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CERTIFIED HVAC DESIGNER CHD OVERVIEW

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LEED AP(BD+C), GSAS CGP, GCP, ISO 14001

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MODULE

2

HVAC Fundamentals

KRISHNAJI PAWAR - CEO & FOUNDER

LEED AP(BD+C),GSAS CGP,GCP,ISO 14001

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CERTIFIED HVAC DESIGNER CHD OVERVIEW

HVAC systems regulate temperature, humidity, and air circulation in residential, commercial, and industrial buildings, crucial for professionals in architecture, engineering, and building management.

Learning Objectives

- Introduction
- HVAC Fundamentals
- The Air-Conditioning Process
- HVAC System Concepts and Process
- HVAC Systems Design
- Engineering, Economics, and Design Decision-Making
- Certified HVAC Designer (CHD) Specialty Certification
- Summary and Resources
- Certified HVAC Designer - CHD Practice Test V.4.1



INTRODUCTION

- HVAC systems regulate temperature, control humidity, and ensure proper air circulation.
- Heating components include furnaces that burn fuel to produce heat and heat pumps that transfer heat.
- Ventilation components include natural and mechanical ventilation systems that remove stale air and introduce fresh air to ensure indoor air quality.
- Air conditioning components include compressors that compress refrigerant gas, evaporators that absorb heat from indoor air, and condensers that release heat to the outside environment and condense back to a liquid state.

HVAC FUNDAMENTALS

OVERVIEW +

- Controls and sensors in modern HVAC systems regulate operation based on real-time feedback, like thermostats that monitor indoor temperatures and signal the HVAC system to activate or deactivate based on preset conditions.
- Thermodynamic principles in HVAC include the First Law of Thermodynamics, which states that energy can only undergo transformations, and the Second Law of Thermodynamics, which states that heat naturally flows from hot to cold bodies.
- System design considerations include load calculations, energy efficiency, and indoor air quality (IAQ).
- Understanding these principles is crucial for professionals involved in HVAC system design, installation, and maintenance.



