Annexure – 6

Procedure for Building Energy Simulation

Annexure – 6: Procedure for Building Energy Simulation

Baseline requirements:

- **Building Envelope:**

Table 1: U-value for Glazing

Climate Zone *	Maximum U-Value (W/m^2K)
Composite	5.7
Hot and Dry	5.7
Warm and Humid	5.7
Moderate	5.7
Cold	5.7

Table 2: U Value for Wall Assembly

Climate Zone*	Maximum 'U'-Value of the overall wall assembly (W/m^2K)
Composite	1.8
Hot and Dry	1.8
Warm and Humid	2.0
Moderate	2.2
Cold	1.1

Table 3: U Value for Roof Assembly

Climate Zone*	Maximum 'U'-Value of the overall roof assembly (W/m^2K)
Composite	1.5
Hot and Dry	1.5
Warm and Humid	1.5
Moderate	1.5
Cold	1.2

Annexure – 6: Procedure for Building Energy Simulation

➢ Lighting system and control

The baseline Lighting Power Density (LPD) shall be achieved outlined as below:

Table 4: Lighting Power Density

Lighting	Applicable Areas	Baseline Lighting Power Density (LPD)
Interior Lighting (for residential units)	Individual dwelling unit, Apartments, Villas, Gated communities	5.0 W/m^2
Interior Lighting (for non-residential units)	Service apartments, Hostels, Guest houses	10.8 W/m^2
Exterior Lighting, excluding Parking Area (for residential & non-residential units)	Landscaping, Façade, Street lighting, Pathways, Signages	2.5 W/m^2
Common Area Lighting, excluding Parking Area (for residential & non-residential units)	Corridors, Lobbies, Staircases, Terrace	4.0 W/m^2
Parking Area	Surface parking (covered & uncovered), Basement parking,	2.5 W/m^2

Notes:

- *Multi-dwelling units should show lighting compliance for all the areas which are in developer's/ owner's scope only.*
- *Compliance for interior, exterior, common and parking area lighting must be shown separately.*
- *Decorative lighting in respective areas should be considered for lighting power density calculations.*
- *This LPD includes the power consumption of the complete fixtures which include lamps and ballasts.*

Annexure – 6: Procedure for Building Energy Simulation

➢ HVAC and Controls

➢ Unitary air-conditioning systems:

Baseline air-conditioning system to be considered as unitary air-conditioners with ISEER equivalent to 3-star rated equipment under BEE labeling programme.

For latest list of air-conditioners rated by BEE, please refer BEE website https://beeindia.gov.in/content/standards-labeling

➢ Centralised air-conditioning systems:

The Minimum Efficiency Requirements for centralised air-conditioning systems are detailed below:

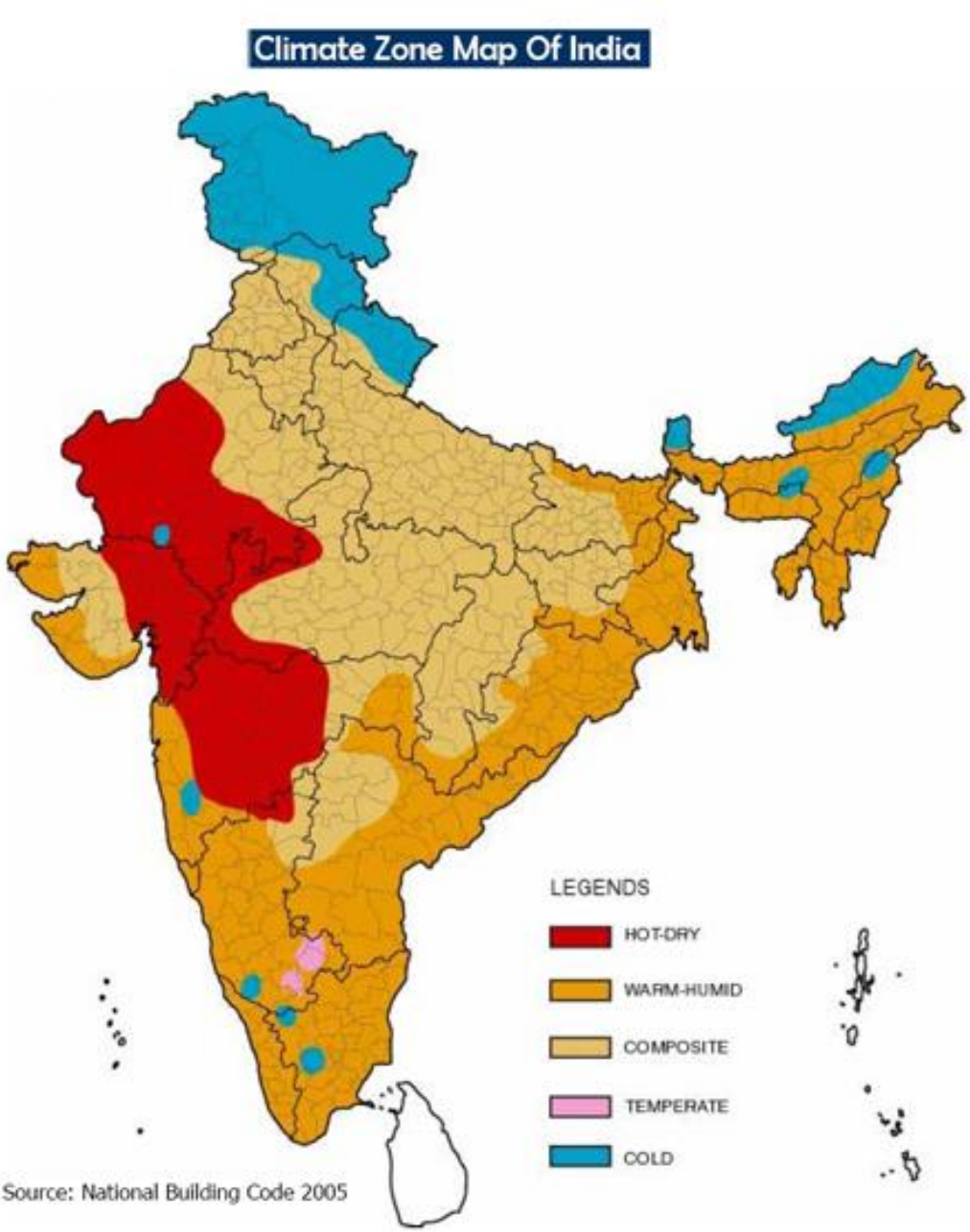
Table 6: Minimum Efficiency Requirements

For Heating or cooling or both			
Type	Size category (kWr)	EER (W/W)	IEER (W/W)
VRF Air Conditioners, Air cooled	< 40	3.28	4.36
	≥ 40 and < 70	3.26	4.34
	≥ 70	3.02	4.07

Note: *Minimum Efficiency Requirements for VRF Systems can be referred from ECBC Table 5-2.*

For other Centralised air-conditioning systems, the efficiency requirements shall be referred from ECBC, 2017.

