

COMMON SERVICES

Recommendation 12: Energy-efficient lighting design for common areas

- Design corridors, staircases, and parking areas to utilise daylighting.
- Incorporate energy-efficient artificial lighting design features for both indoor and outdoor lighting of common areas.

Recommendation 13: Energy-efficient community water pumping system

- Select a pump ensuring that the head and flow parameter for the 'Duty Point' matches with that of the 'Best Efficiency Point' of the pump.
- Design piping so as to reduce frictional losses.
- Use variable frequency drives (VFDs) on pump motors.

Recommendation 14: Incorporate energy-efficiency design features in the design of lifts

- Use light emitting diodes (LEDs) or compact fluorescent lamps (CFLs) for the lighting of the lift car.
- Provide auto switch-off for lights and ventilation fans.
- Use VFDs in motors.
- Consider feasibility of using lifts that have features, such as gearless system, regenerative braking, etc.



RENEWABLE ENERGY INTEGRATION

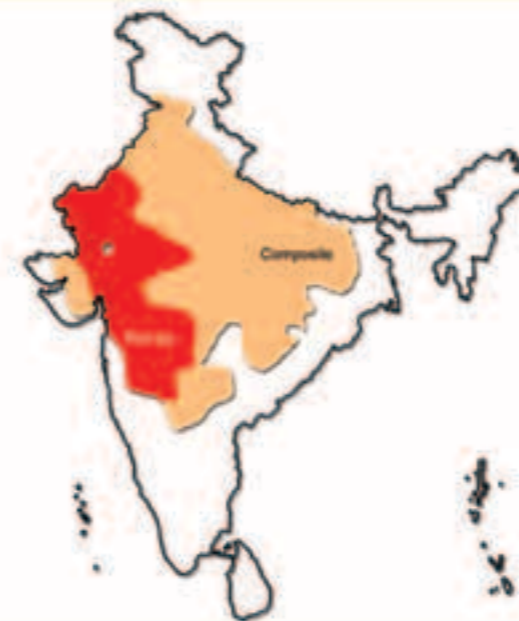
Recommendation 15: Utilise rooftops of multi-storey residential buildings for the generation of hot water and/or electricity using solar energy

- For energy-efficient multi-storey residential buildings (energy performance index <math>< 30 \text{ kWh/m}^2\cdot\text{year}</math>) of up to four storeys, it is possible to generate enough electricity through rooftop solar photovoltaic systems to meet the electricity consumption for a year. Thus it is possible to aspire for net zero-energy multi-storey residential buildings and neighbourhoods. In most cases, a substantial part of the electricity requirement for common services can be met through rooftop solar PV systems.
- In most cases, for multi-storey residential buildings up to 12 storeys, community solar water heating systems on the roof can meet around 70% of the annual electricity requirement for heating water.

DESIGN GUIDELINES

FOR ENERGY-EFFICIENT MULTI-STOREY RESIDENTIAL BUILDINGS

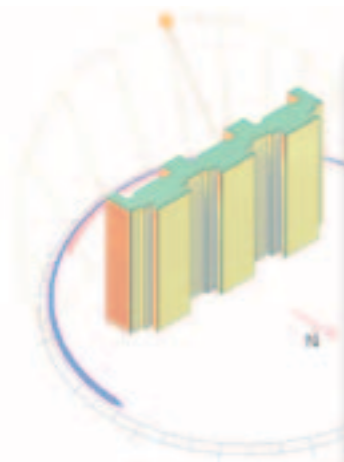
Composite and Hot-Dry Climates



The publication Design Guidelines for Energy-efficient Multi-storey Residential Buildings for composite and Hot-dry climates has been developed under the Indo-Swiss Building Energy Efficiency Project (BEEP). The design guidelines provide 15 recommendations on energy-efficiency features for consideration at the design stage of multi-storey residential buildings. Listed below are the six sections under which these recommendations are featured in.

1. Building massing and spatial configuration (Recommendations 1-3)
2. Building envelope (Recommendations 4-6)
3. Space cooling (Recommendations 7-10)
4. Appliances (Recommendation 11)
5. Common services (Recommendations 12-14)
6. Renewable energy integration (Recommendation 15)

The guidelines are aimed at builders, developers, architects and other building-sector professionals involved in the design and construction of multi-storey residential buildings.



BUILDING MASSING AND SPATIAL CONFIGURATION

Recommendation 1: Orient the buildings to minimise solar exposure on external vertical surfaces

- Longer facades of the building should be oriented north-south direction to minimise solar exposure on external vertical surfaces.

Recommendation 2: Select the building shape to minimise solar exposure on wall surfaces

Recommendation 3: Arrange building blocks to benefit from mutual shading to minimise solar exposure on walls during summer months

- Benefits of mutual shading in reducing the solar exposure are possible if the buildings are closely placed to the east and west of the reference building.

