# Nebraska's Commercial Energy Code: The 2018 IECC

## *Mechanical Systems and HVAC Rightsizing*

Nebraska Energy Code Training Program

Instructors: Thomas Yarbrough and Matt Belcher

October 5, 2022, 11:00 a.m. – 12:30 p.m.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Housekeeping

- Attendees are muted upon entry
- Enter questions in the chat box
- This training is being recorded
- Slides and recording will be emailed to attendees and posted on the MEEA website
- CEUs are provided (ICC and AIA)
- Email Corie at canderson@mwalliance.org with any questions

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# About MEEA

- Nonprofit membership organization with 160+ members, including:
  - Utilities
  - Research institutions
  - State and local governments
  - Energy efficiency-related businesses
- MEEA helps stakeholders understand and implement cost-effective energy efficiency strategies

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# About Matt and Verdatek Solutions

- 40+ Years in the Building Industry
- Served as a Top Building Codes official in St. Louis area
- Director of University of Missouri Columbia High Performance  Buildings Research Center. Created and Instructed Curriculum for Students and Industry Professionals
- Assisting University of Missouri Science & Technology in Building and Energy Code Curriculum and Policy
- ICC Member serving on 2012, 2015, 2018 and 2024 Energy Code Development Committee. 2021 Building Code-General Committee
- NAHB Approved Instructor for Advanced Building Science
- Advanced Business Management

VERDATEK SOLUTIONS

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# About Thomas

- 20+ Years in the Building Industry
- Senior Researcher at CREE (Center for Research in Energy and Environment)
- Instructor at Missouri S&T in Civil, Architectural, and Environmental Engineering department
- Conducts cutting edge research in Building Science, including published papers on envelope assemblies and Smart Home technologies.
- LEED AP BD+C and Homes
- Building Envelope Commissioning Expert
- Passive House Consultant

MISSOURI S&T

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Learning Objectives

- Understand prescriptive energy code requirements and Updates from 2018 IECC for Mechanical Equipment and Systems
- Introduction to Advanced Mechanical systems used in current and upcoming projects
- Understand ASHRAE 90.1 Section 6 as an Alternative
- Understand Proper equipment sizing and commissioning to assure “right-sized” HVAC systems

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# COMcheck Overview

- Basics of using the COMcheck software
- Obtain an overview of the basic functions and how COMcheck calculates compliance
- Understand how the compliance reports are created

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Nebraska Residential Field Study

- Conducted in 2017 by **Nebraska Department of Environment and Energy.** 2009 IECC was the baseline.
- Collected and analyzed several data points for new homes, including:
  - Envelope air leakage
  - Efficacy in lighting
  - Duct leakage
  - Ceiling & exterior wall insulation
  - Basement & slab insulation
  - Windows

**For More Information and Data:**

https://www.energycodes.gov/sites/default/files/documents/Nebraska_Residential_Compliance_Evaluation_final.pdf

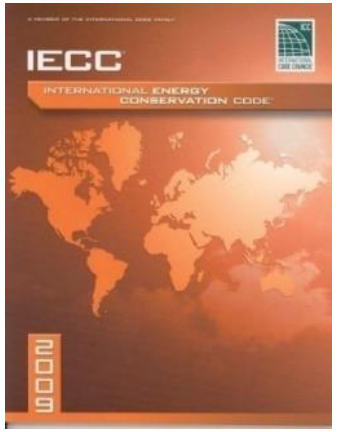
MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

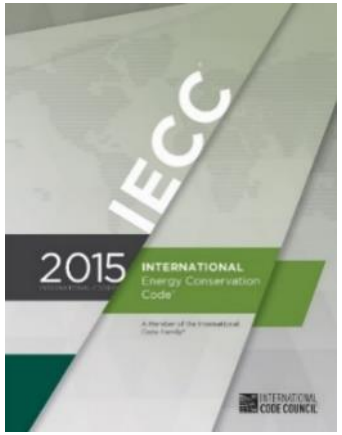
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Scope of the Energy Code

- Focus is on building envelope
  - Ceilings, walls, windows, floors, foundations
  - Sets insulation levels, window U-factors and SHGC
  - Infiltration control
    - Caulk and seal to prevent air leaks
    - Verify envelope tightness with blower door test
    - Ducts
  - No building cavities as ducts (post-2009)
  - Seal properly and insulate
    even if all ductwork is in conditioned space
  - Verify tight with duct pressurization test
- Lighting equipment
  - High-efficacy bulbs required (50%, 75%, 90%)
- HVAC equipment efficiencies covered by different DOE standard

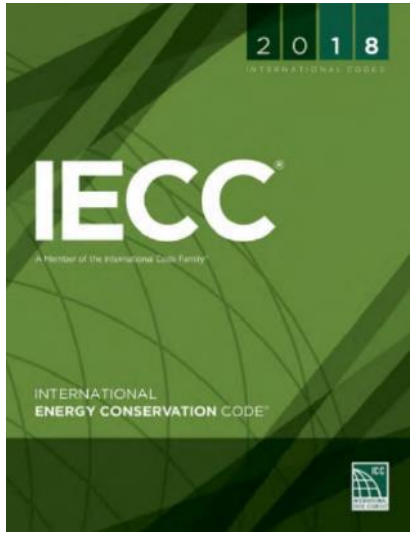




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths




**C401.2 Application.** P

Commercial buildings shall comply with one of the following:

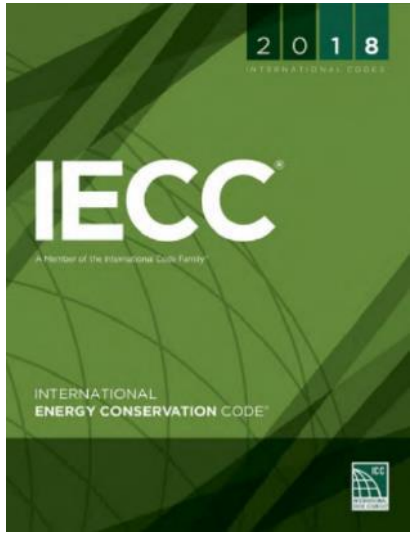
1. The requirements of ANSI/ASHRAE/IESNA 90.1.
2. The requirements of Sections C402 through C405 and C408. In addition, commercial buildings shall comply with Section C406 and tenant spaces shall comply with Section C406.1.1.
3. The requirements of Sections C402.5, C403.2, C403.3 through C403.3.2, C403.4 through C403.4.2.3, C403.5.5, C403.7, C403.8.1 through C403.8.4, C403.10.1 through C403.10.3, C403.11, C403.12, C404, C405, C407 and C408. The building energy cost shall be equal to or less than 85 percent of the standard reference design building.

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths




**C401.2 Application.** P

Commercial buildings shall comply with one of the following:

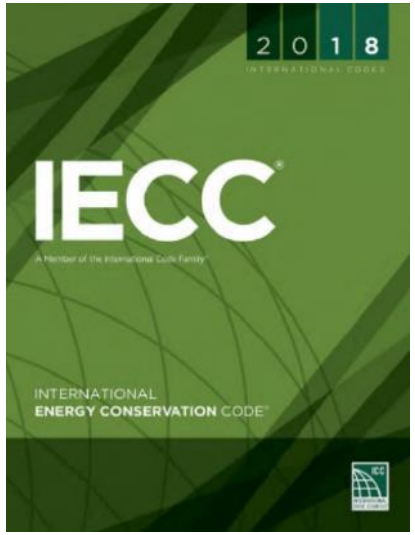
1. The requirements of ANSI/ASHRAE/IESNA 90.1.
2. The requirements of Sections C402 through C405 and C408. In addition, commercial buildings shall comply with Section C406 and tenant spaces shall comply with Section C406.1.1.
3. The requirements of Sections C402.5, C403.2, C403.3 through C403.3.2, C403.4 through C403.4.2.3, C403.5.5, C403.7, C403.8.1 through C403.8.4, C403.10.1 through C403.10.3, C403.11, C403.12, C404, C405, C407 and C408. The building energy cost shall be equal to or less than 85 percent of the standard reference design building.

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths




**C402.5 Air leakage—thermal envelope (Mandatory).**

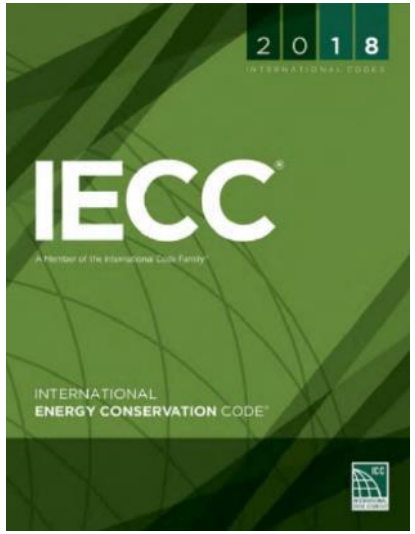
The *thermal envelope* of buildings shall comply with Sections C402.5.1 through C402.5.8, or the building *thermal envelope* shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft$^2$(2.0 L/s • m$^2$). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6 and C402.5.7.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths




**C403.2 System design (Mandatory).** P

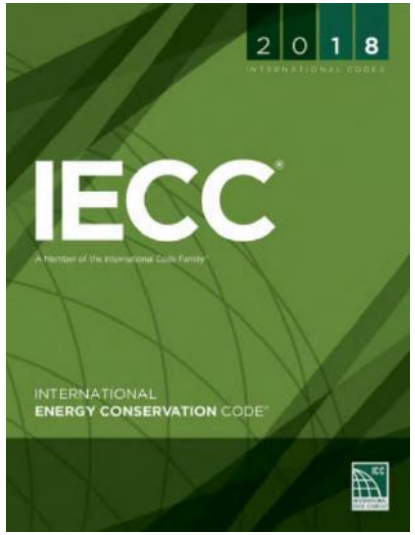
Mechanical systems shall be designed to comply with Sections C403.2.1 and C403.2.2. Where elements of a building's mechanical systems are addressed in Sections C403.3 through C403.12, such elements shall comply with the applicable provisions of those sections.

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths




**C403.2.1 Zone isolation required (Mandatory).** P

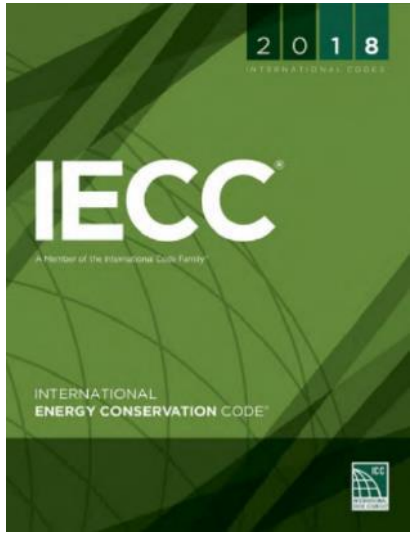
HVAC systems serving *zones* that are over 25,000 square feet (2323 $m^2$) in floor area or that span more than one floor and are designed to operate or be occupied nonsimultaneously shall be divided into isolation areas. Each isolation area shall be equipped with *isolation devices* and controls configured to automatically shut off the supply of conditioned air and outdoor air to and exhaust air from the isolation area. Each isolation area shall be controlled independently by a device meeting the requirements of Section C403.4.2.2. Central systems and plants shall be provided with controls and devices that will allow system and equipment operation for any length of time while serving only the smallest isolation area served by the system or plant.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths




**C403.2.2 Ventilation (Mandatory).**

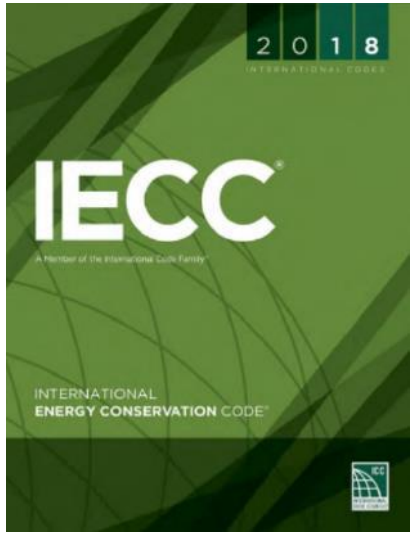
Ventilation, either natural or mechanical, shall be provided in accordance with Chapter 4 of the *International Mechanical Code*. Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by Chapter 4 of the *International Mechanical Code*.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths




**C403.3 Heating and cooling equipment efficiencies (Mandatory).** P

Heating and cooling equipment installed in mechanical systems shall be sized in accordance with Section C403.3.1 and shall be not less efficient in the use of energy than as specified in Section C403.3.2.

