ &= 260.17 \text{Kwh}/m^2 \end{aligned}$$

$$\begin{aligned} MEPI_{\text{proposed}} &= 1954966 / 8007.25 \\ &= 244.15 \text{Kwh}/m^2 \end{aligned}$$

Since $MEPI_{\text{proposed}} < MEPI_{\text{baseline}}$ the project meets the ECSBC compliance provided all the other sections ECSBC compliance requirements are met.

2. Calculation Energy Savings required for Super ECSBC

Following the compliance requirement from ECSBC Table 3.1, Minimum PES requirement from section 12.6 shall be met for super ECSBC compliance. Table is referred below.

Table 3.1: Compliance requirement under ICM (Whole building method)

Building Type	MEPI requirement	Minimum PES requirement
ECSBC	$MEPI_{\text{Baseline}} = MEPI_{\text{Proposed}}$	NA
ECSBC +	$MEPI_{\text{Proposed}} < MEPI_{\text{Baseline}}$	Section 12.6
Super ECSBC	$MEPI_{\text{Proposed}} < MEPI_{\text{Baseline}}$	Section 12.6

Where PES is Percentage Energy Saving

$$PES = \left(\frac{MEPI_{\text{Baseline}} - MEPI_{\text{Proposed}}}{MEPI_{\text{Baseline}}} \right) \times 100$$

Since the building is located in the composite climate Table 12.7 is referred, "Minimum required Percentage Energy Savings (PES) respect to Energy Savings of ECSBC building in Composite Climate." Since the project is defined as commercial office project, reference PES numbers are

Composite Climate		
Building Type	ECSBC+	Super-ECSBC
Office (Regular Use)	14%	22%

For meeting super ECSBC savings of 22% above baseline case are required.

$$MEPI_{\text{baseline}} = 260.17 \text{Kwh}/m^2$$

Required MEPI for proposed case for meetin Super ECBC = $(100-22)\%$ i.e. 78% of $260.17 \text{kWh}/M^2$

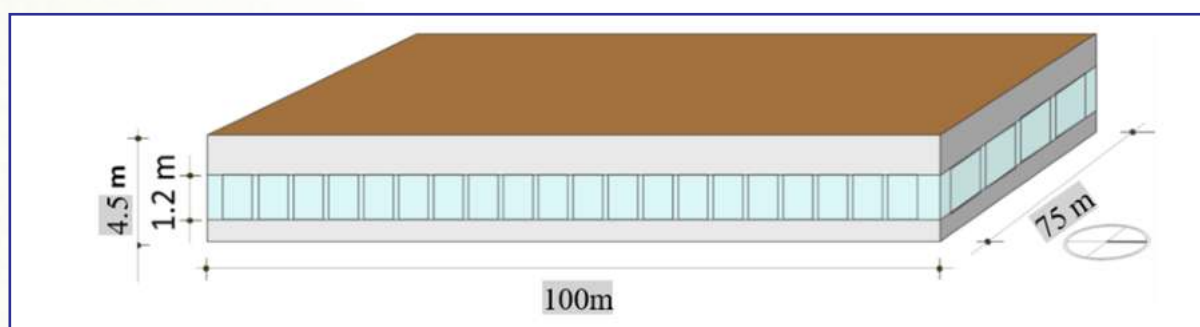
Therefore expected EPI for super ECSBC Buildings is $268.17 \times (78/100) = 202.93 \text{ kWh/m}^2$

$$\begin{aligned} \text{Required Savings For Meeting Super ECSBC} &= 202.93 \text{ kWh/m}^2 \times \text{Net Built-up area} \\ &= 202.93 \text{ kWh/m}^2 \times 8007.25 \text{ m}^2 \\ &= 1624911.24 \text{ kWh} \end{aligned}$$

ECSBC Envelope Compliance Check Using Building tradeoff Method: Practice Problem

Question 12 A 7,500 m² single story 24 hours hospital building in Kolkata is trying to achieve ECSBC level compliance. Each side has a band of windows, without shading. The materials for the envelope have already been selected, prior to opting for ECSBC compliance. Their thermal properties are: Roof assembly U-value = $0.30 \text{ W/m}^2\cdot\text{K}$, external wall assembly U-value = $0.30 \text{ W/m}^2\cdot\text{K}$, Glazing SHGC = 0.25 , VLT = 0.27 , area weighted U-value for glazing for Non-North = $2.5 \text{ W/m}^2\cdot\text{K}$ and area weighted U-value for glazing for North = $2.0 \text{ W/m}^2\cdot\text{K}$.