UNDERSTANDING THE ENERGY IMPACT OF HVAC SYSTEMS



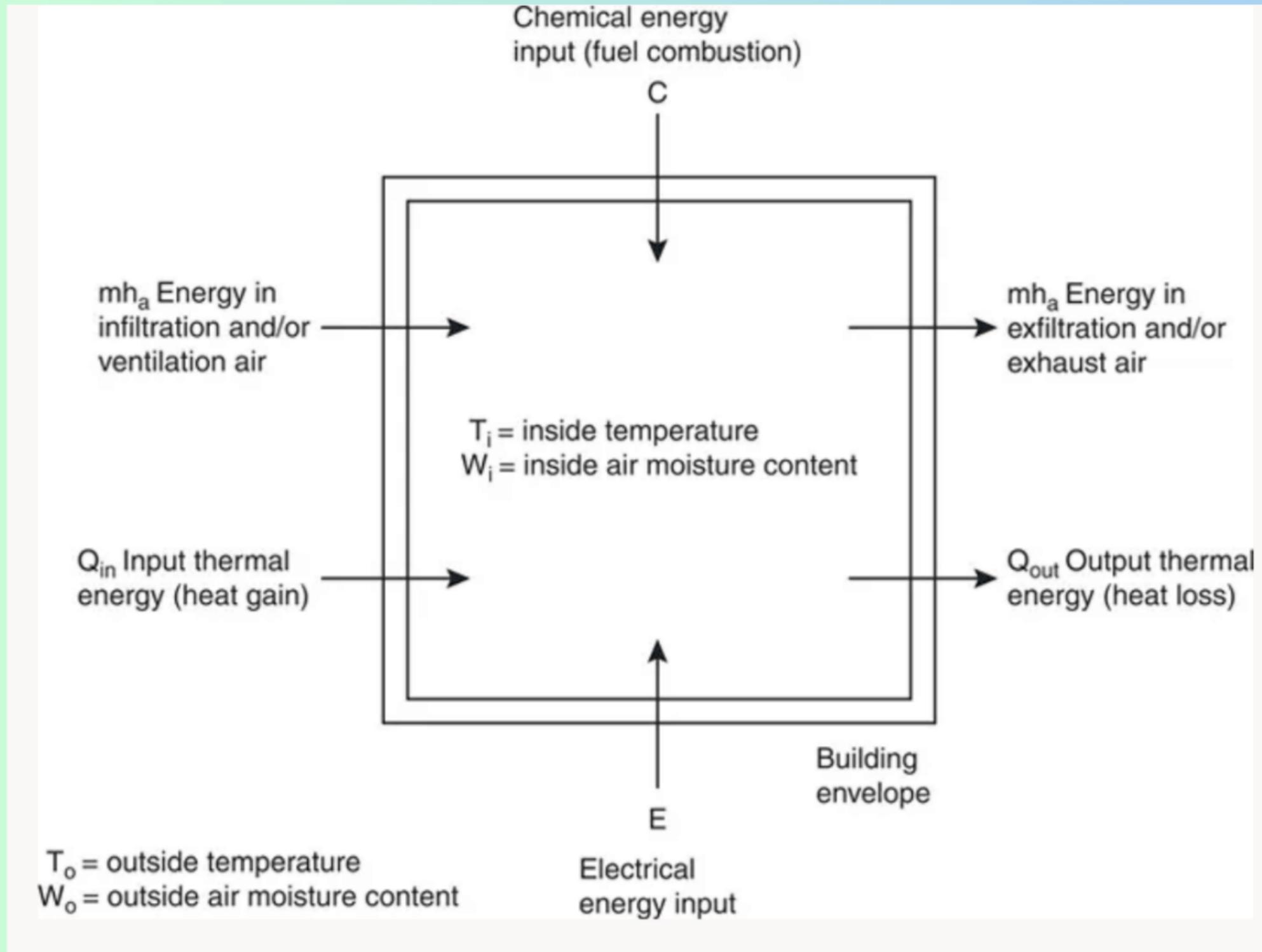
- HVAC systems are major energy consumers in residential, commercial, and industrial buildings.
- Energy consumption varies based on building design, climate, occupancy, and system efficiency.
- HVAC systems account for 40% of total energy use in commercial buildings and 50% in residential buildings.
- Seasonal variations affect energy consumption patterns, with peak heating and cooling demands during winter and summer.
- Proper design and component selection can significantly influence energy impact.
- High-efficiency systems can lead to substantial energy savings.
- The building envelope plays a crucial role in HVAC energy efficiency.
- Smart technologies like programmable thermostats, occupancy sensors, and advanced BMS can optimize HVAC operation.

BUILDINGS AS THERMODYNAMIC SYSTEMS

- Thermodynamics views buildings as complex systems that exchange energy and matter with their environment.
- Buildings are classified into open systems, closed systems, and isolated systems.
- Open systems function through heat transfer, mass transfer, and internal energy.
- Thermodynamic properties include temperature (T), pressure (P), volume (V), internal energy (U), and enthalpy (H).
- The first law of thermodynamics states that energy cannot be created or destroyed, but transformed.
- Energy balance in buildings is a function of internal energy, external heat, internal energy, and system work.
- Building materials play a critical role in a building's thermodynamic behavior. High thermal mass materials can moderate temperature fluctuations, while lightweight materials may require more energy.
- Thermal mass in buildings stores thermal energy, akin to a battery.
- Understanding buildings as thermodynamic systems optimizes energy use, improves comfort, and minimizes environmental impact.