**C403.3.1 Equipment sizing (Mandatory).** P

The output capacity of heating and cooling equipment shall be not greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.1.1. A single piece of equipment providing both heating and cooling shall satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Energy Code Compliance Paths

**C403.3.2 HVAC equipment performance requirements (Mandatory).** P

Equipment shall meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2(9) when tested and rated in accordance with the applicable test procedure. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirement Table C403.3.2(10). The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be

**TABLE C403.3.2(1)**
**MINIMUM EFFICIENCY REQUIREMENTS: ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS**

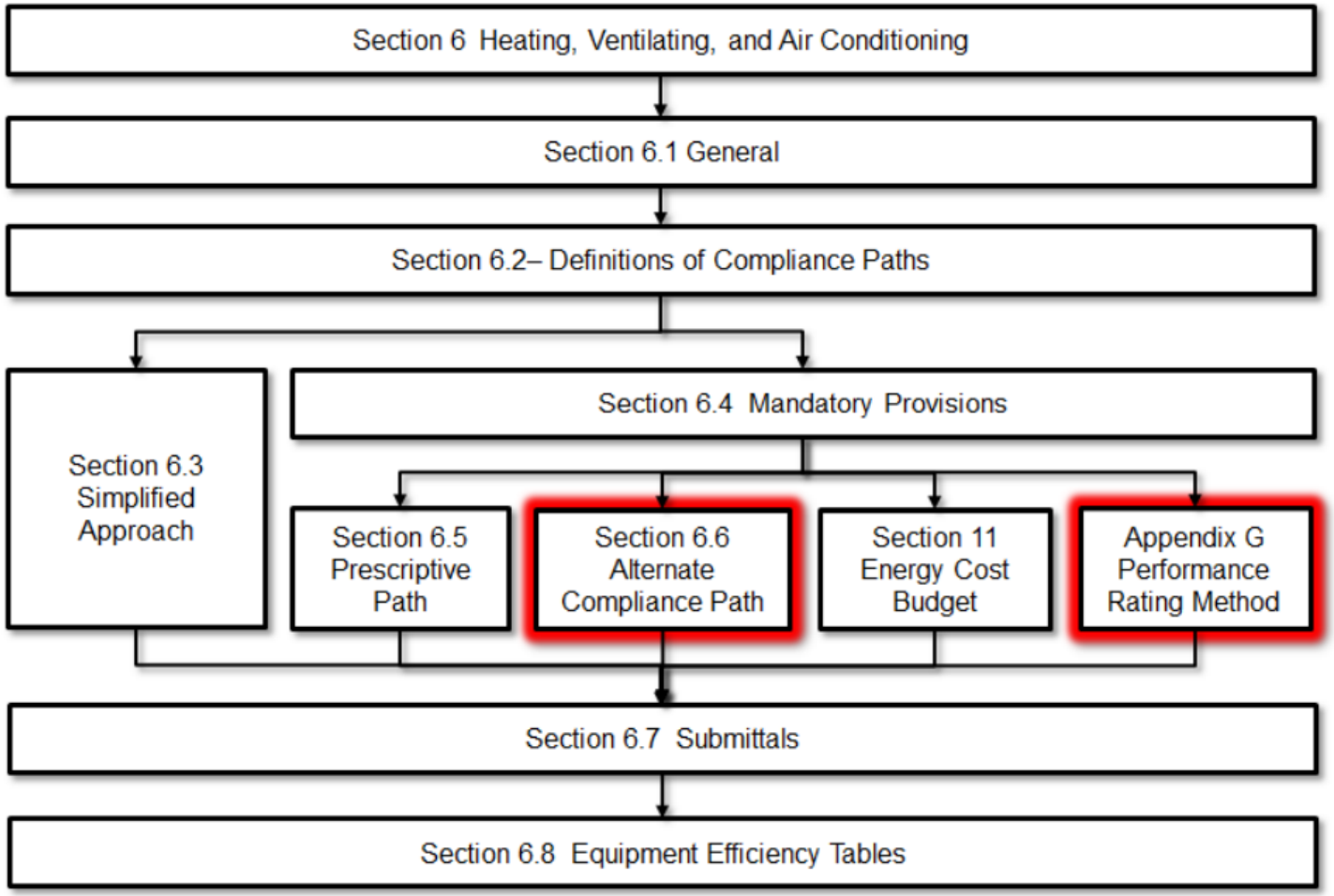
| EQUIPMENT TYPE | SIZE CATEGORY | HEATING SECTION TYPE | SUBCATEGORY OR RATING CONDITION | MINIMUM EFFICIENCY | TEST PROCEDURE[a] |
|---|---|---|---|---|---|
| Air conditioners, air cooled | < 65,000 Btu/h[b] | All | Split System | 13.0 SEER | |
| | | | Single Package | 14.0 SEER | |

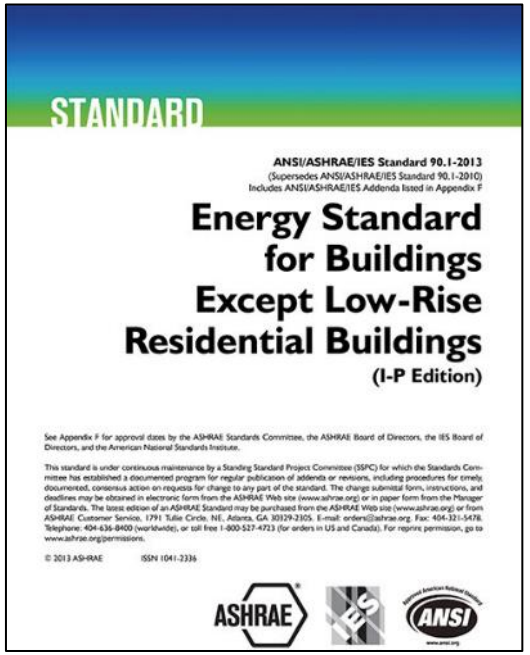
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# ASHRAE 90.1 Compliance Path




*Red sections are updates included in **90.1.2019**

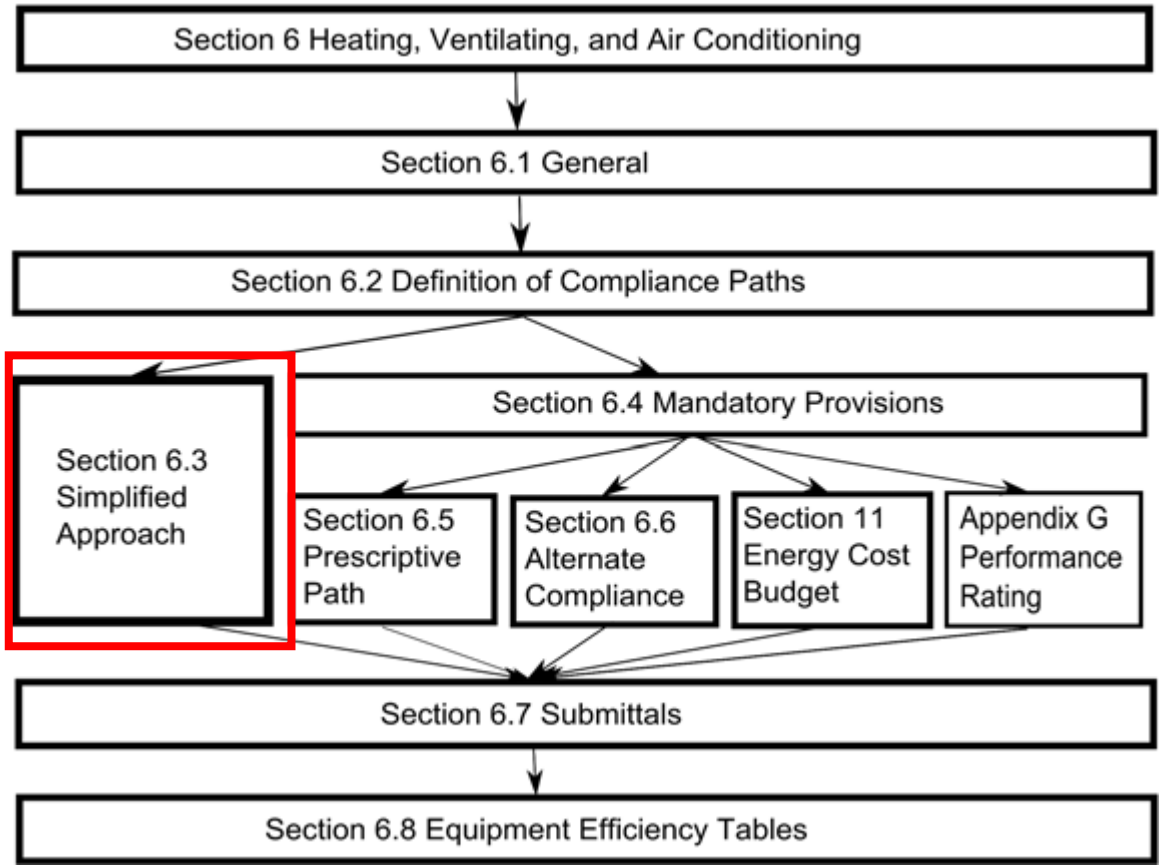
MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Simplified Compliance Path

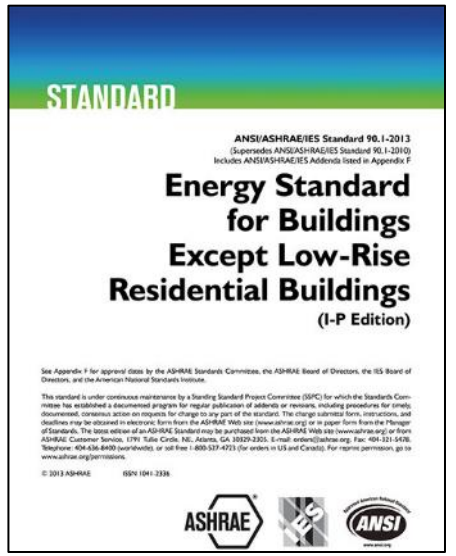
- Simplified Approach is still the easiest pathway
- According to the Department of Energy, 80 to 85% of the building stock is this type of building.



# Simplified Path

The simplified approach is an optional path for compliance when the following are met:

- Buildings with 1 or 2 stories
- Buildings with gross floor area < 25,000 ft2
- System serving single HVAC zone
- Each system complies with 6.3.2




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Simplified Path

Air-handling and fan coil unit supply fans controlled by two-speed motors or variable speed drives

- Chilled-water cooling coils where the supply fans have motors ≥ 1/4 hp
- Direct expansion units ≥ 65,000 Btu/h cooling capacity
- Two speeds of fan control required during economizer operation

| Temperature Control | Typical Zones | Minimum fan speed | Fan power at min speed | Fan control |
|---|---|---|---|---|
| Supply Air | Multiple | ≤ 50% * | ≤ 30% | Modulating |
| Room Temperature | Single | ≤ 66% * | ≤ 40% | Two-speed, Multi-speed or Modulating |

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

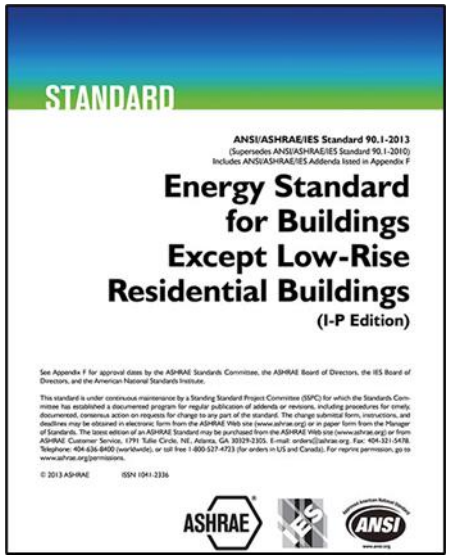
NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Simplified Path

The system shall either have an economizer, Or use the economizer Trade-off Option

- Limited to unitary systems
- Requires higher minimum cooling efficiency (EER)
- Trade-off EER by
  - System size
  - Climate zone
- Eliminated separate table for computer rooms, must follow the same thresholds as other use types



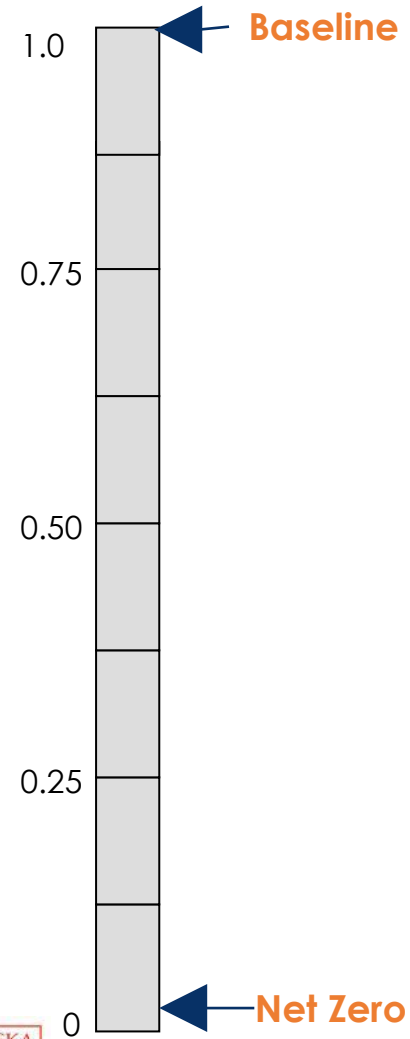
# Appendix G – Performance Rating

- Requires a Performance Cost Index (PCI) specific to building type and climate zone

