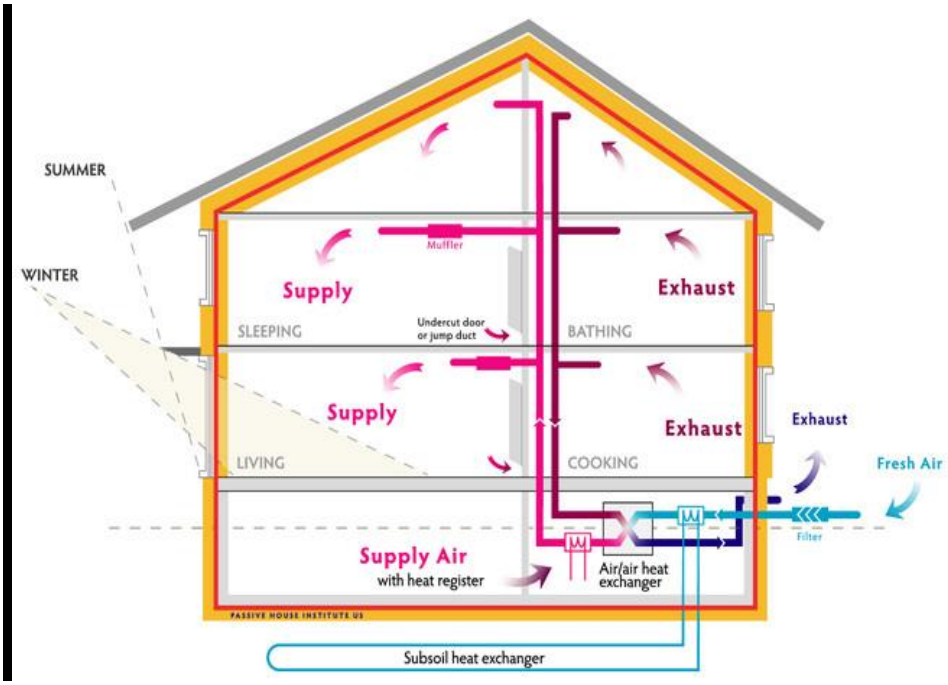
1.5 Passive building

Employs continuous insulation throughout its entire envelope without any thermal bridging. The **building** envelope is extremely airtight, preventing infiltration of outside air and loss of conditioned air.



Passive House Principles

Passive building comprises a set of design principles used to attain a quantifiable and rigorous level of energy efficiency within a specific quantifiable comfort level. "Optimize your gains and losses" based on climate summarizes the approach. To that end, a passive building is designed and built in accordance with these five building-science principles:

- Employs continuous insulation throughout its entire envelope without any thermal bridging.
- The building envelope is extremely airtight, preventing infiltration of outside air and loss of conditioned air.
- Employs high-performance windows (double or triple-paned windows depending on climate and building type) and doors - solar gain is

managed to exploit the sun's energy for heating purposes in the heating season and to minimize overheating during the cooling season.

- Uses some form of balanced heat- and moisture-recovery ventilation.
- Uses a minimal space conditioning system.

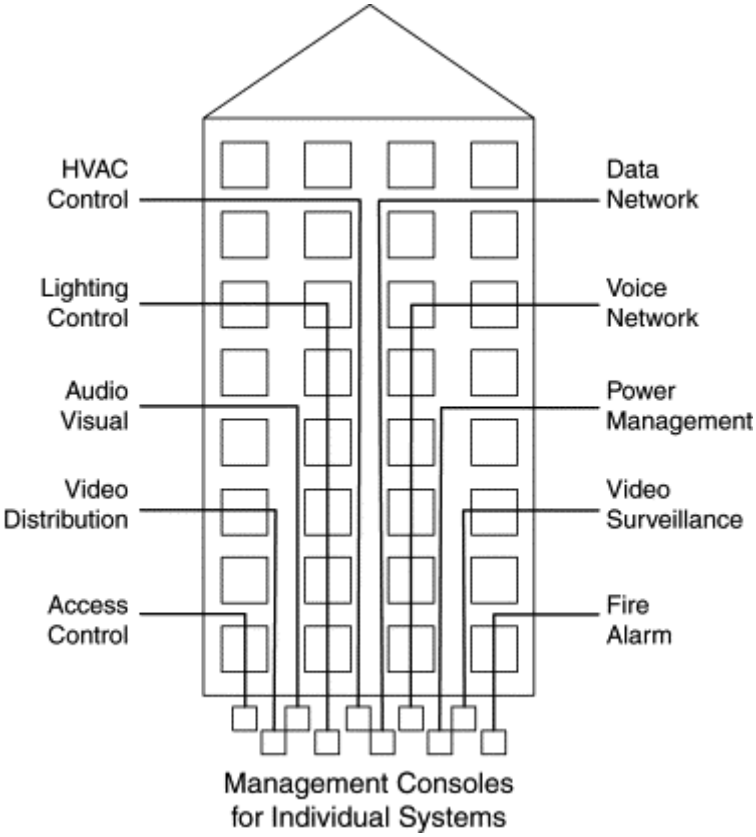
Passive building principles can be applied to all building typologies – from single-family homes to multifamily apartment buildings, offices, and skyscrapers.