BUILDING ENVELOPE

Recommendation 4: Incorporate passive design measures for walls and windows for reduced energy consumption and improved thermal comfort

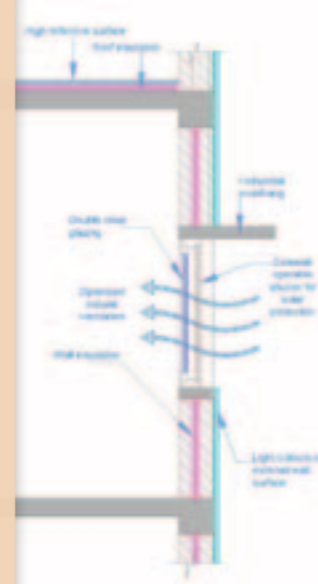
- **Package of Measures I (15%-20% reduction in cooling thermal energy)**
Use of light colours on external wall surfaces + fixed window shades with extended overhangs to protect windows from direct solar radiation + better insulation of walls + optimised natural ventilation.
- **Package of Measures II (40%-45% reduction in cooling thermal energy)**
Package of Measures I + external movable shutters on windows to cut-off solar radiation falling on windows.
- **Package of Measures III (50%-60% reduction in cooling thermal energy)**
Package of Measures II + improved wall insulation + use of double glazing in windows + better building air-tightness

Recommendation 5: Design for adequate daylighting

- Day-use spaces like kitchen and living rooms require more attention for daylight design. Around 10%-15% window-to-wall ratio (WWR) in bedrooms and 30% WWR in living room are needed to provide adequate daylighting. Using light colour on the internal walls and ceiling helps in improving daylighting.

Recommendation 6: Insulate the roof and provide reflective surface

- Provide overdeck insulation and high reflective surface on roof



SPACE COOLING

Recommendation 7: Design for raised cooling set-point of around 28 °C

- Research indicates that the adaptive comfort set-point temperature during summer is around 28 °C. Raising the cooling set-point from 24 °C to 28 °C can bring -55%-60% reduction in cooling thermal energy demand.

Recommendation 8: Design the space-cooling system so as to utilise the full potential of evaporative cooling and fans

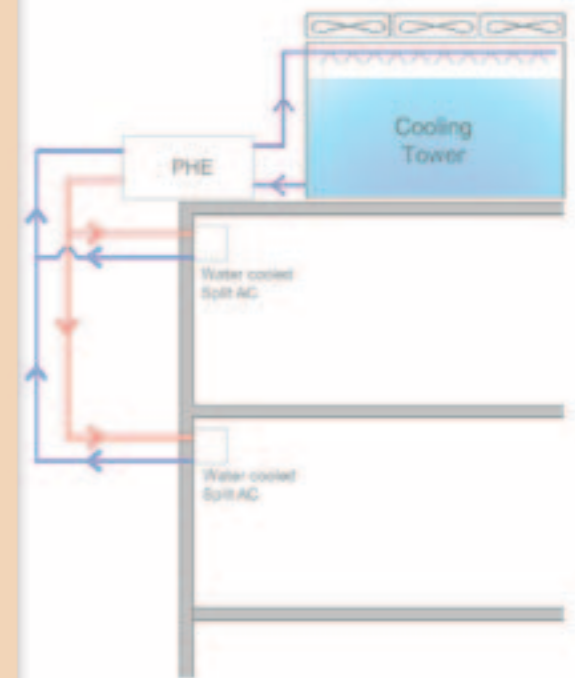
- A cooling system design that uses full potential of evaporative cooling can result in 30%-70% electricity savings annually for space cooling (at 28 °C design set-point) compared to an air-conditioning system. Provide dedicated space and water supply connections for the installation of evaporative-cooling equipment.

Recommendation 9: Incorporate energy-efficiency measures in the air-conditioning system

- Use highest BEE star-rated split or window air-conditioners.
- Incorporation of a central water loop with cooling tower to cool the condensers of split air-conditioners using water has a 40% energy-saving potential against air-cooled split air-conditioners.

Recommendation 10: Design for quick and efficient evacuation of hot air generated in the kitchen

- Heat generated in the kitchen, if not evacuated quickly, can raise the temperature of the adjoining spaces. Kitchen should be designed for good natural ventilation and properly located mechanical air extraction system.



APPLIANCES

Recommendation 11: Select higher BEE star-labelled energy-efficient equipment and appliances

- BEE star label is available for distribution transformers, tubular fluorescent lamps, electromagnetic and electronic ballasts, air-conditioners, ceiling fans, storage-type electric water heaters/geyser, etc.