Dimensions of the building envelope are as follows:



Determine the compliance of the building with respect to the requirements of ECSBC 2024.

Solution : According to 'ECSBC 2024 Appendix 2': Table A2.1 Climate Zone for Major Indian Cities, Kolkata falls under the warm and humid climate zone. To prove compliance through the prescriptive approach, U-factor, and SHGC must comply with requirements listed in Table 5.3 to 5.8 of ECSBC 2024, Table 5.9 TO 5.11 OF ECSBC 2024 and VLT and Window to Wall Ratio (WWR) with requirements in Section 5.3.3 for a daytime use building in the warm and Humid zone. The table below lists thermal properties of the building envelope components and the corresponding prescriptive requirements for ECSBC compliant buildings.

Step 1

A. Prescriptive Requirements and Proposed Thermal Properties as per ECSBC

	Prescriptive / Base case U-factor (W/m ² .K)			Proposed/Design Case U-factor (W/m ² .K)			Area (m ²)
Wall 1– North, South	0.4			0.3			330.00
Wall 2– East, West	0.4			0.3			247.50
Roof	0.26			0.3			7500.00
	Prescriptive/ Base Case			Proposed/Design Case			Area (m ²)
	U-factor	SHGC	VLT	U-factor	SHGC	VLT	
Window –North	2.2	0.5	0.27	2	0.25	0.27	120.00
Window – South	2.2	0.25	0.27	2.5	0.25	0.27	120.00
Window –East	2.2	0.25	0.27	2.5	0.25	0.27	90.00
Window – West	2.2	0.25	0.27	2.5	0.25	0.27	90.00

Prescriptive method requires the WWR to be less than 40%.

Total Fenestration Area North, South = $2 \times (100\text{m} \times 1.2\text{m}) = 240 \text{ m}^2$

Wall Area North, South = $(2 \times (100\text{m} \times 4.5\text{m})) - (2 \times (100\text{m} \times 1.2\text{m})) = 660 \text{ m}^2$

Total Fenestration Area East, West = $2 \times (75\text{m} \times 1.2\text{m}) = 90 \text{ m}^2$

Total Wall Area East, West = $(2 \times (75\text{m} \times 4.5\text{m})) - (2 \times (75\text{m} \times 1.2\text{m})) = 495 \text{ m}^2$

Total Fenestration Area = 420 m^2 .

Total Wall Area = 1575 m^2

WWR = $(420/1575) \times 100$

= 26.67%

Hence, the proposed building is compliant with the WWR requirements.

U-value of the roof of the proposed building, at $0.3 \text{ W/m}^2\text{K}$ does not fulfil prescriptive requirements.

Hence, this building will not be compliant if the prescriptive approach is followed. The compliance in prescriptive approach can also be demonstrated through building envelope trade-off.

Step 2

B. Compliance through Building Envelope Trade-off method: Envelope performance factor (EPF) for the Standard Building and Proposed Building must be compared. As per the Building Envelope Trade-off method, the envelope performance factor (EPF) shall be calculated using the following equations:

$EPF_{\text{Total}} = EPF_{\text{Roof}} + EPF_{\text{Wall}} + EPF_{\text{Fenest}}$

Step 1: Calculation of EPF Proposed Building from actual envelope properties

$$EPF_{\text{Roof}} = (C_{\text{Roof}} \times \sum_{s=1}^n U_s A_s)$$

$$= 51.2 \times 0.3 \times 7500 = 1,15,200$$

$$EPF_{\text{Wall}} = (C_{\text{Wall}} \sum_{s=1}^n U_s A_s)$$

$$= 76.1 \times 0.3 \times 1155 = 26368.65$$

$$EPF_{\text{Fenest}} = C_{1 \text{ fen,north}} \sum_{w=1}^n U_w A_w + C_{2 \text{ fen,north}} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEFW} \right) * A_w \right) + C_{1 \text{ fen,south}} \sum_{w=1}^n U_w A_w$$

$$+ C_{2 \text{ fen,south}} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEFW} \right) * A_w \right) + C_{1 \text{ fen,east}} \sum_{w=1}^n U_w A_w + C_{2 \text{ fen,east}} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEFW} \right) * A_w \right)$$