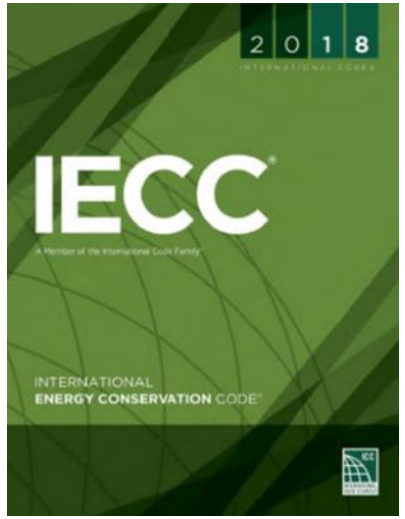
$$PCI = \frac{Proposed\ Building\ Performance}{Baseline\ Building\ Performance}$$

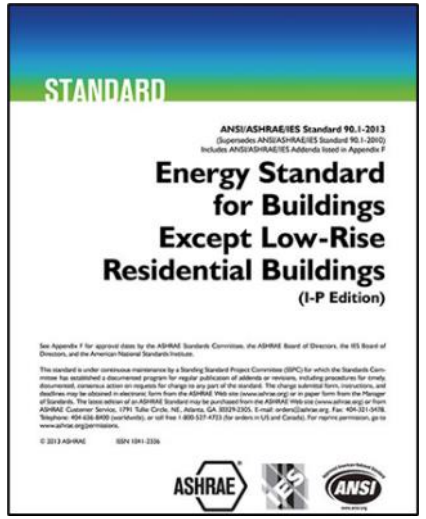
  - PCI of 1.0 = baseline building
  - PCI of 0.0 = zero net energy
  - For compliance, PCI < PCIt

- PCIt specified in Standard, and varies by building type, climate zone, and proportion of regulated to unregulated load



# Compliance Paths




- New Buildings
- Additions to Existing Buildings
- Alterations in Existing Buildings

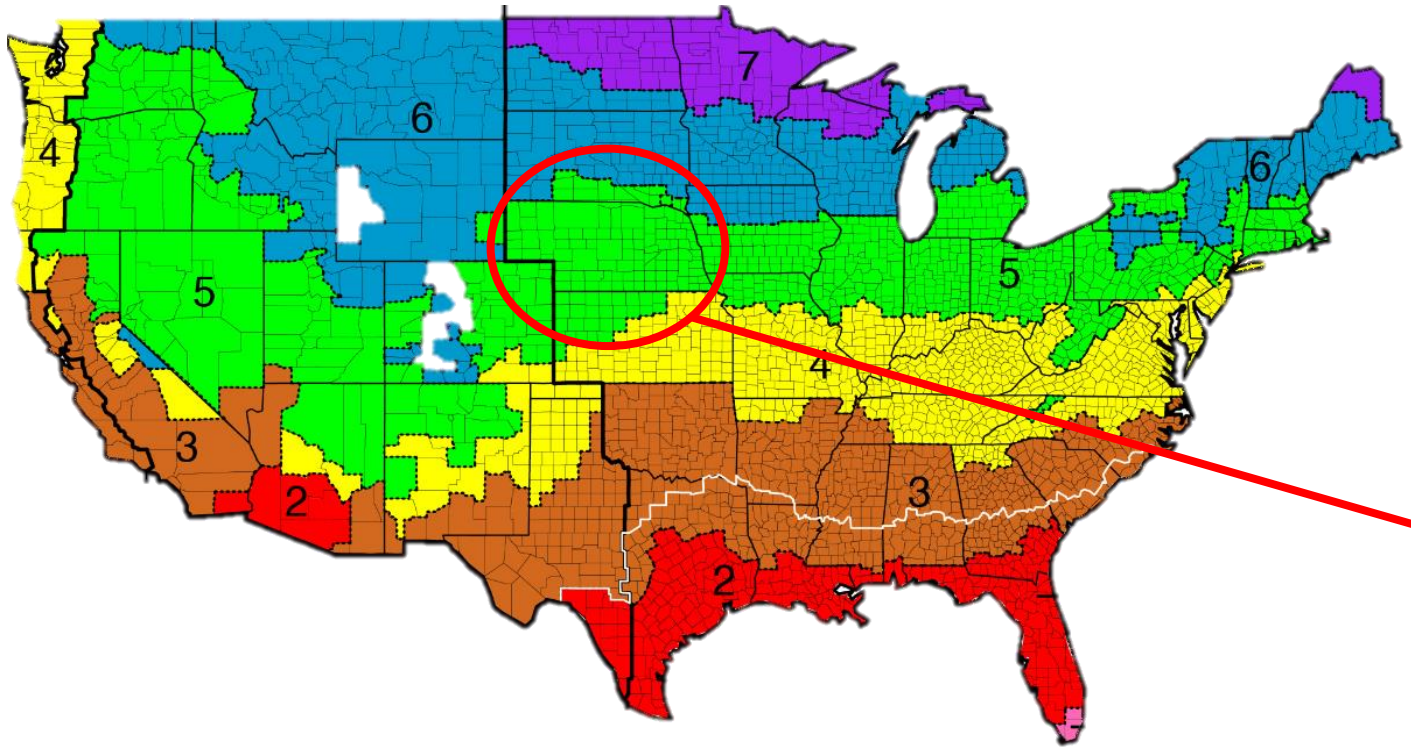
Both paths use forms of phrase "capable of and configured to" so that controls will be set up at time of inspection.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

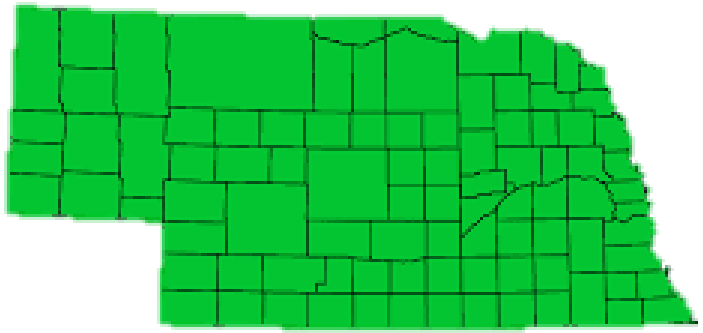
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# ASHRAE Climate Zones




- Nebraska has only one climate zone – 5A
- Cold & Moist climate



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Documentation Requirements

**C408.1.1 Building operations and maintenance information.** P

The building operations and maintenance documents shall be provided to the owner and shall consist of manufacturers' information, specifications and recommendations; programming procedures and data points; narratives; and other means of illustrating to the owner how the building, equipment and systems are intended to be installed, maintained and operated. Required regular maintenance actions for equipment and systems shall be clearly stated on a readily visible label. The label shall include the title or publication number for the operation and maintenance manual for that particular model and type of product.

- Record drawings
- Operating and maintenance manuals
- System balancing
- System commissioning report

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Documentation Requirements

Record drawings of actual installation to building owner within 90 days of :

- Certificate of Occupancy (IECC)
- System acceptance (ASHRAE)

Include at a Minimum:

- Location and performance data on each piece of equipment
- General configuration of duct and pipe distribution system including sizes
- Terminal air or water design flow rates

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

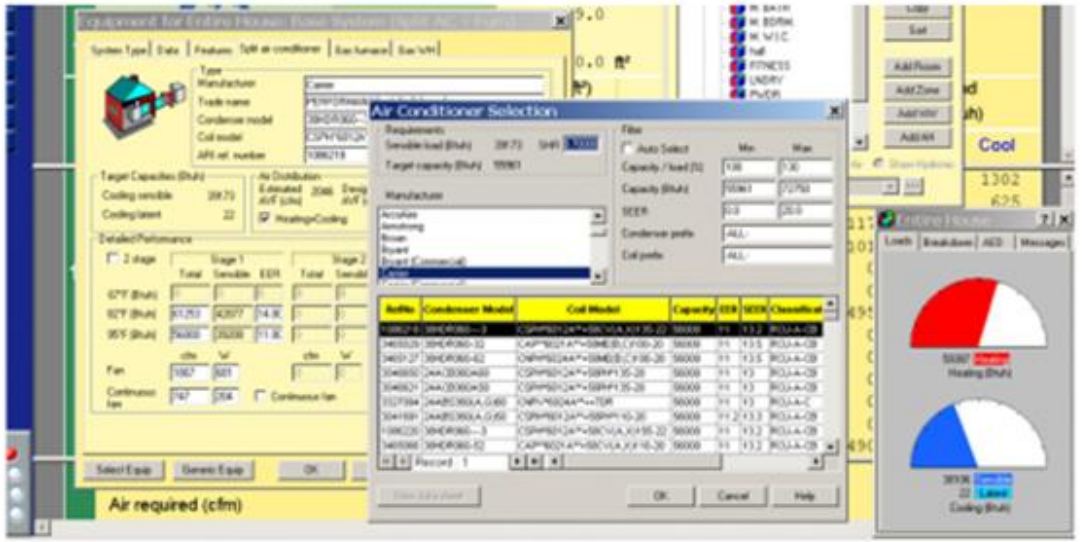
NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – LOAD CALCULATIONS

Sizes heating and cooling equipment

*Accuracy important!*

- Design conditions
- Building shell load
- R / U value
- Solar heat gain
- Internal load
- Ventilation load
- Infiltration
- Occupancy schedules




Southface

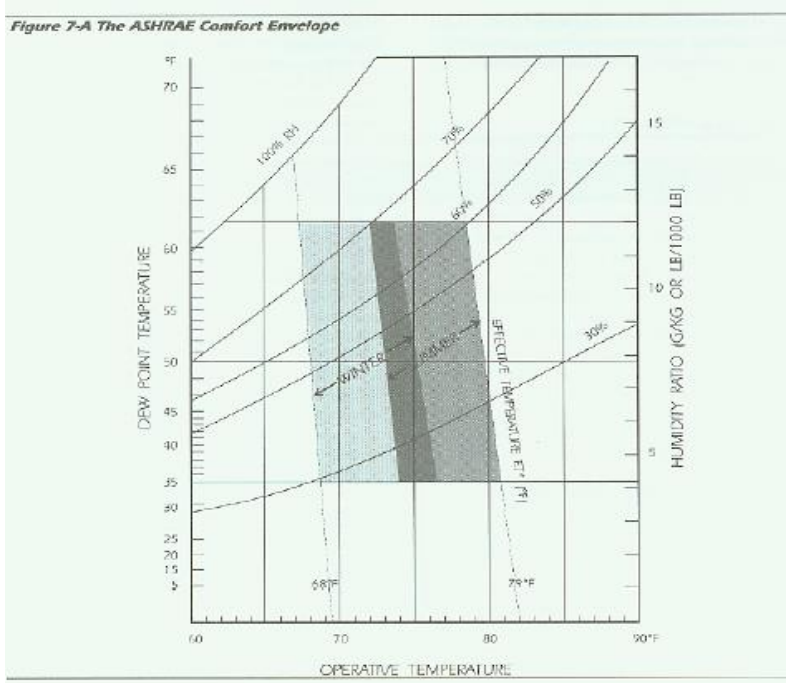
MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

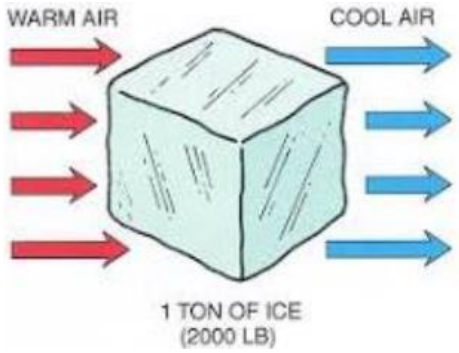
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Load Calculations are mandatory

- Must calculate heating and cooling system design loads
- Must base calculations on generally accepted engineering standards and handbooks – ASHRAE / ACCA 183
- Other approved computation procedures
- Outdoor design conditions
    - Specified by ASHRAE
      (e.g., Lincoln, NE 2°F winter, 93°F summer)
- Interior design conditions
    - Specified the IECC
    - ≤ 72°F for heating load
    - ≥ 75°F for cooling load




1 ton = 12,000 Btu/hr

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# COMcheck-Web™

COM*check*-*Web* simplifies commercial and high-rise residential energy code compliance.