BUILDINGS AS THERMODYNAMIC SYSTEMS



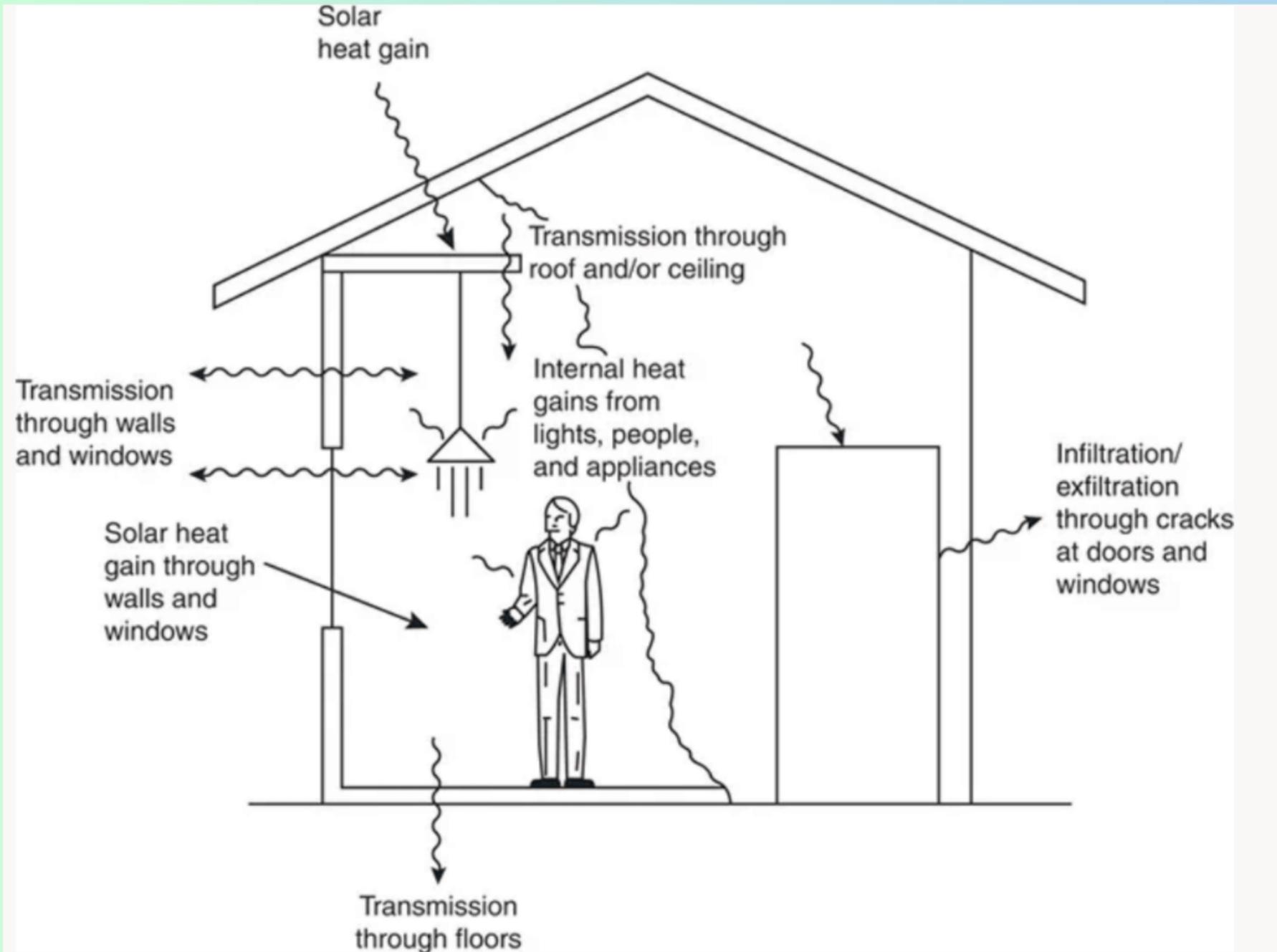
ENERGY GAINS AND LOSSES IN BUILDING SPACES

Energy Gains in Building Spaces

- Solar Gains: Sunlight enters a building through windows, skylights, or other transparent surfaces, increasing a space's thermal load.
- Internal Gains: Activities within the building result in internal gains, such as occupants, equipment, and lighting.
- Ventilation and infiltration: While often associated with energy losses, ventilation can also contribute to energy gains by introducing warmer outdoor air into a building.