Passive design strategy carefully models and balances a comprehensive set of factors including heat emissions from appliances and occupants to keep the building at comfortable and consistent indoor temperatures throughout the heating and cooling seasons. As a result, passive buildings offer tremendous long-term benefits in addition to energy efficiency:

- Superinsulation and airtight construction provide **unmatched comfort** even in extreme weather conditions.
- Continuous mechanical ventilation of fresh filtered air provides **superb indoor air quality**.
- A comprehensive systems approach to modeling, design, and construction produces **extremely resilient buildings.**
- Passive building principles offer the **best path to Net Zero and Net Positive** buildings by minimizing the load that renewables are required to provide.

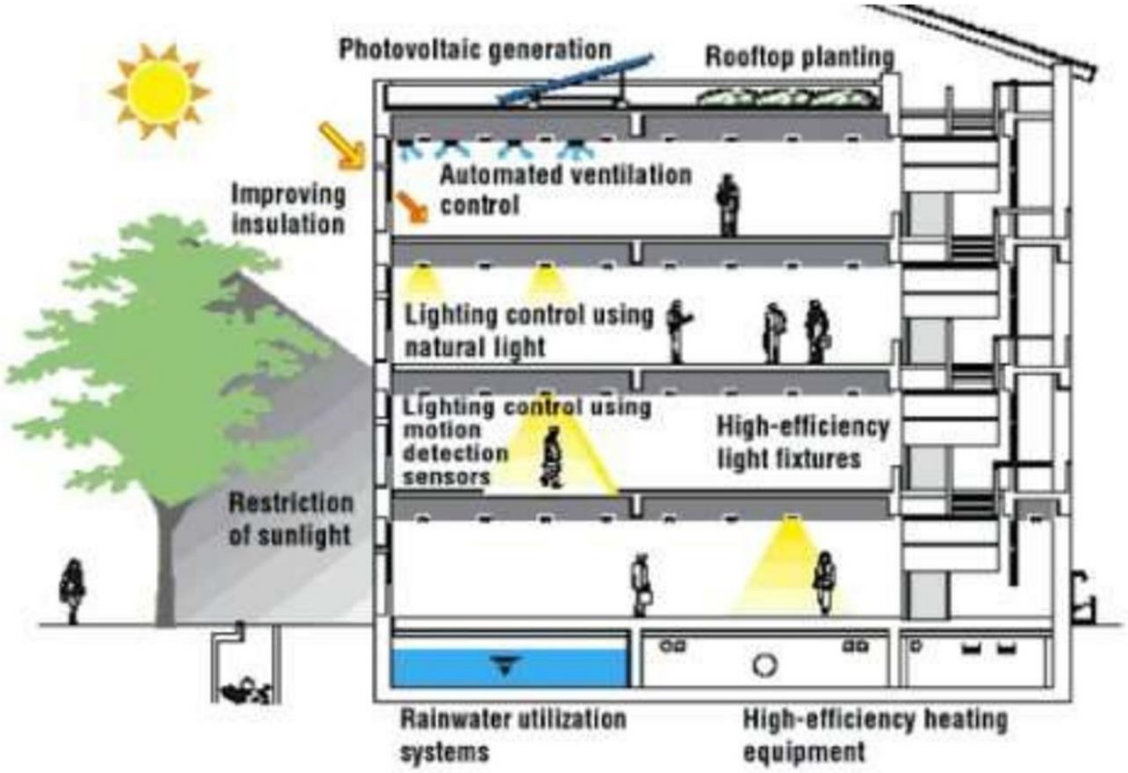
1.6 Intelligent (Smart) Building

At its most basic, a smart building is one that is using technology to share information about what goes on in the building between systems so as to optimize the building's performance. This information is then used to automate various processes, from heating and ventilation to **air** conditioning and security.



5 Smart Building Strategies for High-Performance

- Energy management and sub metering. ...
- Monitoring-based commissioning. ...
- IAQ monitoring. ...
- Space management. ...
- Deploying **Building** Internet of Things systems.



As technologists, architects, engineers and builders look to increase the number of smart buildings constructed and the number of older buildings retrofitted with automation and control technologies, here are five trends to watch for:

Predictive maintenance

From plant-sized chiller systems to elevators to lighting, IoT-connected devices will allow a shift from prevention and repair to conditions-based maintenance in real-time and based on historical performance data from the equipment in question and similar equipment elsewhere in the world, said Yasser Mahmud, vice president for industry strategy and business development at Oracle.

Leveraging data, building operators can see indicators of potential problems and can take corrective actions before products and systems fail. Companies can save approximately 15% of their capital asset spend by focusing on optimizing

existing building assets and prioritizing maintenance, said Mahmud, citing data from the McKinsey Global Institute. “The opportunity to reduce downtime and related costs is tremendous.”

Convergent networks

Wireless plays a key role in smart building development and technology, but fiber is still king in terms of keeping disparate technologies connected to the web and, increasingly, to each other for whole-building systems optimization. “Wireless is an incredible convenience but is still showing its limitations with interference and reliability,” said Bill Lally, president of Chatham, NJ–based integrated building infrastructure is most easily installed during construction. However, the larger opportunity is to bring intelligent building systems to the 5.6 million existing buildings in the U.S. — which is where Wi-Fi comes in.