It performs just like COM*check*, the desktop version, but you don't need to download or install any software on your computer.

» Start COM*check*-*Web*

COM*check*-*Web* has been updated!
Learn what's new. (June 2022)

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

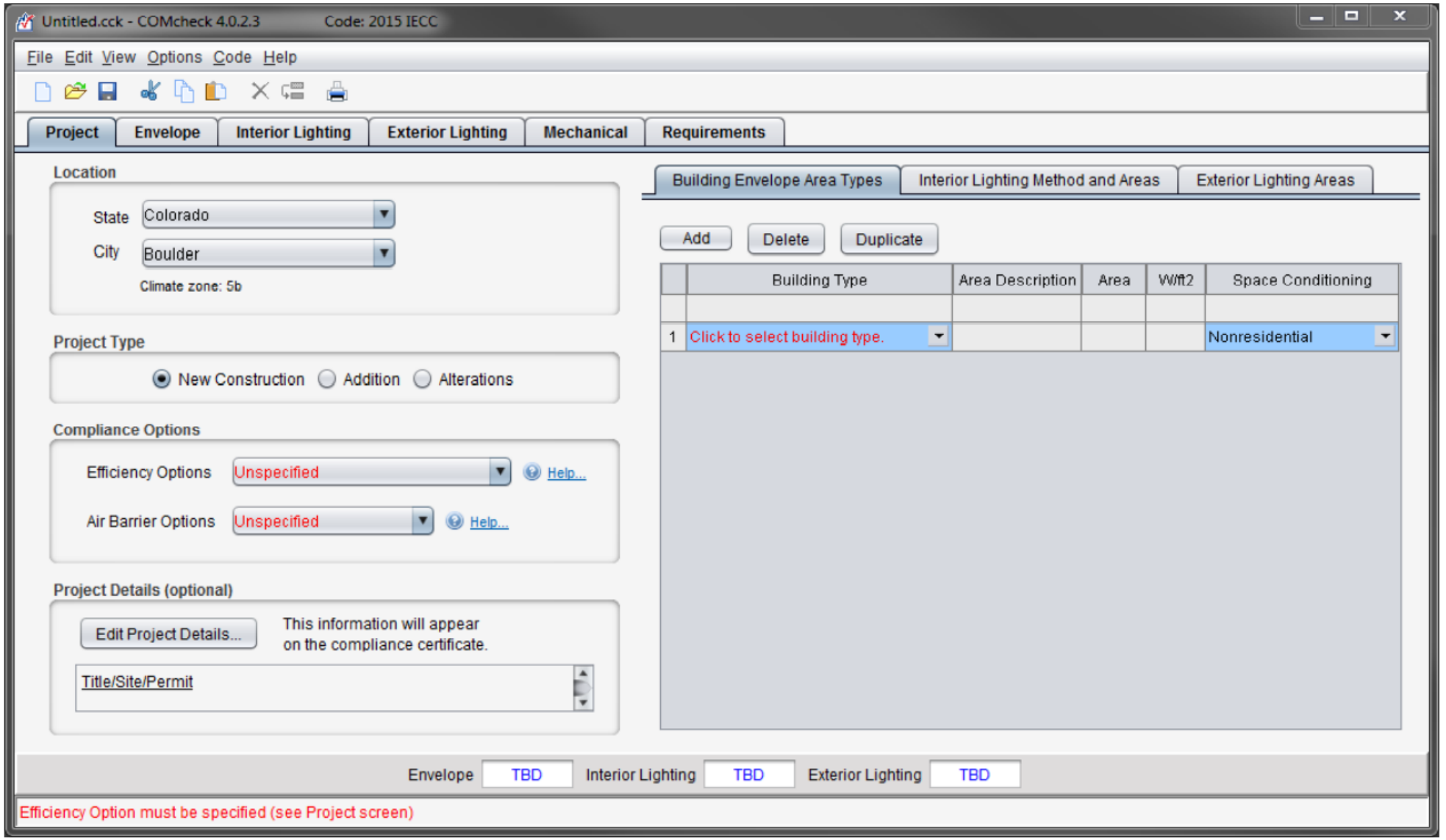
NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL


BECP Tools used only during "Demonstrate Compliance" Stage

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

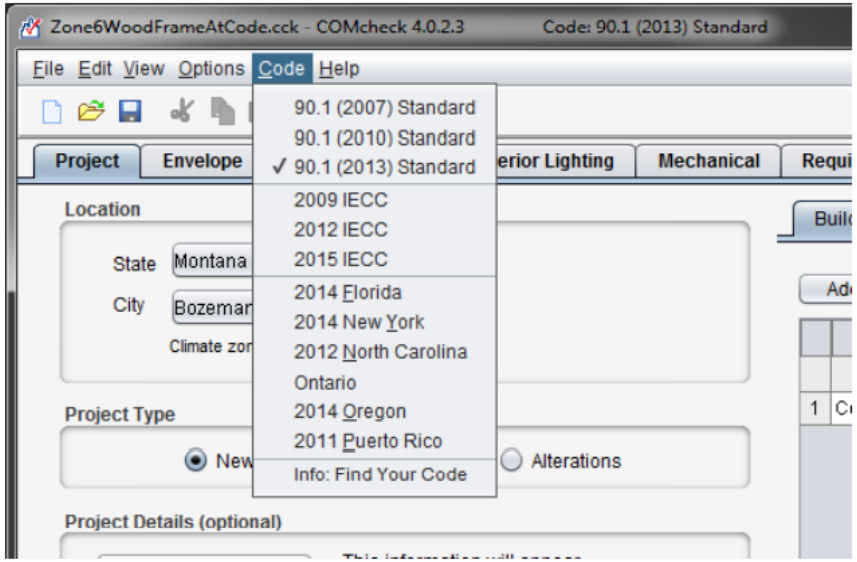



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

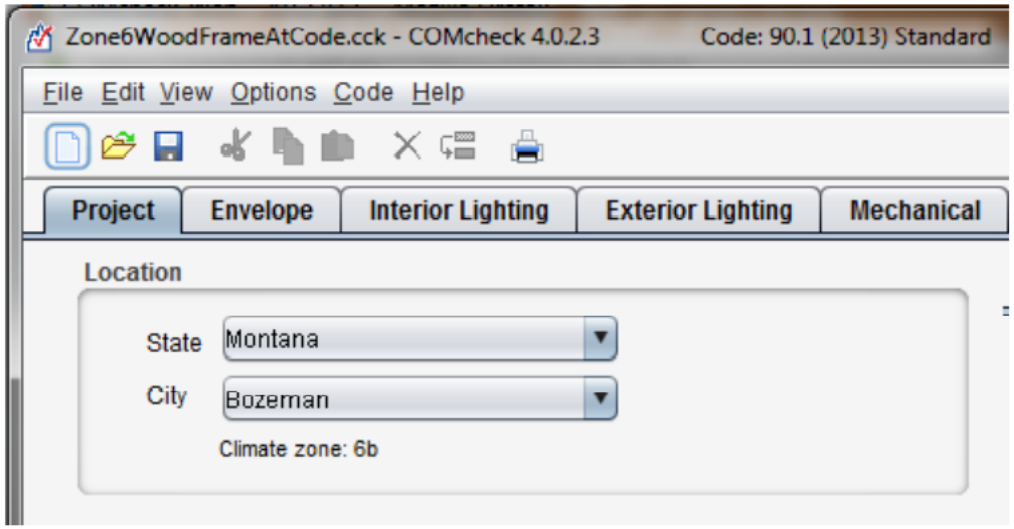
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

- Appropriate Code




- Location




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

- New Construction
- Addition
- Alteration

Project Type

(•) New Construction ( ) Addition ( ) Alterations

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Building Envelope

**MOST** Important part of your building from an energy view

With envelope technologies accounting for approximately 30% of the primary energy consumed in residential and commercial buildings, it plays a key role in determining levels of comfort, natural lighting, ventilation, and how much energy is required to heat and cool a building.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

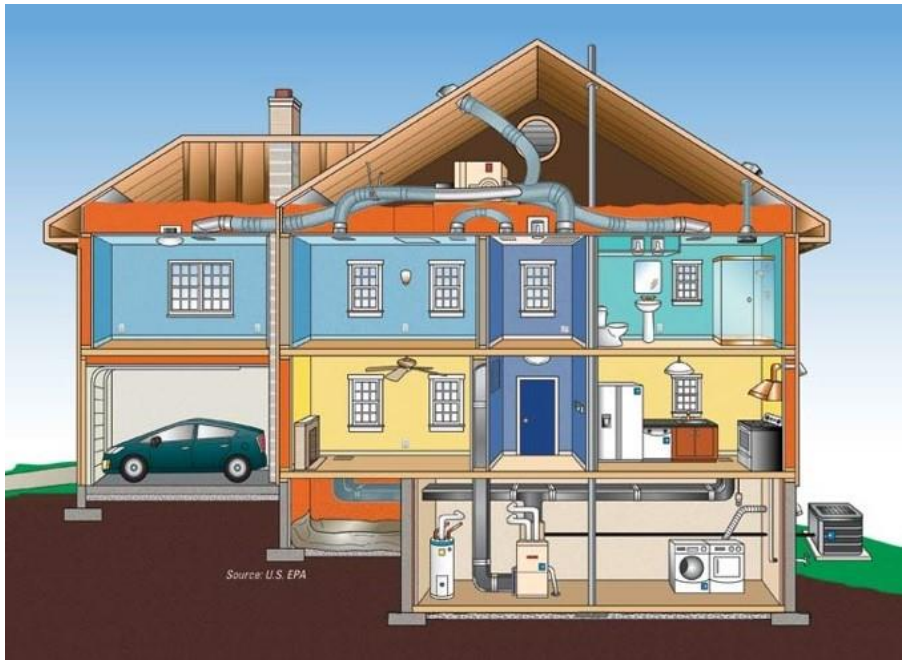
Building Science

# Building Thermal Envelope

## IECC Definition

The basement walls, exterior walls, floor, roof and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

What parts of this Building are enclosed by the thermal envelope?




MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

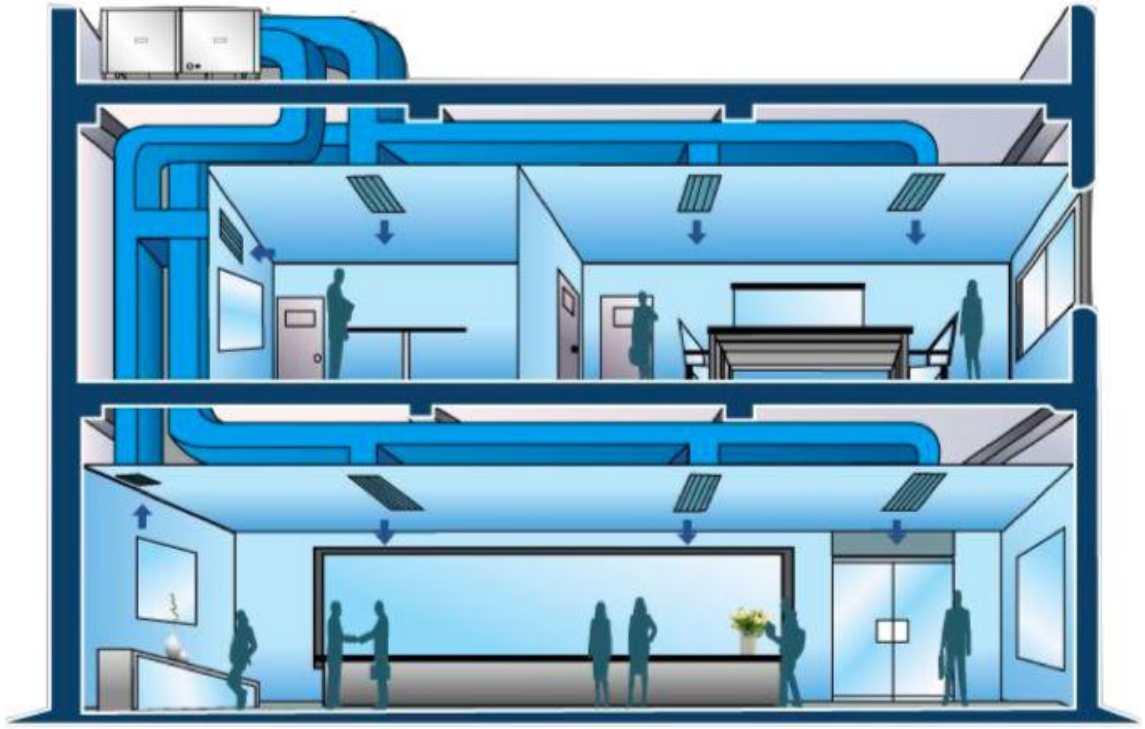
NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