$$+ C_{1 \text{ fen,west}} \sum_{w=1}^n U_w A_w + C_{2 \text{ fen,west}} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEFW} \right) * A_w \right)$$

$$EPF_{\text{fen,north}} = (2 \times 43.6 \times 120 \times 1) + (401.5 \times 0.25 \times 120)$$

$$= 10,464 + 12,045 = 22,509$$

$$EPF_{\text{fen,South}} = (2.5 \times 43.9 \times 120 \times 1) + (546.4 \times 0.25 \times 120)$$

$$= 13170 + 16392 = 29562$$

$$EPF_{\text{fen,East}} = (2.5 \times 41.1 \times 90 \times 1) + (490.6 \times 0.25 \times 90)$$

$$= 9247.5 + 11038.5 = 20286$$

$$EPF_{\text{fen,West}} = (2.5 \times 46 \times 90 \times 1) + (560.8 \times 0.25 \times 90)$$

$$= 10350 + 12618 = 22968$$

Therefore, $EPF_{\text{Fenest}} = 95,325$

$$EPF_{\text{Proposed}} = 115200 + 26368.65 + 95,325 = 2,36,893.65$$

Step 2: Calculating EPF Standard Building from prescriptive envelope requirements

The Baseline Building shall have the same building floor area, gross wall area and gross roof area as the Proposed Building. For mixed- use building the space distribution between different typologies shall be the same as the Proposed Design.

The U-factor of each envelope component shall be equal to the criteria from section 5.3 of ECSBC 2024 for each class of construction.

The SHGC of each window shall be equal to the criteria from section 5.4.3 of ECSBC 2024. Shading devices shall not be considered for calculating EPF for Baseline Building (i.e. SEF=1).

$$EPF_{Roof} = (C_{roof} * \sum_{s=1}^n U_s A_s)$$

$$= 51.2 \times 0.6 \times 7500 = 99,840$$

$$EPF_{wall} = (C_{wall} \sum_{s=1}^n U_s A_s)$$

$$= 76.1 \times 0.4 \times 1155 = 35158.2$$

$$EPF_{Fenest} = C_{1 fen,north} \sum_{w=1}^n U_w A_w + C_{2 fen,north} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEF_w} \right) * A_w \right) + C_{1 fen,south} \sum_{w=1}^n U_w A_w + C_{2 fen,south} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEF_w} \right) * A_w \right) + C_{1 fen,east} \sum_{w=1}^n U_w A_w + C_{2 fen,east} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEF_w} \right) * A_w \right) + C_{1 fen,west} \sum_{w=1}^n U_w A_w + C_{2 fen,west} \sum_{w=1}^n \left(\left(\frac{SHGC_w}{SEF_w} \right) * A_w \right)$$

$$EPF_{fen,north} = (2.2 \times 43.6 \times 120 \times 1) + (401.5 \times 0.5 \times 120) \\ = 11510.4 + 24090 = 35600.4$$

$$EPF_{fen,South} = (2.2 \times 43.9 \times 120 \times 1) + (546.4 \times 0.25 \times 120) \\ = 11589.6 + 16392 = 27981.6$$

$$EPF_{fen,East} = (2.2 \times 41.1 \times 90 \times 1) + (490.6 \times 0.25 \times 90) \\ = 8137.8 + 11038.5 = 19176.3$$

$$EPF_{fen,West} = (2.2 \times 46 \times 90 \times 1) + (560.8 \times 0.25 \times 90) \\ = 9108 + 12618 = 21726$$

$$\text{Therefore, } EPF_{fenest} = 1,04,484.3$$

$$EPF_{Proposed} = 35158.2 + 99840 + 1,04,484.3 = 2,39,482.50$$

Since $EPF_{Baseline} > EPF_{Proposed}$

Therefore, the building is compliant with ECSBC building envelope requirements.

Key Learning Points

- Compliance with WWR
- Heat of Roof wall and glazing of building
- Compliance of components of envelope with respect to ECSBC

Practice Question: ECSBC Compliance and Wall and Roof Insulation Design

Question 13 A commercial office building (9:00 AM to 5:00 PM occupancy) is proposed for a Composite Climate Zone (Delhi). The project team is evaluating the building for compliance under the Energy Conservation and Sustainable Building Code (ECSBC).