Exhibit C – Climatic Zones of India



Annexure – 6: Procedure for Building Energy Simulation

Table 8: Climate Zone for Major Indian Cities

City	Climate Type	City	Climate Type
Ahmedabad	Hot & Dry	Kurnool	Warm & Humid
Allahabad	Composite	Leh	Cold
Amritsar	Composite	Lucknow	Composite
Aurangabad	Hot & Dry	Ludhiana	Composite
Bangalore	Temperate	Chennai	Warm & Humid
Barmer	Hot & Dry	Manali	Cold
Belgaum	Warm & Humid	Mangalore	Warm & Humid
Bhagalpur	Warm & Humid	Mumbai	Warm & Humid
Bhopal	Composite	Nagpur	Composite
Bhubaneshwar	Warm & Humid	Nellore	Warm & Humid
Bikaner	Hot & Dry	New Delhi	Composite
Chandigarh	Composite	Panjim	Warm & Humid
Chitradurga	Warm & Humid	Patna	Composite
Dehradun	Composite	Pune	Warm & Humid
Dibrugarh	Warm & Humid	Raipur	Composite
Guwahati	Warm & Humid	Rajkot	Composite
Gorakhpur	Composite	Ramgundam	Warm & Humid
Gwalior	Composite	Ranchi	Composite
Hissar	Composite	Ratnagiri	Warm & Humid
Hyderabad	Composite	Raxaul	Warm & Humid
Imphal	Warm & Humid	Saharanpur	Composite
Indore	Composite	Shillong	Cold
Jabalpur	Composite	Sholapur	Hot & Dry
Jagdelpur	Warm & Humid	Srinagar	Cold
Jaipur	Composite	Sundernagar	Cold
Jaisalmer	Hot & Dry	Surat	Hot & Dry
Jalandhar	Composite	Tezpur	Warm & Humid
Jamnagar	Warm & Humid	Tiruchirappalli	Warm & Humid
Jodhpur	Hot & Dry	Trivandrum	Warm & Humid
Jorhat	Warm & Humid	Tuticorin	Warm & Humid
Kochi	Warm & Humid	Udhagamandalam	Cold
Kolkata	Warm & Humid	Vadodara	Hot & Dry
Kota	Hot & Dry	Veraval	Warm & Humid
Kullu	Cold	Vishakhapatnam	Warm & Humid

**Source: Energy Conservation Building Code for Residential Buildings, 2017*

Annexure – 6: Procedure for Building Energy Simulation

Performance Based Approach

This method can be adopted for buildings which implement energy efficiency measures beyond those specified in the baseline parameters.

Simulation General Requirements

The simulation program shall, at a minimum, have the ability to explicitly model all of the following:

- 8,760 hours per year
- Hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points and HVAC system operation, defined separately for each day
- Thermal mass effects
- Two or more thermal zones
- Part-load performance curves for mechanical equipment
- Capacity and efficiency correction curves for mechanical heating and cooling equipment
- The simulation program shall have the ability to either (1) Directly determine the proposed building performance and baseline building performance or (2) produce hourly reports of energy use by an energy source suitable for determining the proposed building performance and baseline building performance using a separate calculation.

➢ Climate Data:

The simulation program shall perform the simulation using latest weather data hourly values of climatic data, such as temperature and humidity from representative climatic data, for the site in which the proposed design is to be located. For cities or urban regions with several climatic data entries, and for locations where weather data are not available, the designer shall select available weather data that best represent the climate at the construction site.

➢ Energy Rates:

Annual energy costs shall be determined using actual rates for purchased energy from respective DISCOM.

➢ On-Site Renewable Energy Sources:

On-site renewable energy sources (such as solar photovoltaic, wind turbines, etc.,) should not be modeled in either the base case or the proposed case, to show energy savings. Such systems are separately recognised under EE Credit 3 – On-site Renewable Energy.

➢ Water Heating Systems:

Alternate Hot water systems should not be modeled in either the base case or the proposed case, to show energy savings. Such systems are separately recognised under EE Credit 2 – Alternate Water Heating Systems.

Annexure – 6: Procedure for Building Energy Simulation

➢ Schedules:

Schedules capable of modeling hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat set points, and HVAC system operation shall be used. The schedules shall be typical of the proposed case are detailed below:

Time Period	Occupancy Schedule		Elevator Schedule	External Lighting Schedule	Basement Lighting	Basement Ventilation	HVAC Schedule	
							Common Area (Gym, club house, community Hall)	Dwelling Units (Bedrooms)
	Weekends	Weekdays	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week	7 Days/ week
00:00-01:00	1.00	1.00	0.01	0.80	0.5	0.00	0.00	1.00
01:00-02:00	1.00	1.00	0.01	0.80	0.5	0.00	0.00	1.00
02:00-03:00	1.00	1.00	0.01	0.80	0.5	0.00	0.00	1.00
03:00-04:00	1.00	1.00	0.01	0.80	0.5	0.00	0.00	1.00
04:00-05:00	1.00	1.00	0.01	0.80	0.5	0.00	0.00	1.00
05:00-06:00	1.00	1.00	0.25	0.80	0.5	0.00	1.00	1.00
06:00-07:00	1.00	1.00	0.25	0.00	0.5	0.00	1.00	0.01
07:00-08:00	1.00	1.00	0.5	0.00	0.5	0.00	1.00	0.01
08:00-09:00	1.00	0.5	0.9	0.00	0.8	1.00	1.00	0.01
09:00-10:00	1.00	0.5	0.9	0.00	0.8	1.00	1.00	0.01
10:00-11:00	1.00	0.5	0.25	0.00	0.8	0.2	0.2	0.01
11:00-12:00	1.00	0.5	0.25	0.00	0.8	0.2	0.2	0.01
12:00-13:00	1.00	0.5	0.25	0.00	0.8	0.2	0.2	0.01
13:00-14:00	1.00	0.5	0.25	0.00	0.8	0.2	0.2	0.01
14:00-15:00	1.00	0.5	0.25	0.00	0.8	0.2	0.2	0.5
15:00-16:00	1.00	0.5	0.25	0.00	0.8	0.2	0.2	0.5
16:00-17:00	1.00	0.5	0.50	0.00	0.8	0.2	0.2	0.5
17:00-18:00	1.00	0.5	0.90	0.00	1.00	0.2	1.00	0.01
18:00-19:00	1.00	1.00	0.90	0.80	1.00	1.00	1.00	0.01
19:00-20:00	1.00	1.00	0.90	0.80	1.00	1.00	1.00	0.01
20:00-21:00	1.00	1.00	0.90	0.80	1.00	1.00	1.00	0.01
21:00-22:00	1.00	1.00	0.25	0.80	1.00	0.2	0.00	1.00
22:00-23:00	1.00	1.00	0.25	0.80	1.00	0.2	0.00	1.00
23:00-24:00	1.00	1.00	0.01	0.80	0.5	0.00	0.00	1.00

➢ Equipment Efficiencies:

All HVAC equipment in the baseline building design shall be modeled at the minimum efficiency levels, both part load and full load. Where efficiency ratings, such as ISEER and COP, include fan energy, the descriptor shall be broken down into its components so that supply fan energy can be modeled separately.

Annexure – 6: Procedure for Building Energy Simulation

➢ Equipment Capacities:

The equipment capacities for the baseline building design shall be oversized by 15% for cooling and 25% for heating as compared to the system sizing done by the simulation tool.

➢ Unmet Hours:

Unmet load hours for each of the zones in the proposed design or baseline building designs shall not exceed 300 hours. The unmet hours in the proposed case shall not exceed the unmet hours in the base case by more than 50 hours.

If unmet load hours for the proposed design or baseline building design exceed 300, simulated capacities shall be increased incrementally, and the building with unmet loads shall be re-simulated until unmet load hours are reduced to 300 or less.

- Fan System Operation: (for centralised air-conditioning system)

  Supply and return fans shall operate continuously whenever spaces are occupied and shall be cycled to meet heating and cooling loads during unoccupied hours. If the supply fan is modeled as cycling and fan energy is included in the energy-efficiency rating of the equipment, fan energy shall not be modeled explicitly. Supply, return, and/or exhaust fans will remain on during occupied and unoccupied hours in spaces that have health and safety mandated minimum ventilation requirements during unoccupied hours.

- Ventilation:

  Minimum air ventilation rates shall be the same for the proposed and baseline building designs. Design a ventilation system as per the space and design according to ASHRAE 62.1.

➢ Heat Pumps:

Electric air-source heat pumps shall be modeled with electric auxiliary heat. The systems shall be controlled with multistage space thermostats and an outdoor air thermostat wired to energize auxiliary heat only on the last thermostat stage and when outdoor air temperature is less than 4.4°C (40°F).