Building Science

# Building Thermal Envelope

…elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

- Commercial Buildings can be more complex
- ACT ceilings and plenum regions can be “in-between” regions
- Often difficult to condition
- Issues with accurate energy modeling



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

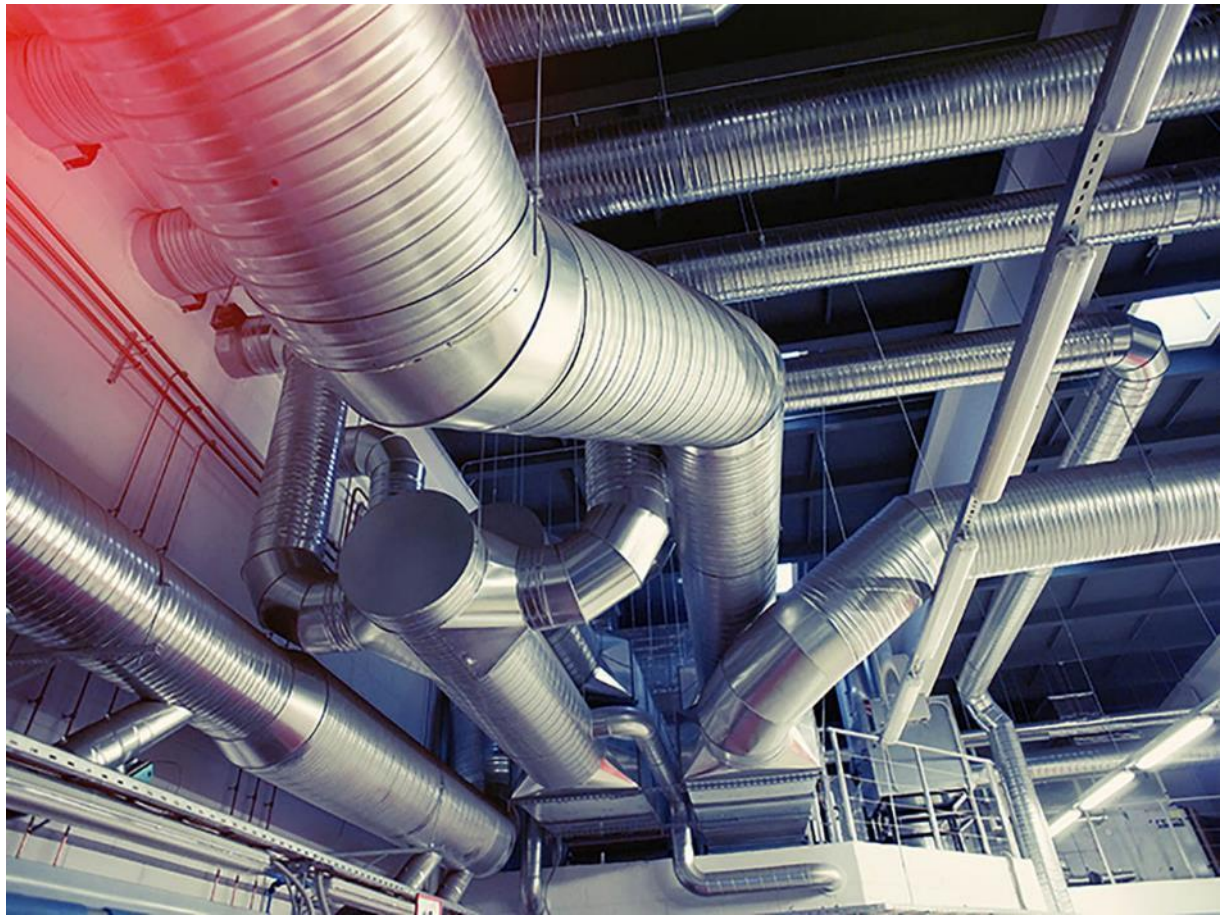
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 - Components

## Basic HVAC Equipment

- Fans / Blowers
- Furnace / Heating unit
- Filters
- Compressor
- Condensing units
- Evaporator (cooling coil)
- Control System
- Air Distribution System

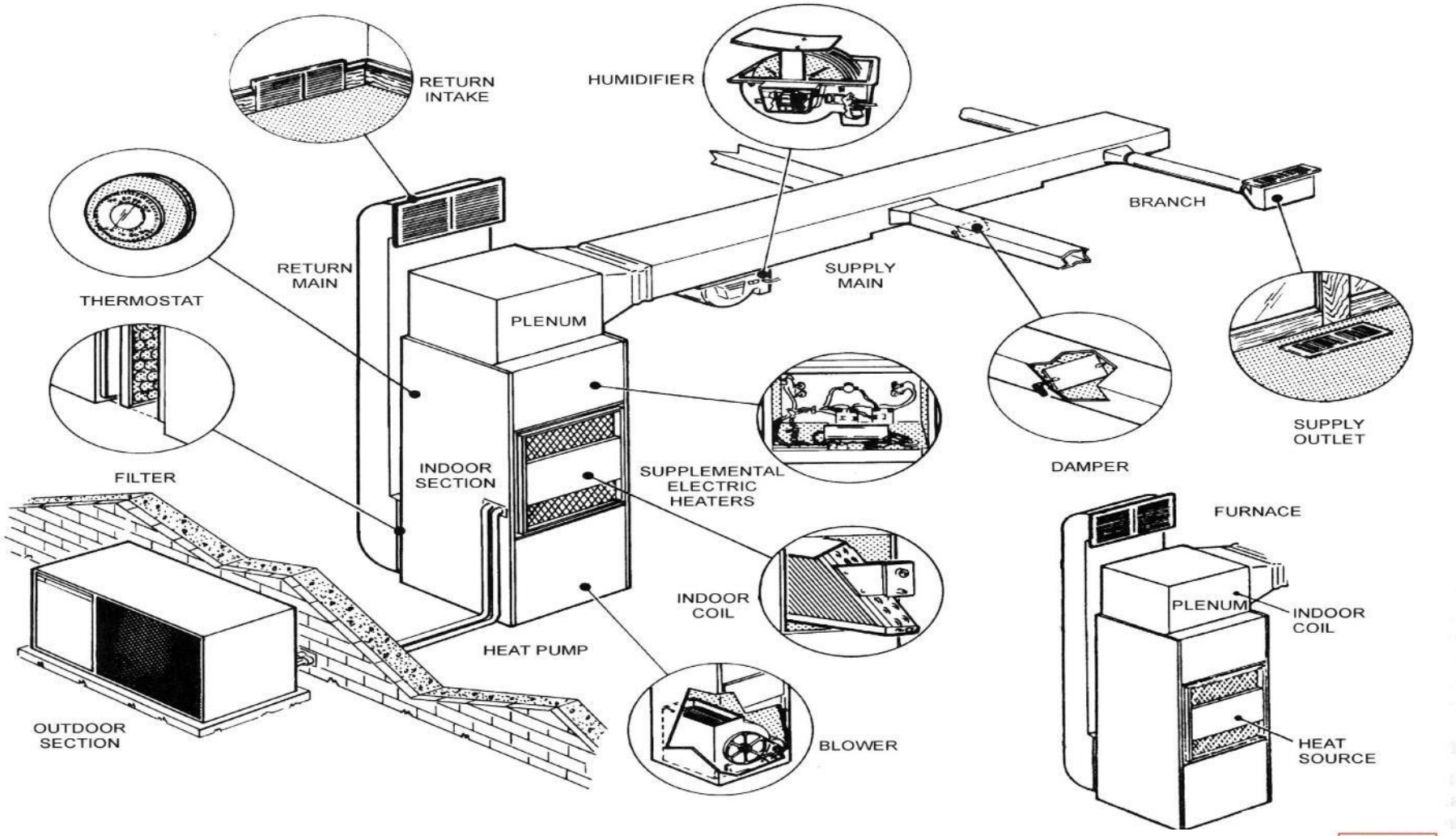


MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – Anatomy of a split System




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – System Types

## Split System: Separate Air Handling Unit (AHU)


MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – System Types

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – System Types

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – System Types

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – System Types

Packaged versus Split Systems

RTU: Roof Top Unit


MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – System Types

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

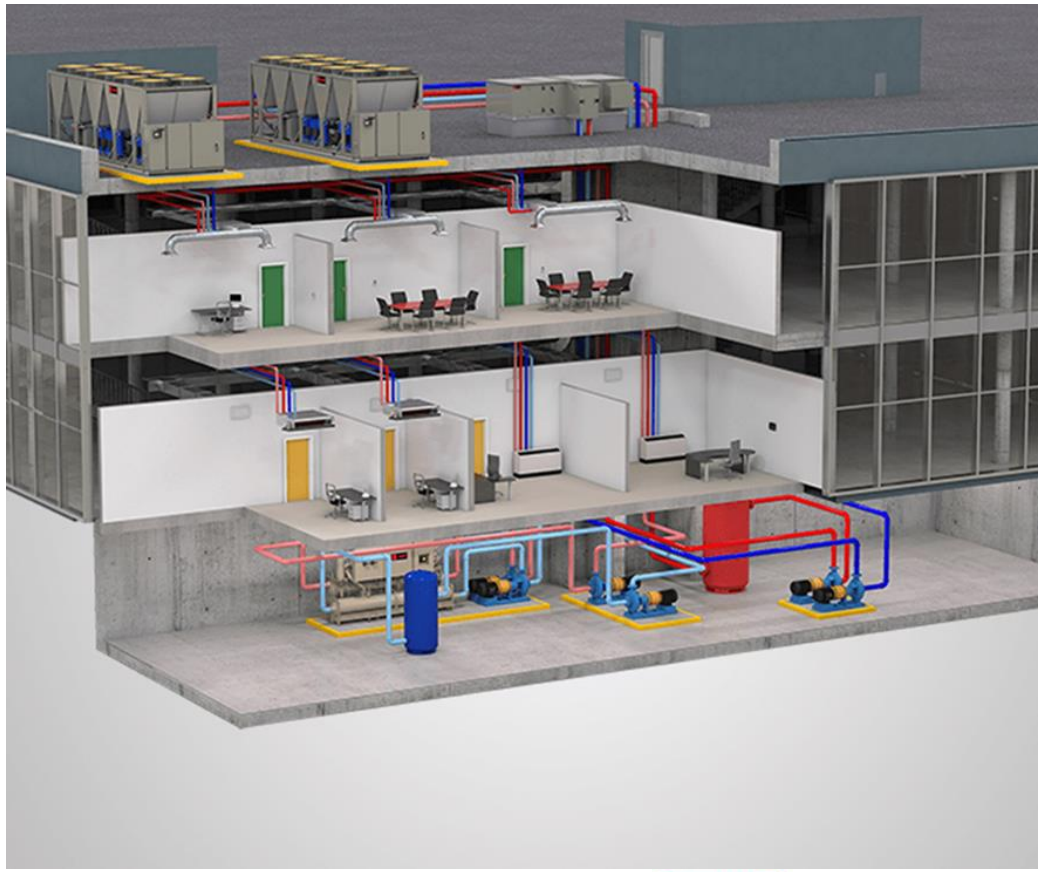
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Retrofit of Component Type

**Push towards Full Electrification**

- Heat pumps everywhere
  - Heating/cooling
  - DHW
  - Water to water
- Heat pump chiller plants



# Tandem Heat Pump System

**Summer**

- Chiller operates as standard air cooled
- Glycol system

**Winter**

- Operation reversed
- Condenser becomes evaporator
- Evaporator providing process water

# Why the Push?

**Increased Energy Costs**

- Efficiencies
- Much lower imbedded costs
- Tax Incentives
- Operation and Maintenance

**"Future Readiness"**

- On-Site Renewables
- Grid Interactive
- Demand Response
- Reduced Costs
- ….maybe more tax incentives?...