1. Building Description

- Building Use: Commercial Office (Regular Use)
- Structure: 1 Basement (Parking/Services) + 1 Stilt Floor (Open Parking) + Ground Floor + 7 Upper Floors
- Floor Area: Typical floor plate area = 1,800 m²
- Conditioned Space: Office spaces on the Ground Floor and 6 Upper Floors (Total = 8 conditioned floors)
- Window-to-Wall Ratio (WWR): 40%
- Wall Assembly:
 - 8-inch (203.2 mm) Solid Burnt Clay Brick (Density = 1920 kg/m³)
 - 15 mm Internal Cement Plaster
 - 20 mm External Cement Plaster

2. Simulation Results

- Base Case Building Annual Energy Consumption: 1,650,000 kWh/year
- Proposed Case Building Annual Energy Consumption: 1,470,000 kWh/year

3. Reference Data

Thermal Conductivity (k)

Material	Thermal Conductivity (W/m·K)
Brick	0.80
Cement Plaster	0.721
Expanded Polystyrene (EPS)	0.035

Surface Film Resistances

- Internal Surface Resistance (R_{si}) = 0.12 m²·K/W
- External Surface Resistance (R_{se}) = 0.06 m²·K/W

ECSBC Prescriptive Requirement

- Maximum Wall U-value = 0.4 W/m²·K

Percentage Energy Savings (PES) Requirements for Office Buildings in Composite Climate

Compliance Level	Minimum PES
ECSBC+	14%
Cement Plaster	22%

Tasks

Part A – Insulation Requirement

Calculate:

1. The total thermal resistance (R_t) of the base wall assembly (brick + plaster + surface resistances).
2. The corresponding wall U-value.
3. The minimum thickness (mm) of Expanded Polystyrene (EPS) insulation required to achieve the ECSBC prescriptive wall U-value limit of $0.4 \text{ W/m}^2\cdot\text{K}$.

Part B – MEPI and PES Calculation

Calculate:

1. The total conditioned floor area of the building.
2. The Modified Energy Performance Index (MEPI) of the proposed building in $\text{kWh/m}^2\cdot\text{year}$.
3. The Percentage Energy Savings (PES) achieved relative to the base case building.

Use:

- $\text{MEPI} = \text{Annual Energy Consumption} \div \text{Conditioned Floor Area}$
- $\text{PES (\%)} = [(\text{Base Case Energy} - \text{Proposed Case Energy}) \div \text{Base Case Energy}] \times 100$

Part C – Compliance Assessment

Based on the calculated PES:

1. Determine whether the building complies with ECSBC+ requirements.
2. Compare the achieved PES with the Super-ECSBC threshold.
3. State the applicable compliance level.

Part D – Super-ECSBC Goal

If the building does not currently achieve Super-ECSBC compliance:

1. Calculate the maximum allowable annual energy consumption (kWh/year) for the proposed building to meet the Super-ECSBC requirement of 22% PES.
2. Determine the additional annual energy reduction (kWh/year) required beyond the current proposed design.

Show all calculations, assumptions, and final results.

Solution: ECSBC Compliance and Wall Insulation Design

The following calculations demonstrate compliance assessment using the ECSBC Performance Method and prescriptive building envelope requirements.

Part A – Insulation Requirement**1. Calculation of Total Thermal Resistance of the Base Wall Assembly**

The total thermal resistance of the wall assembly is obtained by summing the thermal resistances of all wall layers and the internal and external surface film resistances.

Surface Film Resistances

- Internal Surface Resistance (R_{si}) = $0.12 \text{ m}^2 \cdot \text{K/W}$
- External Surface Resistance (R_{se}) = $0.06 \text{ m}^2 \cdot \text{K/W}$

Material Layer Resistances

The thermal resistance of each layer is calculated using:

$$R = t / k$$

where:

- R = Thermal resistance ($\text{m}^2 \cdot \text{K/W}$)
- t = Thickness (m)
- k = Thermal conductivity ($\text{W/m} \cdot \text{K}$)

