

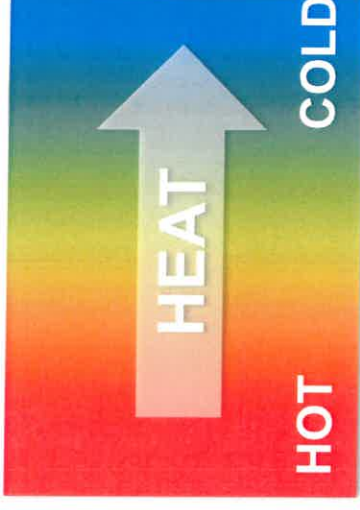


# Laws of Thermodynamics

## Laws of Thermodynamics

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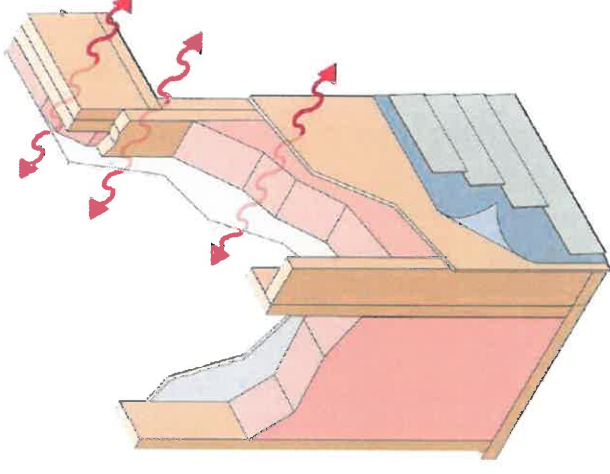
1. Energy is neither created or destroyed, it simply moves and changes form.
2. Heat moves from hot to cold, seeks a balance.
  - The greater the temperature difference, the greater the rate of heat transfer



## Heat Gain and Loss

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- Heat gain in a building occurs when the outdoor temperature is greater than the indoor temperature (external heat gain)
- Heat gain in buildings can also come from people, lights, appliances and process equipment (internal heat gain)
- Heat loss occurs when the indoor temperature is greater than the outdoor temperature



## Air Infiltration

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Infiltration is the unintentional introduction of outside air into a building and occurs through cracks in the building envelope or through doors and windows.

Forms of infiltration include:

- Wind Effect
- Stack Effect
- Ventilation Effect
- Mechanical Effect



# Indoor Thermal Comfort Factors

Determined by the building

Air temperature

Mean Radiant Temperature

Relative Humidity

Ventilation

Air Speed

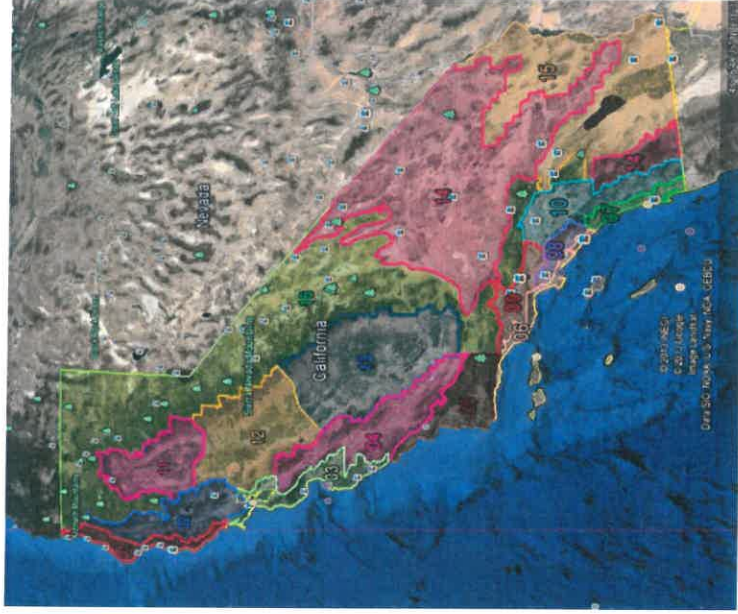
Determined by the occupant

Clothing

Metabolic Rate



# California Climate Zones

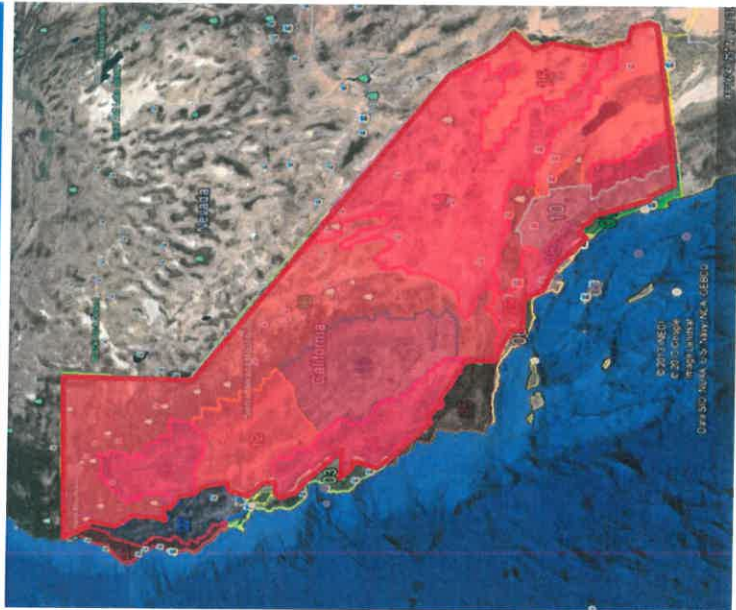


- Focus on Climate Diversity
- Energy Standards set expectations for climate-specific design
- CA weather data captures statewide coincident peak demand climate conditions
- Sixteen climate zones
- Hot inland and desert climates
- Moderate coastal climates
- Cold mountain climates



# Design for the Climate

Hot/Cold Climate Zones



Mild Climate Zones



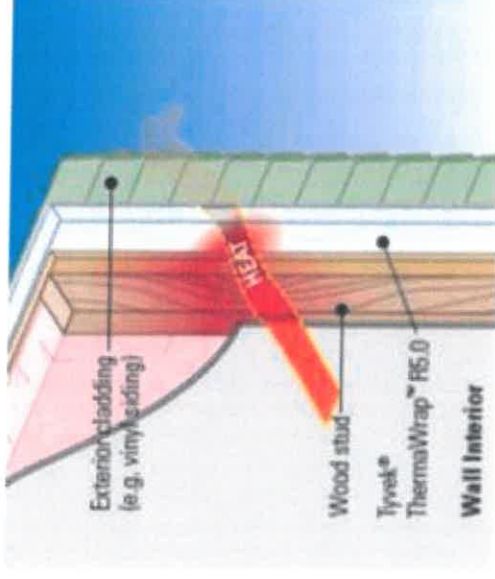
## Energy Strategies for Cold Climates

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Minimize heat loss through the building envelope due to cold outside air temperatures in the winter.

Strategies for cold climates include:

- Increased wall, roof and floor insulation.
- Reduced air infiltration.
- Low U-factors windows.



Credit: Dupont



## Energy Strategies for Hot Climates

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Reduce the impact of intense solar heat gain and high air temperatures in the summer.

Strategies for hot climates include:

- Reduce solar heat gain with HPAs and HPWs.
- Low U-factors and low SHGC windows.
- Optimize orientation, size, and shading of windows, glass doors and skylights.



Credit: James Hardie Building Products Inc.