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Whitney Young

**Westchester NY**

- $22M reno
- $12M allocated to efficiency
- Hybrid Heat plant
- 2 pipe FCU in each apartment
- ERV for entire complex
- 87kW rooftop array
- Real time energy management
- ~62 % utility cost decrease
- 5-6 year payback

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

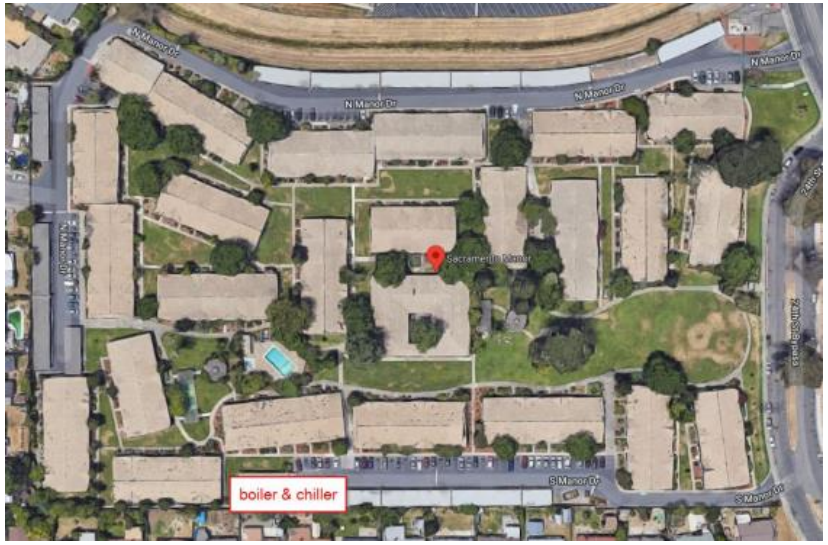
NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Sac Manor

**Sacramento CA**

- 1961 Building
- Full renovation ($18M)
- Unitized mini splits
- DHW plant
- High efficiency fenestrations
- Electric upgrade/refit entire facility
- Real time energy management
- ~70 decrease in energy use
- 4-5 year payback




MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

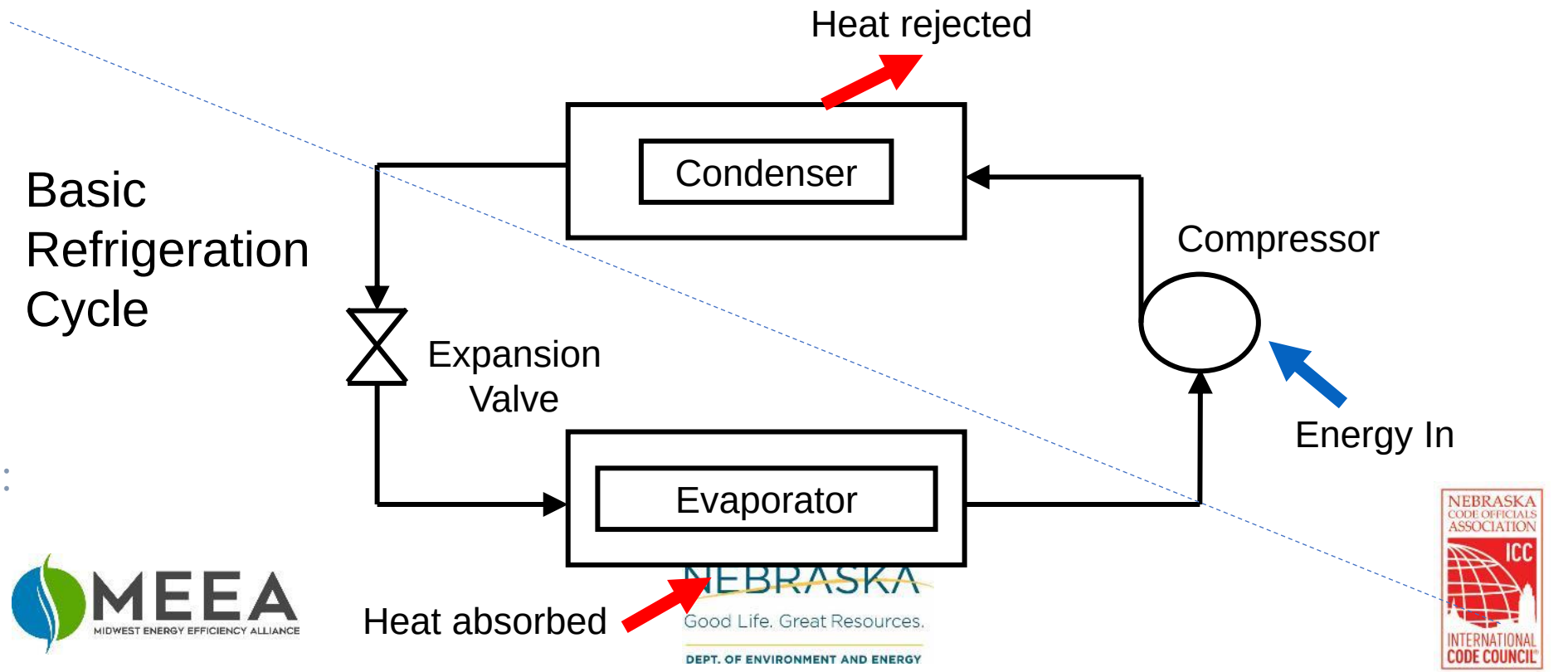
NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# HVAC 101- Basic Concepts

- Heating, Ventilation and Air Conditioning
- Provides *comfort* for people
- Allows humans to *exist* under adverse conditions

Basic Refrigeration Cycle




Cooling: Outdoors

Cooling: Indoors

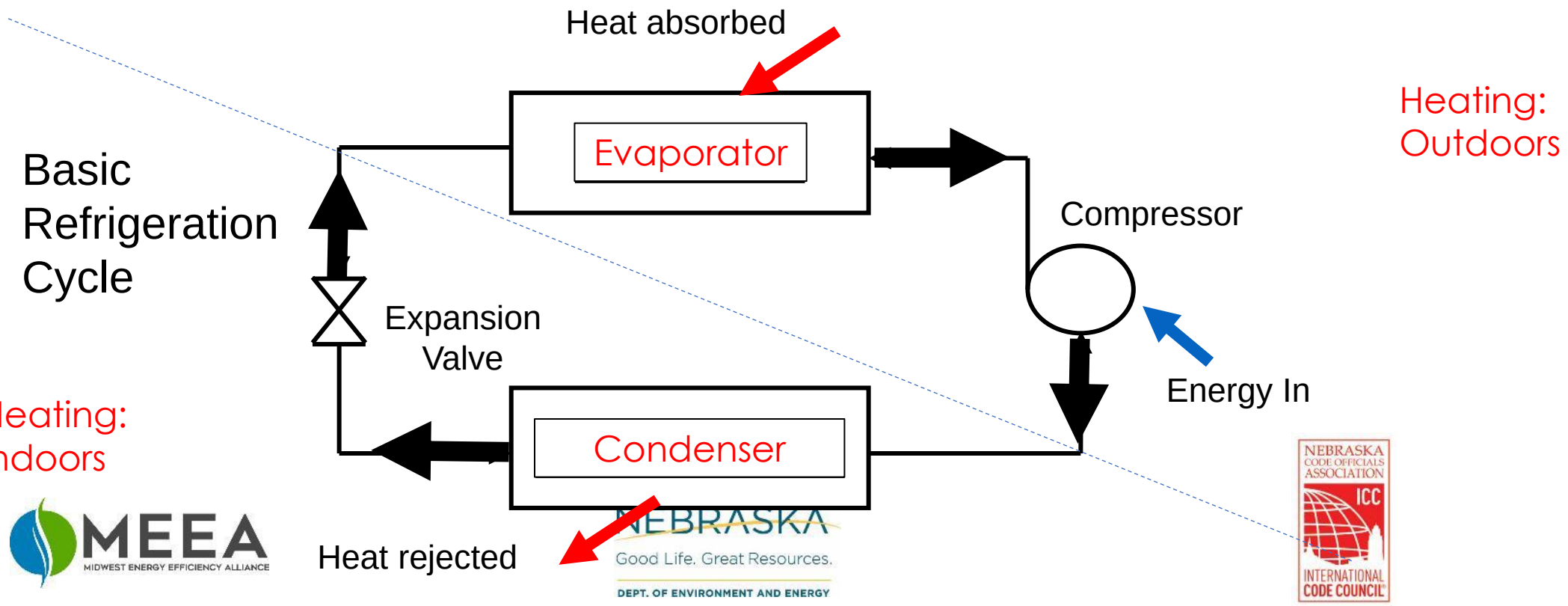
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

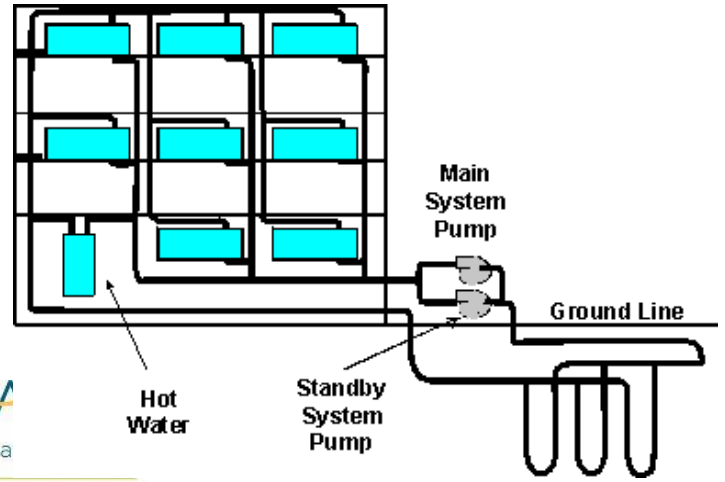
# HVAC 101- Basic Concepts

- Heat pump in heating mode – compressor drives refrigerant in opposite direction (by means of a reversing valve)



# HVAC 101 – Heat Pumps

- Operate on basic refrigeration cycle
- Reversing the cycle provides heating
- Temperature limitations
- Extract/Reject heat
  - Air to air
  - Geothermal
  - Lake coupled
- Water source




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRA
Good Life. Grea
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – Using Water to Move Heat

## Hydronic Systems

- Pumps
- Piping
- Valves
- Coils

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – Large Systems

## Major Equipment

- Chillers
- Boilers
- Cooling Towers

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 - Controls

## Control Devices

- Thermostats
  - Manual
  - Programmable
- DDC Systems
- Automatic Valves and Dampers
- Outdoor Sensors
- Optimum Start
- Variable Speed Drives



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Mandatory Controls


**C403.4 Heating and cooling system controls (Mandatory).** P

Each heating and cooling system shall be provided with controls in accordance with Sections C403.4.1 through C403.4.5.

**C403.4.1 Thermostatic controls (Mandatory).** P

The supply of heating and cooling energy to each *zone* shall be controlled by individual thermostatic controls capable of responding to temperature within the *zone*. Where humidification or dehumidification or both is provided, not fewer than one humidity control device shall be provided for each humidity control system.

**C403.4.1.1 Heat pump supplementary heat (Mandatory).** P

Heat pumps having supplementary electric resistance heat shall have controls that, except during defrost, prevent supplementary heat operation where the heat pump can provide the heating load.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Mandatory Controls (cont.)


**C403.4.1.2 Deadband (Mandatory).** P

Where used to control both heating and cooling, *zone* thermostatic controls shall be configured to provide a temperature range or deadband of not less than 5°F (2.8°C) within which the supply of heating and cooling energy to the *zone* is shut off or reduced to a minimum.

**C403.4.2 Off-hour controls (Mandatory).** P

Each *zone* shall be provided with thermostatic setback controls that are controlled by either an automatic time clock or programmable control system.

**C403.4.2.2 Automatic setback and shutdown (Mandatory).** P

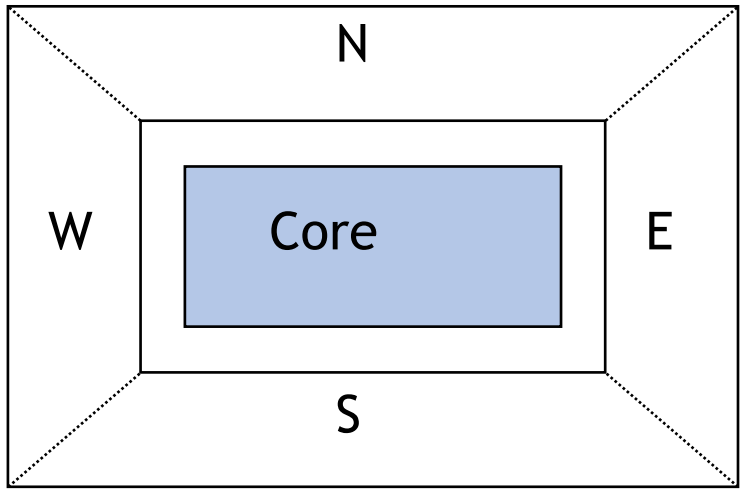
Automatic time clock or programmable controls shall be capable of starting and stopping the system for seven different daily schedules per week and retaining their programming and time setting during a loss of power for not fewer than 10 hours. Additionally, the controls shall have a manual override that allows temporary operation of the system for up to 2 hours; a manually operated timer configured to operate the system for up to 2 hours; or an occupancy sensor.