Layer-1: Internal Cement Plaster (15 mm)

$$R = 0.015 / 0.721$$

$$R = 0.0208 \text{ m}^2 \cdot \text{K/W}$$

Layer-2: Solid Burnt Clay Brick (203.2 mm)

$$R = 0.2032 / 0.80$$

$$R = 0.2540 \text{ m}^2 \cdot \text{K/W}$$

Layer-3: External Cement Plaster (20 mm)

$$R = 0.020 / 0.721$$

$$R = 0.0277 \text{ m}^2 \cdot \text{K/W}$$

Total Thermal Resistance

$$R_{t, \text{base}} = R_{si} + R_{se} + R_{\text{plaster}(\text{internal})} + R_{\text{brick}} + R_{\text{plaster}(\text{external})}$$

$$R_{t, \text{base}} = 0.12 + 0.06 + 0.0208 + 0.2540 + 0.0277$$

$$= 0.4825 \text{ m}^2 \cdot \text{K/W}$$

2. Calculation of Base Wall U-Value

The thermal transmittance (U-value) is calculated as:

$$U = 1 / R_t$$

Therefore,

$$U_{\text{base}} = 1 / 0.4825$$

$$= 2.07 \text{ W/m}^2 \cdot \text{K}$$

The calculated U-value is significantly higher than the ECSBC prescriptive limit of $0.40 \text{ W/m}^2 \cdot \text{K}$, indicating that additional insulation is required.

3. Minimum EPS Insulation Thickness Required

Required Total Resistance

To meet the ECSBC requirement:

$$\text{Target U-value} = 0.40 \text{ W/m}^2 \cdot \text{K}$$

Therefore,

$$R_{\text{target}} = 1 / 0.40$$

$$= 2.50 \text{ m}^2 \cdot \text{K/W}$$

Required Insulation Resistance

R_{ins}

$$= R_{\text{target}} - R_{\text{t,base}}$$

$$= 2.50 - 0.4825$$

$$= 2.0175 \text{ m}^2 \cdot \text{K/W}$$

EPS Thickness

Using the thermal conductivity of Expanded Polystyrene (EPS):

$$k_{\text{EPS}} = 0.035 \text{ W/m} \cdot \text{K}$$

Thickness

$$= R_{\text{ins}} \times k_{\text{EPS}}$$

$$= 2.0175 \times 0.035$$

$$= 0.0706 \text{ m}$$

$$= 70.6 \text{ mm}$$

Result

The minimum EPS insulation thickness required is approximately:

71 mm EPS insulation

Part B – MEPI and PES Calculation

1. Total Conditioned Floor Area

Conditioned Floors:

- Ground Floor + 7 Upper Floors
- Total Conditioned Floors = 8

Typical Floor Area:

- 1,800 m²

Total Conditioned Area

$$= 8 \times 1,800$$

$$= 14,400 \text{ m}^2$$

2. Modified Energy Performance Index (MEPI)

MEPI is calculated as:

$$\text{MEPI} = \text{Annual Energy Consumption} / \text{Conditioned Floor Area}$$

Proposed Building MEPI

MEPI_{proposed}

$$= 1,470,000 / 14,400$$

$$= 102.08 \text{ kWh/m}^2 \cdot \text{year}$$

3. Percentage Energy Savings (PES)

Percentage Energy Savings are calculated as:

$$\text{PES (\%)} = [(\text{Base Energy} - \text{Proposed Energy}) / \text{Base Energy}] \times 100$$

Substituting the values:

PES

$$= [(1,650,000 - 1,470,000) / 1,650,000] \times 100$$

$$= (180,000 / 1,650,000) \times 100$$

$$= 10.91\%$$

Part C – Compliance Assessment

ECSBC Compliance

Base Case MEPI

$$= 1,650,000 / 14,400$$

$$= 114.58 \text{ kWh/m}^2 \cdot \text{year}$$

Proposed Case MEPI

$$= 102.08 \text{ kWh/m}^2 \cdot \text{year}$$

Since the proposed MEPI is lower than the base case MEPI and all mandatory ECSBC provisions are satisfied, the building complies with the ECSBC Performance Compliance Method.

ECSBC+ Compliance

Required PES for ECSBC+:

$$\geq 14\%$$

Achieved PES:

$$10.91\%$$

Since 10.91% is less than 14%, the building does not comply with ECSBC+.

Super-ECSBC Compliance

Required PES for Super-ECSBC:

$$\geq 22\%$$

Achieved PES:

$$10.91\%$$

Since 10.91% is less than 22%, the building does not comply with Super-ECSBC.

Applicable Compliance Level

The building satisfies the requirements of:

ECSBC

However, it does not achieve:

- ECSBC+
- Super-ECSBC

Part D – Super-ECSBC Goal

1. Maximum Allowable Annual Energy Consumption

To achieve Super-ECSBC, the proposed building must demonstrate a minimum of 22% energy savings compared to the base case.