➢ Receptacle and Process Loads:

Both the proposed and the baseline building performance shall include all end-use load components, such as receptacle and process loads. Receptacle, process and equipment loads shall be estimated based on the building type or space type category and shall be assumed to be identical in the proposed and baseline building designs.

Annexure – 6: Procedure for Building Energy Simulation

Documentation Requirements

Simulated performance shall be documented and related documentation shall be submitted. The information submitted shall include the following:

1. A list of the energy-related features which are included in the design. This list shall document all energy features that differ between the models used in the baseline building performance and proposed building performance calculations.
2. Comparison & calculated values for the baseline building performance and the proposed building performance.
3. The percentage improvement in energy consumption between baseline building performance and proposed building performance.
4. The schedules for lighting power, thermostat set-point, HVAC system, miscellaneous equipment power, etc., for proposed building, as determined by the designer.
5. Input and output report(s)*from the simulation program or compliance software including a breakdown of energy usage by at least the following components: lights, space cooling & heating equipment and heat rejection equipment, fans, other HVAC equipment (such as pumps), internal equipment loads, etc.,. The output reports shall also show the amount of time any loads are not met by the HVAC system for both the proposed design and baseline building design.
6. An explanation of any error messages noted in the simulation program output.
7. Details of proposed glazing along with the list of identified manufacturers and respective specifications of glazing (SHGC value, U-value and VLT). Also, specify window-to-wall ratio (WWR) for each building.
8. Construction details of proposed wall and roof (including roof insulation material, etc.,) along with U-value of the overall assembly and Sectional drawings of assembly
9. Details of the proposed lighting system including list of interior and exterior lighting fixtures, with make and model.
    - Proposed LPD calculations for interior, exterior, common and parking areas, in owner's/ developer's scope, separately.
    - Conceptual lighting layout of interior and common areas for each typical floor, as applicable
    - Conceptual exterior lighting layout
10. Manufacturer brochures/ cut-sheets/ letters indicating the efficiency parameters for glazing (SHGC value, U-value and VLT), roof insulation materials, lighting fixtures and air-conditioning system, as applicable.

* BEPU/BEPS - Energy use by category & Percent of hours outside throttling range
LV-D: Total (opaque + glass) wall area by orientation
LV-B: Lighting density in each space
LS-C Peak space load per sqft (building total)
SV-A: Amount of outside air (if not scheduled)
PV-A: Equipment sizes
PS-C Calculate overall equipment efficiencies
SS-A: For unitary DX, monthly pattern of loads

Annexure – 6: Procedure for Building Energy Simulation

Calculation of the Proposed and Baseline Building Performance

Building energy modeling requirements for proposed and baseline building:

The baseline model shall be identical to the proposed model except as specifically detailed in the table below.

S. No.	Case	Proposed building	Baseline building
1.	Design model	a) The simulation model of the proposed design shall be consistent with the actual design and should include envelope measures and all systems b) All end use energy consumers in the building and associated with the building must be modeled.	a) The baseline model should have the same conditioned area and same number of floors as the proposed building. b) All end use energy consumers in and associated with the building in the base case should be the same as the proposed case
2.	Schedules	The schedules for lighting power, thermostat set-point, HVAC system, miscellaneous equipment power, etc., shall be typical of the proposed building as determined by the designer.	Same as proposed design
3.	Building envelope	All components of the building envelope in the proposed design shall be modeled as shown on architectural drawings or as installed for existing building envelopes. a) Orientation: As per design	The standard design shall have identical conditioned, unconditioned floor area and identical exterior dimensions and orientations as proposed design, unless otherwise mentioned. a) Orientation: The baseline energy performance shall be the average of the performance with original orientation and after rotating the entire building 90, 180, 270 degrees. The building shall be modeled so that it does not shade itself.