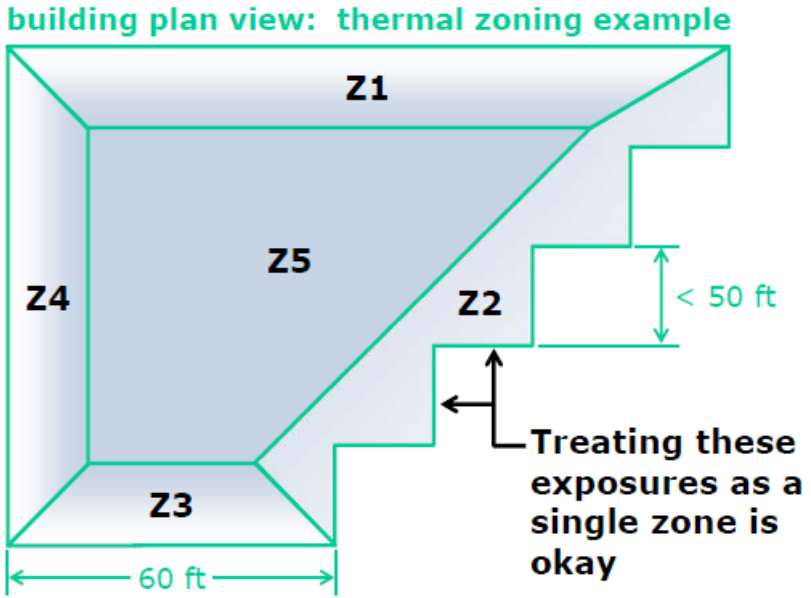
MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

ASSOCIATION ICC
INTERNATIONAL CODE COUNCIL

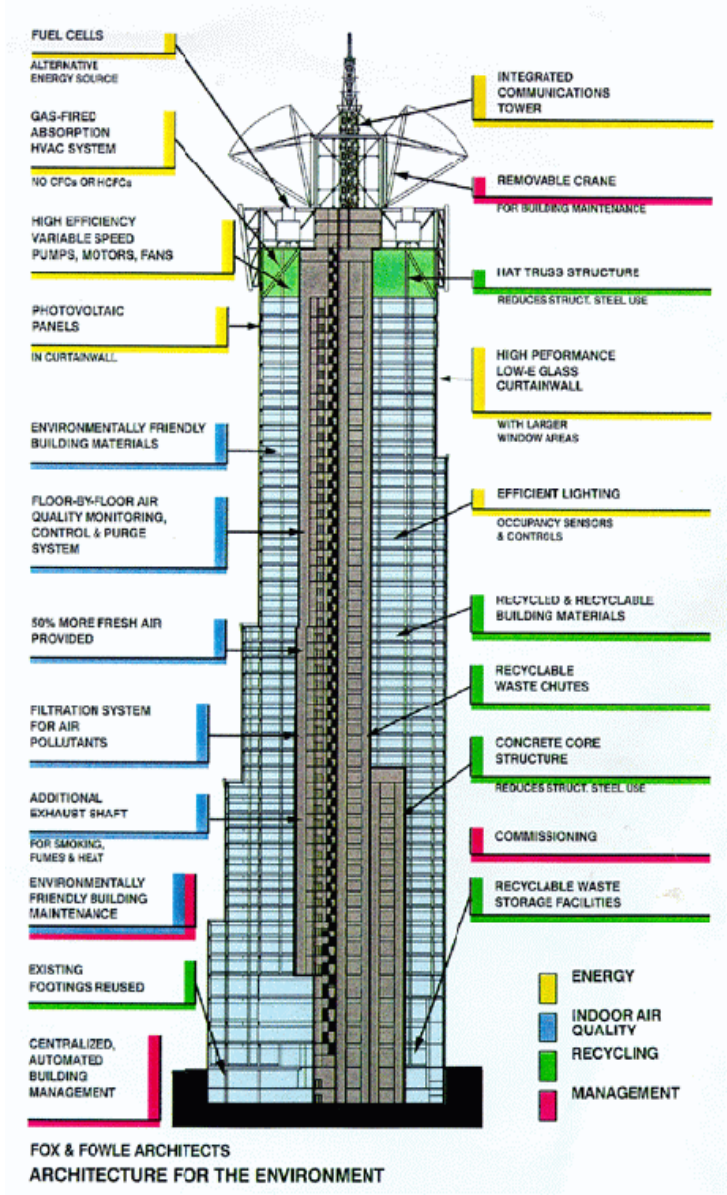
# HVAC Terminology - zones




**Core and each long exposure must be zoned separately**

**Treating these exposures as a single zone is okay**

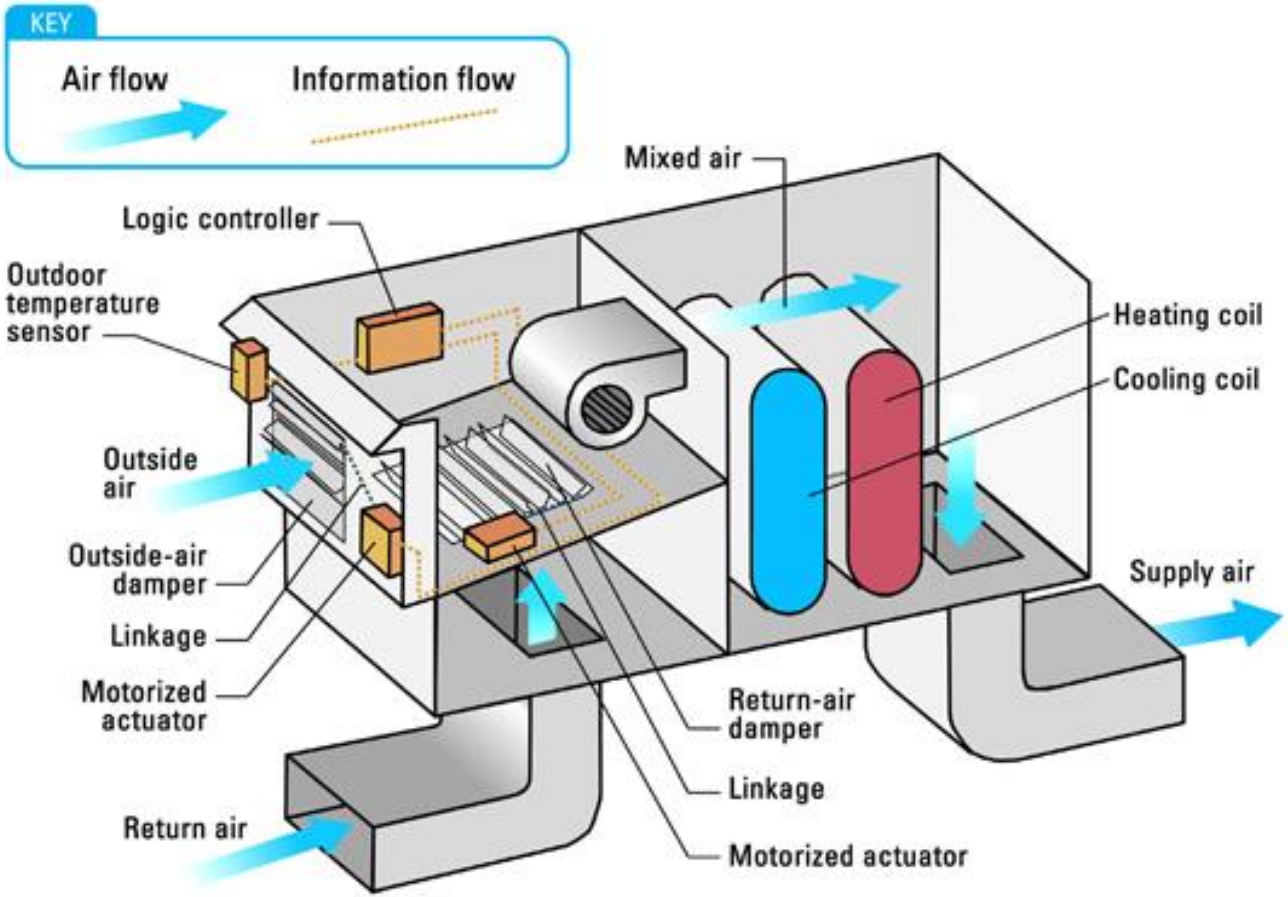



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

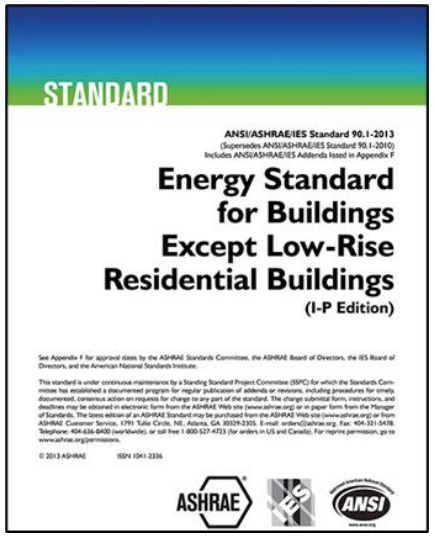
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Economizers








MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

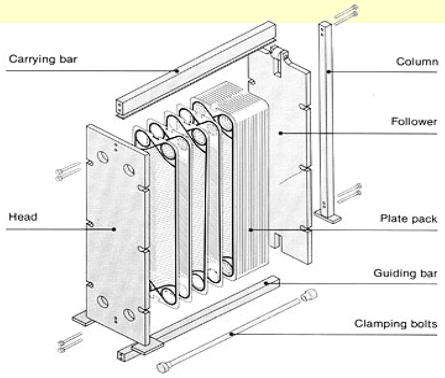
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 - Economizers