Maximum Allowable Energy

$$= \text{Base Energy} \times (1 - 0.22)$$

$$= 1,650,000 \times 0.78$$

$$= 1,287,000 \text{ kWh/year}$$

2. Additional Annual Energy Reduction Required

Current Proposed Energy Consumption

$$= 1,470,000 \text{ kWh/year}$$

Required Energy Consumption

$$= 1,287,000 \text{ kWh/year}$$

Additional Reduction Required

$$= 1,470,000 - 1,287,000$$

$$= 183,000 \text{ kWh/year}$$

Parameter	Result
Base Wall Thermal Resistance	0.4825 m ² ·K/W
Base Wall U-Value	2.07 W/m ² ·K
Minimum EPS Insulation Required	70.6 mm (≈71 mm)
Total Conditioned Floor Area	14,400 m ²
Proposed MEPI	102.08 kWh/m ² ·year
Percentage Energy Savings (PES)	10.91%
ECSBC Compliance	Yes
ECSBC+ Compliance	No
Super-ECSBC Compliance	No
Maximum Energy for Super-ECSBC	1,287,000 kWh/year
Additional Energy Reduction Required	183,000 kWh/year

Conclusion

The existing wall assembly does not satisfy the ECSBC prescriptive envelope requirement and requires approximately 71 mm of EPS insulation to achieve a wall U-value of $0.40 \text{ W/m}^2\cdot\text{K}$. The building complies with the basic ECSBC performance requirements but falls short of ECSBC+ and Super-ECSBC thresholds. To achieve Super-ECSBC compliance, annual energy consumption must be reduced by an additional 183,000 kWh/year, resulting in a maximum annual consumption of 1,287,000 kWh/year.

Practice Question: ECSBC Compliance Building envelope

Question 14 A 12-hour regular-use commercial office building is being designed in Chennai, located in the Warm-Humid climatic zone. The project team must verify whether the proposed building envelope complies with the prescriptive requirements of the Energy Conservation and Sustainable Building Code (ECSBC) or whether compliance must be demonstrated through the Building Envelope Trade-off Method due to the proposed Window-to-Wall Ratio (WWR) and roof specification.

Building Data

Window-to-Wall Ratio (WWR)

- Proposed WWR: 45%
- ECSBC Prescriptive Limit: 40%

Wall Assembly A

- 15 mm Internal Cement Plaster
- 300 mm Solid Brick Masonry (Density: 1920 kg/m^3)
- 4-inch Expanded Polystyrene (EPS) Insulation
- 20 mm External Cement Plaster

Wall Assembly B

- 15 mm Internal Cement Plaster
- 200 mm AAC Block (Density: 400 kg/m^3)
- Thermal Conductivity of AAC Block: $0.11 \text{ W/m}\cdot\text{K}$
- 20 mm External Cement Plaster

Roof Assembly C

- 8-inch Reinforced Cement Concrete (RCC)
- 3-inch Plain Cement Concrete (PCC)

Roof Insulation

- Material: Extruded Polystyrene (XPS)
- Density: 25 kg/m^3
- Thermal Conductivity (k): $0.022 \text{ W/m}\cdot\text{K}$

Glazing Options

Option	Maximum U-factor ($\text{W/m}^2\cdot\text{K}$)	SHGC	VLT
A	5.0	0.50	0.80
B	3.0	0.25	0.27
C	2.2	0.25	0.15
D	2.0	0.25	0.45
E	1.5	0.80	0.90

Tasks

The project team is required to perform the following assessments:

1. Calculate the overall thermal transmittance (U-value) of Wall Assembly A and Wall Assembly B and determine whether they comply with the ECSBC prescriptive wall requirement of $U \leq 0.40 \text{ W/m}^2\cdot\text{K}$.
2. Determine the minimum thickness of XPS insulation required for Roof Assembly C to satisfy the ECSBC roof U-value requirement for Warm-Humid climates ($U \leq 0.26 \text{ W/m}^2\cdot\text{K}$).
3. Evaluate the glazing options and identify the most suitable glazing configuration that satisfies ECSBC prescriptive requirements while providing good daylight performance.
4. Assess whether the Building Envelope Trade-off Method can be used to demonstrate compliance when:
 - o The Window-to-Wall Ratio exceeds the prescriptive limit; and/or
 - o The roof assembly does not meet the prescriptive thermal performance requirement.
5. Verify whether improved glazing performance can compensate for deficiencies in roof performance under the ECSBC Building Envelope Trade-off Method.