Annexure – 6: Procedure for Building Energy Simulation

S. No.	Case	Proposed building	Baseline building
		b) Opaque assemblies such as roof and walls shall be modeled with the same heat capacity and U-value as per proposed design.	b) Opaque assemblies such as roof and walls shall be modeled with U-values as per Mandatory requirement (Table 2 and 3).
		c) Fenestration: as per design manually operated fenestration shading devices such as blinds or shades shall not be modeled. Permanent shading devices such as fins, overhangs, and light shelves shall be modeled.	c) Fenestration: Fenestration areas shall be equal to that in the proposed design or 30% of gross wall area above grade, whichever is smaller, shall be distributed on each face of the building in the same proportions in the proposed design. • No shading projections are to be modeled; fenestration shall be assumed to be flush with the exterior wall or roof. • Manually operated fenestration shading devices such as blinds or shades shall not be modeled. • Fenestration U-factor and SHGC shall be as per Mandatory requirement (Table 1)
		d) For exterior roofs the reflectance and emittance of the roof surface shall be modeled as per design.	d) Roof albedo: For exterior roofs the reflectance and emittance of the roof surface shall be modeled as 0.45 if the actual value is more than 0.7 for reflectance and 0.75 for emittance.

Annexure – 6: Procedure for Building Energy Simulation

S. No.	Case	Proposed building	Baseline building
4.	Lighting	Lighting power in the proposed design shall be as per the actual design. In addition, the following Energy conservation measures (ECM) can be factored, if considered in design. a) For Occupancy/Motion sensors with daylight cut-off features used in the common areas (like staircases, common corridors, parking areas) in the proposed case, should not be modeled but can be giving a direct saving up to 15% over the lighting power of those fixtures connected to such sensors. b) For Timer/daylight control based system, the system shall be modeled in proposed case and savings shall be as per the design model. ***Notes:*** ***Individual residential unit – Interior & Exterior LPDs should be considered as per design.*** ***Multi-dwelling residential units - Interior LPD should be same as base case (or, as per design, if interior lighting is in the scope of developer) and Exterior, Common & Parking area LPD should be considered as per design.***	Lighting power in the standard design shall be determined using the Baseline values as detailed in Table 4.

Annexure – 6: Procedure for Building Energy Simulation

S. No.	Case	Proposed building	Baseline building
5.	Heating and Cooling systems	a) Where a cooling and heating system has been designed for more than 25% of living spaces of the project, the model shall be consistent with design documents. b) Where no heating or cooling system is proposed, the system shall be same as the baseline.	a) The Cooling system for the base case is to be modeled considering the system defined in Air conditioning and Heating Systems/ Equipment. If the building requires heating the heating system would incorporate heat pump with efficiencies as per the baseline criteria – Table 5. ***Notes:*** ***Individual & Multi-dwelling residential units:*** • ***In actual design, if less than 25% of living spaces are air-conditioned, then model at least 25% of living spaces as air-conditioned in both base case and proposed case.*** • ***If more than 25%, then consider air-conditioned area as per actual design in both base case and proposed case.*** • ***The project should consider minimum of 12 hours per day for at least 120 days in a year (for cooling & heating in summer and winter respectively), for air-conditioning in both base Case and proposed case.***

Annexure – 6: Procedure for Building Energy Simulation

S. No.	Case	Proposed building	Baseline building
6.	Receptacle and Process loads	a) Receptacle and Process loads shall be modeled as designed. All end-use load components shall be modeled.	a) Receptacle and Process loads shall be modeled same as the proposed design. ***Notes:*** • ***The default receptacle and process loads cost shall be considered as 25% of the total energy cost for the baseline building.*** • *For buildings, where the process energy cost is less than 25% of the baseline building energy cost, the submittal must include supporting documentation substantiating that process energy inputs are appropriate.*

Note: In cases, where the parameters and their values are not specified in the document, they should be referred to ENS, 2018 or ECBC, 2017 or ASHRAE 90.1 – 2019. If the values are specified neither in ECBC nor in ASHRAE 90.1, they should be taken from the proposed design.