“We are looking more and more technology company Mode: Green.

On the hospitality side, smart buildings are incorporating 4K video on-demand, access control, energy management and occupancy control, and they are integrating those features through a central dashboard and controls. The key is to avoid redundancy. "The more intersecting points we have in these various systems, the more intelligent we can make them as a whole," Lally said.

Wireless retrofits

From wiring to networks to HVAC, smart building into wireless technologies and putting infrastructure into the cloud as much as possible for storage and data management,” said Anil Ahuja, President of CCJM, Engineering Infrastructure and Facilities Solutions for Smart Cities. “Wireless technologies are also the key to making the built environment of ‘dumb buildings’ more smart [because] we don’t have to open up the floors and the walls [to update infrastructure].”

For new buildings, too, wireless can minimize the volume of cooper wire installation, keeping first costs down.

Biometric integration

The industry should also expect more research and product development around the intersection of occupants' biometric data and enhanced smart building operations. By using sensors to detect and trigger the control of lighting and thermal comfort, researchers are finding ways to increase productivity in office buildings and reduce stress in hospitals and other environments by mimicking circadian rhythms.

"The accuracy of sensors will have greater importance as we try to improve cognitive function with air quality and lighting levels," said Nathan Gauthier, director of facilities management integration and sustainability for Shawmut Design and Construction in Boston.

Gauthier is not alone "We're working with light and mimicry of circadian rhythms to optimize work spaces and sleep spaces to take advantage of lighting and environmental control," Lally said.

Self awareness

In a parallel to machine learning, smart buildings may eventually become intelligent enough to diagnose and repair structural and system damage without human intervention.

Researchers are investigating new sensing technologies for buildings to output data on structural integrity. Among them is a new computational model developed by researchers at the Massachusetts Institute of Technology to measure structural damage and stress after a seismic event. The researchers outfitted the 21-story, I.M. Pei-designed MIT Green Building with 36 accelerometers to track how the building respondent to ambient vibrations.

"Smartness does not happen by automation only—the technology needs to encourage smart human behavior."

Building scientists are likewise investigating the use of bacteria in concrete formulations for infrastructure to self-heal by exuding calcium carbonate to fill micro cracking as it occurs, for example. “Self-awareness is definitely a movement that we're looking at in smart buildings,” Ahuja said.

Regardless of where — and how soon — technology leads the development and optimization of smart buildings, providing building occupants with better information on energy management and other installed smart systems is integral to advancing the smart building ethos. Equally important to maintaining the efficacy of smart buildings is the behavior of building occupants.

“Smartness does not happen by automation only. The technology needs to encourage smart human behavior,” Ahuja said. “Turning off lights, recycling and tracking energy usage via apps will all lead to the behavior change that’s a critically important part of smart buildings.”

Building automation

Building automation is the automatic centralized control of a **building's** HVAC (heating, ventilation and air conditioning), electrical, lighting, shading, Access Control, Security **Systems**, and other interrelated **systems** through a **Building** Management **System** (BMS) or **Building Automation System** (**BAS**).

A building automation system is a system, or set of systems, that provide automated control and monitoring within a building. Control is centralized, meaning that these systems can be monitored and adjusted from a small number of stations located throughout the building. Their purpose is to provide a comfortable, consistent environment, ensure the safety of all occupants, and reduce energy costs

A building automation system (BAS) combines everything from HVAC and lighting to security alarms and AV features into a single system that operates within an office or building. This centralized system uses computer-controlled automation to manage the operation of all of the various components included in the BAS. When combined with sensors and other automation technology, a BAS can eliminate the need for human control over various systems

BAS core functionality keeps building climate within a specified range, provides light to rooms based on an occupancy schedule (in the absence of overt switches to the contrary), monitors performance and device failures in all systems, and provides malfunction alarms to building maintenance staff. A BAS should reduce building energy and maintenance costs compared to a non-controlled building. Most commercial, institutional, and industrial buildings built after 2000 include a BAS. Many older buildings have been retrofitted with a new BAS, typically financed through energy and insurance savings, and other savings associated with pre-emptive maintenance and fault detection.

Almost all multi-story green buildings are designed to accommodate a BAS for the energy, air and water conservation characteristics. Electrical device demand response is a typical function of a BAS, as is the more sophisticated ventilation and humidity monitoring required of "tight" insulated buildings. Most green buildings also use as many low-power DC devices as possible. Even a passive design intended to consume no net energy whatsoever will typically require a BAS to manage heat capture, shading and venting, and scheduling device use.

Energy efficient buildings services with proper selection of equipment

This plays the most vital role. Building services such lighting, HVAC fire etc. consumes less energy by selection of energy efficient equipments and integrating them for efficient utilization of services.

Information management

Facility owners and managers require large amount of data of various types for quality and efficient management. Typically this information such as management data of utilities, energy, maintenance, space, tenant and environmental compliance is available and recorded on various computers or control stations.