Solution : ECSBC Compliance Verification for a Commercial Office Building in Chennai (Warm-Humid Climate)

To verify compliance with the Energy Conservation and Sustainable Building Code (ECSBC) for the proposed commercial office building in Chennai (Warm-Humid Climate), the thermal performance of the building envelope has been evaluated. The assessment includes wall and roof U-value calculations, glazing selection, and applicability of the Building Envelope Trade-off Method.

1. Wall Thermal Transmittance (U-Value) Assessment

The thermal transmittance (U-value) of a wall assembly is calculated as the inverse of the total thermal resistance:

$$U = 1 / R_t$$

where the total thermal resistance, R_t , is the sum of the internal and external surface film resistances and the thermal resistance of each material layer.

Common Data

Parameter	Value
Internal Surface Resistance (R _{si})	0.12 m ² ·K/W
External Surface Resistance (R _{se})	0.06 m ² ·K/W
Cement Plaster Conductivity	0.721 W/m·K
Solid Brick Conductivity	0.80 W/m·K
EPS Conductivity	0.035 W/m·K
AAC Block Conductivity	0.11 W/m·K

Wall Assembly A

Construction:

- 15 mm Internal Cement Plaster
- 300 mm Solid Brick Masonry
- 4-inch EPS Insulation
- 20 mm External Cement Plaster

Thermal Resistance of Individual Layers

Layer	Resistance (m ² ·K/W)
Internal Plaster	0.0208
Solid Brick	0.3750
EPS Insulation	2.9030
External Plaster	0.0277

Total Thermal Resistance

$$R_t = 0.12 + 0.06 + 0.0208 + 0.3750 + 2.9030 + 0.0277$$

$$R_t = 3.5065 \text{ m}^2 \cdot \text{K/W}$$

U-Value

$$U = 1 / 3.5065$$

$$U = 0.285 \text{ W/m}^2 \cdot \text{K}$$

Result: $U \approx 0.29 \text{ W/m}^2 \cdot \text{K}$

Compliance Status: Complies with ECSBC wall requirement ($U \leq 0.40 \text{ W/m}^2 \cdot \text{K}$).

Wall Assembly B

Construction:

- 15 mm Internal Cement Plaster
- 200 mm AAC Block
- 20 mm External Cement Plaster

Thermal Resistance of Individual Layers

Layer	Resistance ($\text{m}^2 \cdot \text{K/W}$)
Internal Plaster	0.0208
AAC Block	1.8180
External Plaster	0.0277

Total Thermal Resistance

$$R_t = 0.12 + 0.06 + 0.0208 + 1.8180 + 0.0277$$

$$R_t = 2.0465 \text{ m}^2 \cdot \text{K/W}$$

U-Value

$$U = 1 / 2.0465$$

$$U = 0.489 \text{ W/m}^2 \cdot \text{K}$$

Result: $U \approx 0.49 \text{ W/m}^2 \cdot \text{K}$

Compliance Status: Does not comply with the ECSBC wall requirement, as the calculated U-value exceeds the maximum allowable value of $0.40 \text{ W/m}^2 \cdot \text{K}$.

2. Minimum Roof Insulation Thickness

For roofs in the Warm-Humid climatic zone, ECSBC specifies a maximum U-value of $0.26 \text{ W/m}^2 \cdot \text{K}$.

Roof Construction

- 8-inch Reinforced Cement Concrete (RCC)
- 3-inch Plain Cement Concrete (PCC)
- XPS Insulation

Surface Film Resistances

Parameter	Value
Internal Surface Resistance (R_{si})	$0.17 \text{ m}^2 \cdot \text{K/W}$
External Surface Resistance (R_{se})	$0.04 \text{ m}^2 \cdot \text{K/W}$

Thermal Resistance of Existing Roof Layers

Layer	Resistance ($\text{m}^2 \cdot \text{K/W}$)
RCC (203.2 mm)	0.1286
PCC (76.2 mm)	0.0438
Internal Surface Film	0.1700
External Surface Film	0.0400