BASIC ELEMENTS OF HEAT TRANSFER TO AND FROM A BUILDING SPACE



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BALANCING ENERGY GAINS AND LOSSES +



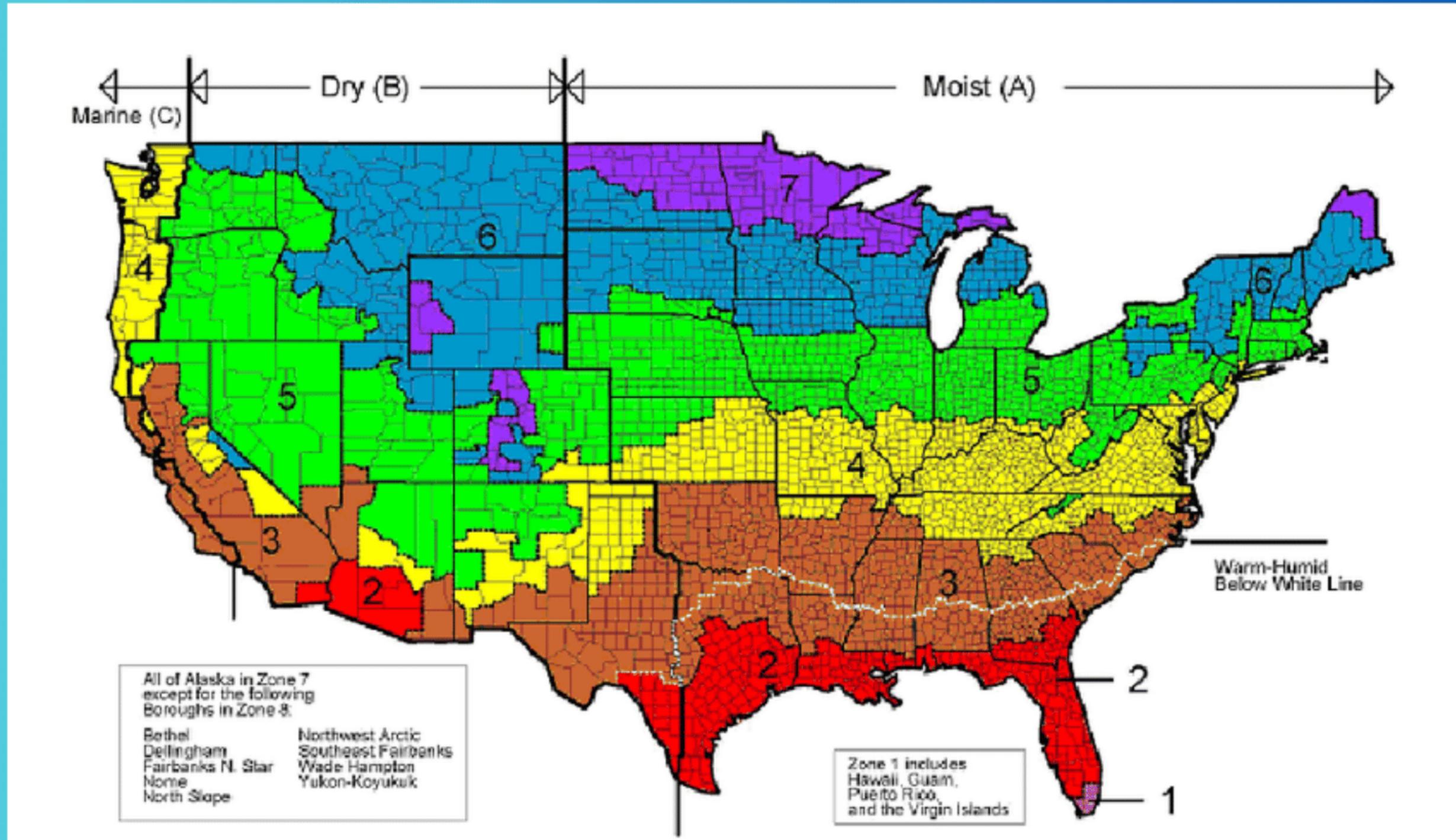
- Improved Insulation: Enhances thermal resistance of building envelopes to reduce conductive heat losses.
- High-Performance Windows: Utilizes double or triple-glazed windows with low-E coatings to minimize solar heat loss while maximizing solar gains.
- Efficient HVAC Systems: Employs energy recovery ventilators (ERVs) to help recover heat from exhaust air, thereby reducing ventilation energy losses.
- Passive Design Strategies: Designing buildings to maximize natural light and solar gains while minimizing heat loss through strategic orientation and shading devices can significantly improve energy performance.
- Ventilation and infiltration: While often associated with energy losses, ventilation can also contribute to energy gains by introducing warmer outdoor air into a building.

