

Zero Energy Commercial Buildings Consortium (CBC)

Building Envelopes for Commercial Net-Zero Energy Buildings: The Vision - June 2010

Conventional Components

Floors

- In-floor radiant heating and cooling systems common, enabled
- Much less use of drop ceilings
 - Decrease building heights and associated cost and embodied energy

Roofs

- Cool roofs, including dynamic roof surface properties (variable reflectance and/or emissivity)
- Limiting roof penetrations (no rooftop HVAC, common exhaust fan, etc)
- Rainwater harvesting common
- Translucent, high-performance insulation
- Radiative cooling of water on roof surface at night to provide chilled water for HVAC systems

Walls

- Super insulation
- Thin, high-performance insulation materials (e.g., aerogel)
- Continuous insulation
- SIPS Panels
- ICF Walls
- Thermal mass enhancement common, using phase-change materials (PCMs) in most effective ways for building type and local climate
- Integrated curtainwall framing systems – integrate electric and data services, potentially ventilation, etc.
- Translucent, high-performance insulation
- Dynamic U-value walls
- Vegetative layers and screens

Windows

- Dynamic exterior shading and/or insulation for windows
- Vacuum glass (U-values approaching 0.05)
- Improving U-value of glass-frame assembly – window pane spacers
- Triple-pane windows
- Vacuum glazing
- Operable windows
- Fiberglass frames

- Phase change materials in windows
- Decrease in glazing-to-wall area ratio

General

- Use local materials
- Incorporate controls and features that are sensitive to changes in the environment.
- Low embodied energy materials
 - Recycled and recyclable materials

Building Systems Integration

Energy Production

- PV and solar thermal energy production
 - Roof
 - Façade
 - Exterior solar thermal panel systems harvest energy during the day, heat used by HVAC system for cooling and heating
 - Suggests some thermal energy storage for time/load shifting
 - Moveable exterior window shades
 - Fixed and variable tile angles
 - Window-integrated PV
 - Separate and integrated system (e.g., for roof)
- Wind energy on roof
- Taller buildings still may not achieve net-zero energy

Lighting (e.g., daylighting)

- Dynamic windows – variable VT, SHGC – for integration of dynamic window control with HVAC, lighting, and electric demand management controls
 - Zoned control of groups of panes on the façade to provide enhanced flexibility in savings energy (daylighting, HVAC loads) and providing comfort (glare management)
 - Integrate with occupancy sensing, too

Space heating or cooling

- Moveable exterior window shades
 - Integrate with lighting and HVAC systems
- Building thermal mass
- Solar thermal (HVAC system) integrated into façade
- Walls with dynamic U-values (HVAC system integration)
- Radiative cooling of water on roof surface at night to supply chilled water for HVAC system

Ventilation

- Natural and mixed-mode ventilation
 - Operable windows
 - Damper-based systems
 - Façade as skin modulating airflows

- Approach zero infiltration (require blower door testing on all buildings)

Other

- Envelopes that adapt to occupant preferences and needs
 - Balance of automated and occupant-driven control
- Sensing, computation, and communications functionality integrated into much greater range of envelope products
 - For system and whole-building control, fault detection and diagnostics, moisture issue detection

Design Process

- Regional/ climate zone focus in building codes
- BIM design process integrating energy simulation and environmental performance evaluation to maximize passive strategies and technological solutions for energy efficiency
 - Beginning at earliest design stages
 - Provide interactive constructive feedback and recommendations/scenarios to stakeholders, help ~guide process
 - Integrated design, energy, ventilation, IEQ, cost, hygrothermal (moisture), etc. performance evaluation tools to facilitate this for most buildings
- Performance-based building codes with energy intensity requirements (i.e., kWh/ft²) instead of prescriptive codes
 - Leverage BIM tool above, simplified tools for earlier design stages
- Integrated design standard – cross- functional teams enabling innovative holistic designs.
- Frequent use of site-specific concepts (e.g., subterranean dwellings)
 - Optimal sun exposure / orientation for BIPV, passive solar, natural daylighting and ventilation.
- Limit number of floors (makes net-zero energy achievable for more buildings)
- Develop of packaged design solutions for typical building types (including modules and footprints)

Financing

- Lending agencies recognize the benefits of low energy buildings and structure loans to cover the increase first costs of systems with up to a 30-year payback.

Delivery

- Approach zero infiltration (require blower door testing on all buildings)
- Building envelope commissioning pervasive
- Widespread commissioning essential for effective implementation of high-performance, integrated systems
- Use of pre-fabricated components pervasive
 - Maximize off-site assembly to minimize on-site construction issues
- Modular envelopes constructed of components that allow for easy retrofit for future change of building use, users, or expansion
- Commissioning of new buildings

- To deliver much more integrated solutions will require either collaboration across trades or contractor organizations with cross-trade functionality within their organizations
- Increased training and competence needed for contractors to install, tune and commission more complex, inter-linked building systems.

Operations

- Turn-key building training will be required for facility managers
- Ongoing commissioning pervasive, crucial for effective functioning of high-performance and highly integrated systems
- Typical building operations and maintenance will have become more sophisticated to deal with more complex and integrated systems
- Flexible functions and use of space allocation for users to maximize building use
- User manuals and workforce training required for building occupants
- Adaptive (self-teaching and –learning) integrated whole-building control algorithms (e.g., based on neural networks)
 - Grid integration
- Expanded occupant comfort ranges

Retrofit-Specific Vision

In general, the input received suggests that retrofits will have similar features as new buildings. They do present special challenges, which have different and/or additional requirements.

- Phased and rapid envelope renovation strategies / systems that minimally disrupt building operations
 - Rapid exterior renovations preferred
- Rapid screening technologies to quickly evaluate energy savings retrofit opportunities for building envelopes
 - Self-configuring and calibrating whole-building performance models based on prior building operations data
- Exterior retrofit rainscreen systems providing high-performance continuous insulation that allows the building to breathe and eliminate double vapor barrier issues
- Effective and aesthetically acceptable high-performance insulation retrofit systems for brick buildings
- Thin, high-performance insulation materials (e.g., aerogel) deployed
- 30 - 40 years is beyond the useful life of most curtain wall systems
- For windows, strategies ranging from re-glazing to applying reflective film