Total Base Resistance:

$$R_t = 0.3824 \text{ m}^2 \cdot \text{K/W}$$

Required Resistance

Target U-value:

$$U = 0.26 \text{ W/m}^2 \cdot \text{K}$$

Required total resistance:

$$R_t = 1 / 0.26 = 3.846 \text{ m}^2 \cdot \text{K/W}$$

Required insulation resistance:

$$R_{\text{ins}} = 3.846 - 0.3824$$

$$R_{\text{ins}} = 3.4636 \text{ m}^2 \cdot \text{K/W}$$

XPS Thickness Requirement

Using XPS conductivity of $0.022 \text{ W/m} \cdot \text{K}$:

$$\text{Thickness} = 3.4636 \times 0.022$$

$$\text{Thickness} = 0.0762 \text{ m}$$

$$\text{Thickness} = 76.2 \text{ mm}$$

Result: A minimum XPS insulation thickness of approximately 76 mm (3 inches) is required to achieve compliance with the ECSBC roof U-value requirement.



3. Glazing Evaluation

For Warm-Humid climates, ECSBC prescriptive glazing requirements generally require:

- $U\text{-Factor} \leq 2.2 \text{ W/m}^2\cdot\text{K}$
- $\text{SHGC} \leq 0.25$

Evaluation of Available Options

Option	U-Factor	SHGC	VLT	Compliance
A	5.0	0.50	0.80	No
B	3.0	0.25	0.27	No
C	2.2	0.25	0.15	Yes
D	2.0	0.25	0.45	Yes
E	1.5	0.80	0.90	No

Recommended Glazing Option

Both Options C and D satisfy the thermal requirements. However, Option D provides a significantly higher Visible Light Transmittance ($\text{VLT} = 0.45$) compared to Option C ($\text{VLT} = 0.15$), resulting in improved daylight penetration and reduced dependence on artificial lighting.

Recommended Option: Glazing D

4. Building Envelope Trade-off Method Assessment

The proposed building has a Window-to-Wall Ratio (WWR) of 45%, which exceeds the ECSBC prescriptive limit of 40%.

In addition, Wall Assembly B does not satisfy the prescriptive wall U-value requirement.

Under ECSBC, compliance may alternatively be demonstrated through the Building Envelope Trade-off Method when one or more envelope components fail to meet prescriptive requirements or when the proposed WWR exceeds the prescribed limit.

The trade-off method evaluates the overall thermal performance of the building envelope rather than assessing each component independently.

5. Verification of Performance Compensation

Under the ECSBC Building Envelope Trade-off Method, improved performance of one envelope component may compensate for lower performance in another component.

Accordingly, high-performance glazing with lower U-factor and SHGC values may offset the impact of a roof or wall assembly that does not fully satisfy the prescriptive requirements.

Compliance is achieved when:

Proposed Envelope Performance Factor (EPF) $\leq$ Baseline Envelope Performance Factor (EPF)

Therefore, by selecting high-performance glazing such as Option D and ensuring that the overall envelope performance is equal to or better than the baseline building, the project can demonstrate ECSBC compliance through the Building Envelope Trade-off Method.

Conclusions

1. Wall Assembly A achieves a U-value of $0.29 \text{ W/m}^2\cdot\text{K}$ and complies with ECSBC requirements.
2. Wall Assembly B achieves a U-value of $0.49 \text{ W/m}^2\cdot\text{K}$ and does not comply with ECSBC requirements.
3. Roof Assembly C requires approximately 76 mm of XPS insulation to satisfy the roof U-value requirement of $0.26 \text{ W/m}^2\cdot\text{K}$.
4. Glazing Option D is the most suitable option, providing both ECSBC compliance and superior daylight performance.
5. Since the proposed WWR exceeds the prescriptive limit and Wall Assembly B is non-compliant, the Building Envelope Trade-off Method may be used to demonstrate compliance.
6. Improved glazing performance can be used to offset deficiencies in other envelope components, provided the Proposed Envelope Performance Factor does not exceed the Baseline Envelope Performance Factor.

Recommended further reading reference material from BEE:

- Energy Conservation & Sustainable Building Code 2024 (ECSBC 2024)
- Eco-Niwas Samhita (ENS) 2024
- Energy-Efficient Retrofit Manuals: Transforming Existing Buildings residential 4 climates
- Energy Efficiency Solutions for Existing Buildings Commercial 4 climates
- Energy Efficient Retrofit Manuals: Transforming Existing Buildings Commercial Cold Climate
- The Energy Conservation Act, 2001. Amended 2022





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