BUILDING ENVELOPE DESIGN OVERVIEW

- Thermal envelope reduces heat transfer due to temperature differences and solar radiation.
- Moisture envelope prevents water migration into the building in liquid or vapor form.
- The moisture envelope consists of a rain barrier, an air barrier, and a vapor barrier or retarder.
- Envelope design criteria can be established using Figure CHD2, which defines various climate zones in the U.S.
- Thermal envelope should be located inside walls, roofs, and floors in all climate zones.
- HVAC engineer advises architects on ensuring high thermal performance and reducing heat loss and gain.
- Moisture envelope design includes a rain barrier, an air barrier, and a vapor barrier or retarder.



CLIMATE ZONES IN THE UNITED STATES



RAIN AND AIR BARRIER INSTALLATION IN CLIMATE ZONES

- Rain and air barriers are necessary in all climate zones to prevent liquid moisture from entering the air-conditioned building.
- Vapor barrier or retarder location varies based on climate type.
- Vapor retarders should not be placed on the indoor wall in hot, humid climate zones 1, 2A, 2B, and 3A.
- In hot, humid climates, vinyl wallcovering should be used as a vapor barrier.
- Vapor retarders should be located inboard or near the air barrier near the outer boundary of the wall construction.
- In mixed, humid climates, the vapor retarder placement requires more analysis.
- Interior vapor barriers are detrimental as they prevent wall assembly from drying towards the interior during cooling periods.
- For hospitals, laboratories in mixed, humid climates, detailed analysis of vapor retarder placement is required.
- In cold climate zones, vapor retarders should be located at or near the inside surface of the wall.
- No vapor retarder is required in hot, dry climates.



COMMON HVAC ELEMENTS

Heating Elements:

- Boilers: Closed vessels that circulate water or generate steam for heating purposes.
- Furnaces: Use air as the primary heat transfer medium.
- Heat Pumps: Function by transferring heat from one location to another.
- Air Handlers: Manage the flow and distribution of conditioned air.
- Ductwork: Serves as the pathway for conditioned air to travel from the HVAC system to various spaces within a building.
- Exhaust Systems: Eliminating stale air, pollutants, and excess humidity from indoor environments.



COMMON HVAC ELEMENTS +

Air Conditioning Elements:

- Chillers: Specialized mechanical devices that remove heat from a liquid via a vapor-compression or absorption refrigeration cycle.
- Condensers: Work in tandem with chillers in a refrigeration cycle by rejecting heat from the refrigerant.
- Evaporators: Absorb heat from the surrounding air or liquid, causing the refrigerant to evaporate into a gas.

Control Systems:

- Thermostats: Devices that monitor and regulate the temperature within a space.
- Building Management Systems (BMS): Integrated systems that monitor and control various building operations.



INDOOR ENVIRONMENTAL QUALITY (IEQ) OVERVIEW



- IEQ encompasses the overall indoor environment, including thermal comfort, ventilation, lighting, and air quality.
- Thermal comfort is influenced by air temperature, humidity levels, and air movement. ASHRAE standards guide comfort, considering factors like clothing insulation, activity level, and metabolic rate.
- Proper ventilation removes pollutants and odors, providing fresh air for occupants. ASHRAE recommends a minimum ventilation rate for different spaces.
- Air conditioning regulates indoor temperature and humidity levels, improving energy efficiency and comfort. Regular maintenance is crucial for optimal performance and air quality.
- Proper design, maintenance, and operation practices can enhance IEQ and occupant well-being.

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CONTACT US



+91 6363032722



info@beyondsmartcities.in



learn.beyondsmartcities.in



#55,HMR Layout ,Bengaluru ,India



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