- "**Free cooling**": Use cool outdoor air instead of mechanically cooled air

Air Side




Water Side

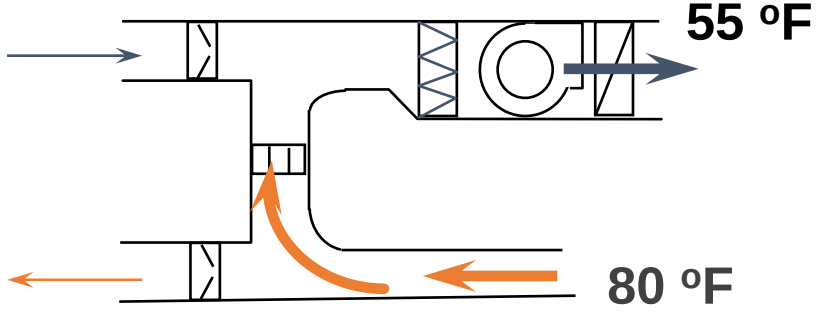
**Normal** Operation

Outside air dampers provide minimum outside air

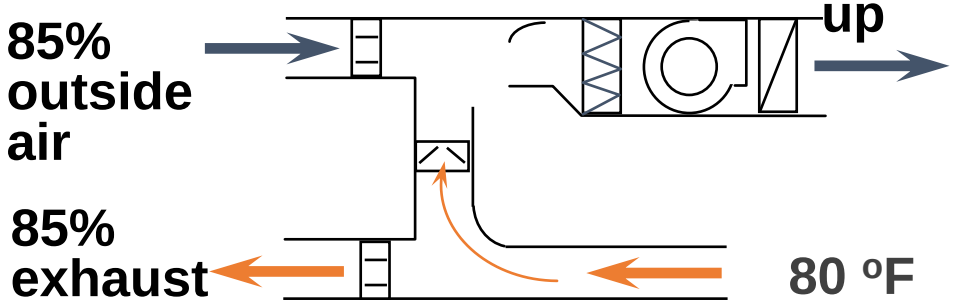
**Economizer** Operation

Outside air dampers are open to provide maximum outside air

**Minimum supply of outside air**




**Maximum supply of outside air**



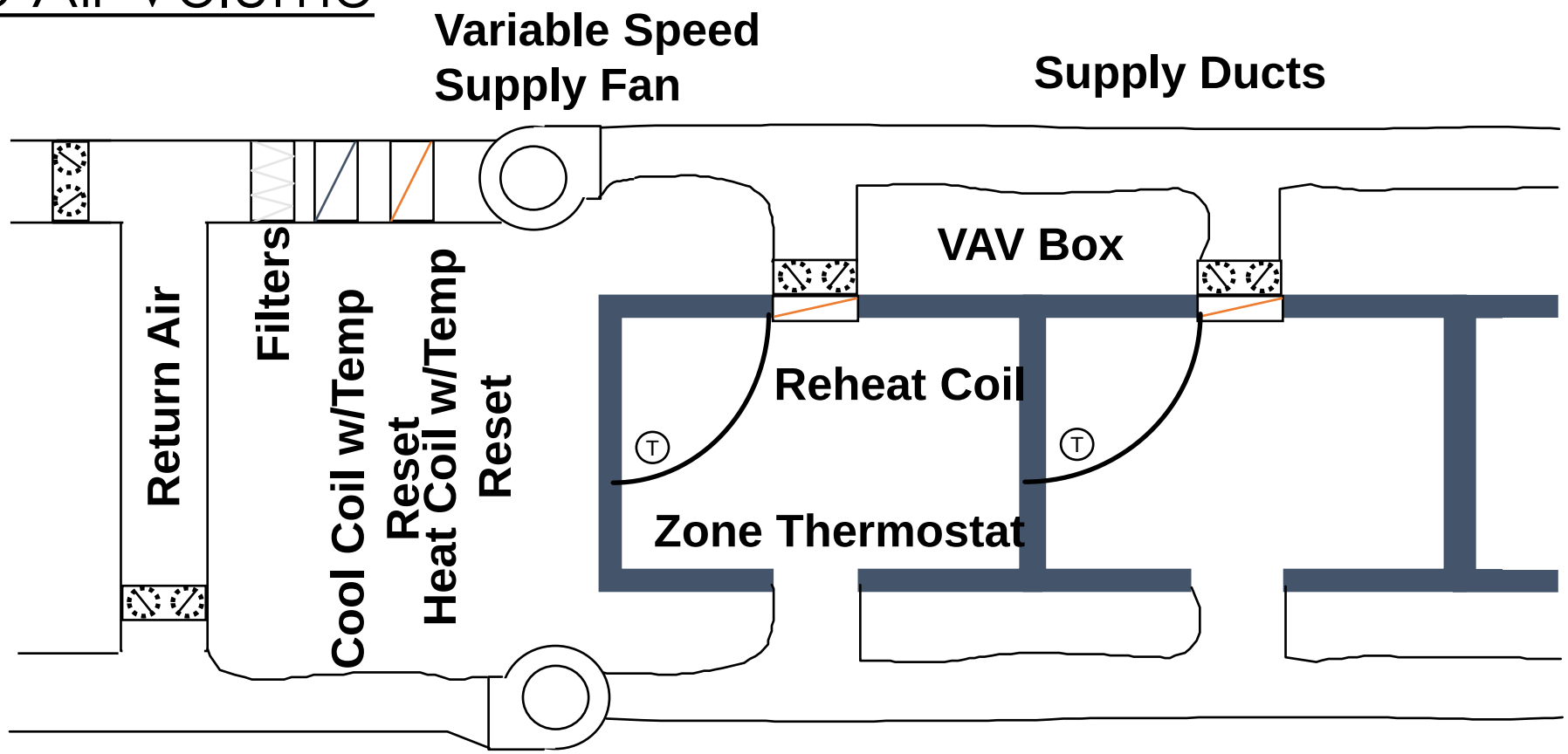

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# HVAC 101 - Distribution

## Variable Air Volume

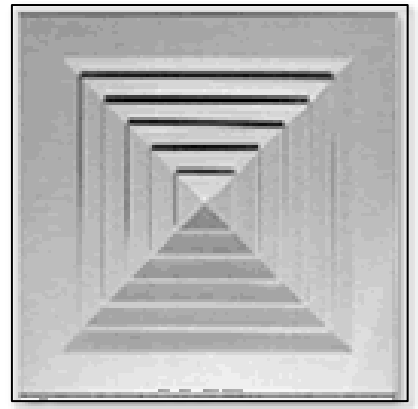



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 - Distribution



## Air Distribution

- Ductwork
  - Metal
  - Flexible
  - Ductboard
- Grilles, Louvers, & Registers
- Dampers
  - Shut off
  - Fire
  - Smoke
- Sealants
- Supports
- UFAD

Photo: Jonathan Hillyer,

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

INTERNATIONAL CODE COUNCIL

# Impacts of non-ducted Return Air Plenums

- Reduced HVAC system costs of about 10% to 20% of the total HVAC system cost.
- Reduced efforts for coordination of overhead utilities.
- Assumed reduced fan energy costs due to lower pressure drop of the plenum return system.

*Photo by Yuji Sakai*

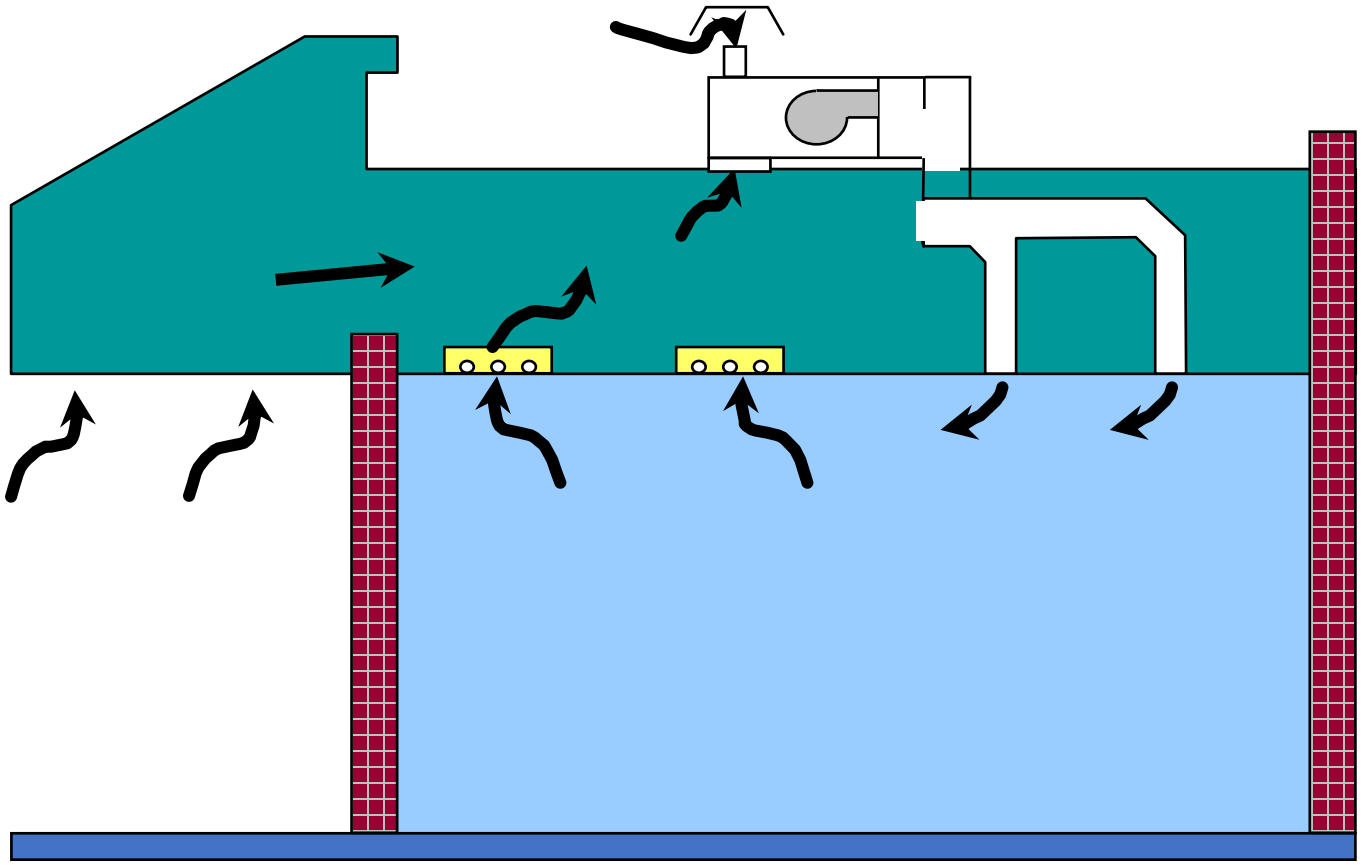
MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Problems of non-ducted Return Air Plenums

- What could possibly go wrong here?



MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Problems of non-ducted Return Air Plenums

- Cavities above suspended ceilings are used as equipment tunnels and chases causing major air leakage
- These areas are highly (de)pressurized, which exacerbates the air leakage
- They are often adjacent to unconditioned spaces (storage, plant, warehouse, etc.)

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Water, water everywhere

- Roof leak or something else?

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Plenum Insulation


- **C403.2.9 Duct and plenum insulation and sealing**
- Supply and return air ducts and plenums shall be insulated with a minimum of R-6 insulation where located in unconditioned spaces and where located outside the building with a minimum of R-8.
- Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by a minimum of R-8 insulation.

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Piping Insulation


**C403.11.3 Piping insulation (Mandatory).** P

Piping serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.11.3.

**TABLE C403.11.3 MINIMUM PIPE INSULATION THICKNESS (in inches)[a, c]**

| FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F) | INSULATION CONDUCTIVITY | | NOMINAL PIPE OR TUBE SIZE (inches) | | | | |
|---|---|---|---|---|---|---|---|
| | Conductivity Btu • in./(h • ft$^2$• °F)[b] | Mean Rating Temperature, °F | < 1 | 1 to < 1 1/2 | 1 1/2 to < 4 | 4 to < 8 | ≥ 8 |
| > 350 | 0.32 – 0.34 | 250 | 4.5 | 5.0 | 5.0 | 5.0 | 5.0 |
| 251 – 350 | 0.29 – 0.32 | 200 | 3.0 | 4.0 | 4.5 | 4.5 | 4.5 |
| 201 – 250 | 0.27 – 0.30 | 150 | 2.5 | 2.5 | 2.5 | 3.0 | 3.0 |
| 141 – 200 | 0.25 – 0.29 | 125 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 |
| 105 – 140 | 0.21 – 0.28 | 100 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 |
| 40 – 60 | 0.21 – 0.27 | 75 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| < 40 | 0.20 – 0.26 | 50 | 0.5 | 1.0 | 1.0 | 1.0 | 1.5 |

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Health care facilities

- The 2018 or later Facility Guidelines Institute standards were adopted in many states.
- Those standards **require** ducted returns in many healthcare-related facilities to reduce the spread of infections.


MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

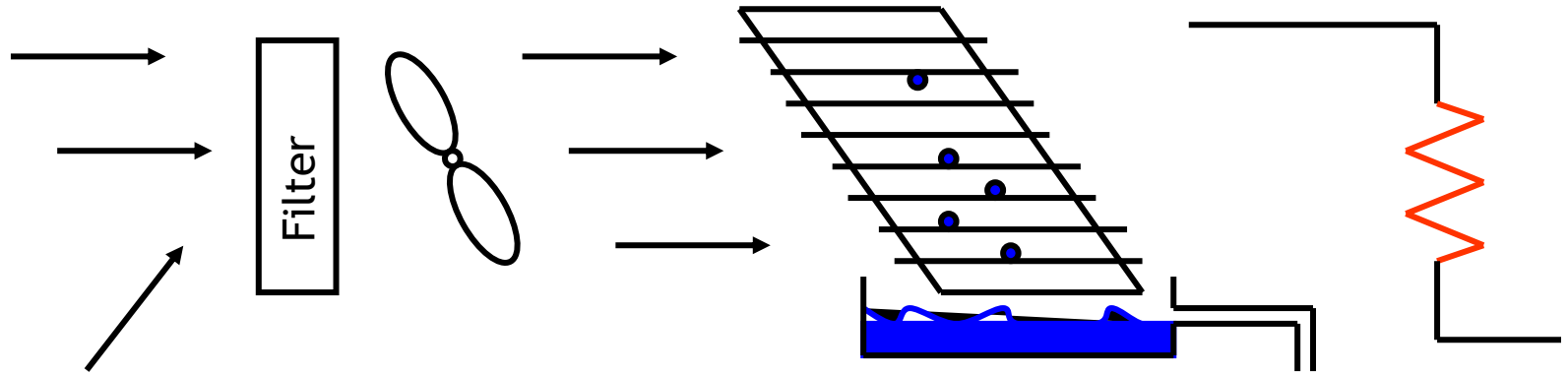
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

INTERNATIONAL CODE COUNCIL

# HVAC 101 – Moisture Removal

## Mechanical Dehumidification

- Return air is mixed with ventilation air
- Cold coil condenses moisture
- Heat is sometimes added back (electric or gas) so that room air is not over cooled - Reheat




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – Energy Recovery

## Additional Equipment

- Energy Recovery Units
- Desiccant Systems

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

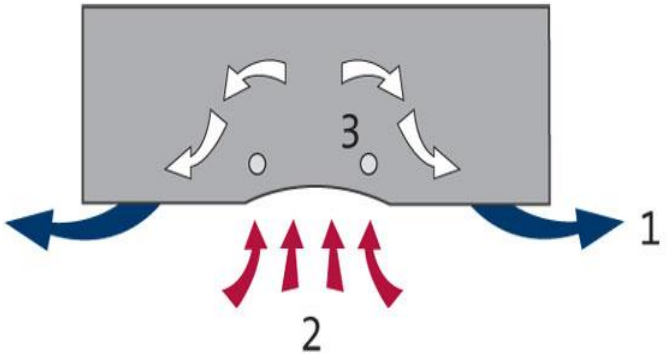
NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# HVAC 101 – "New" Stuff

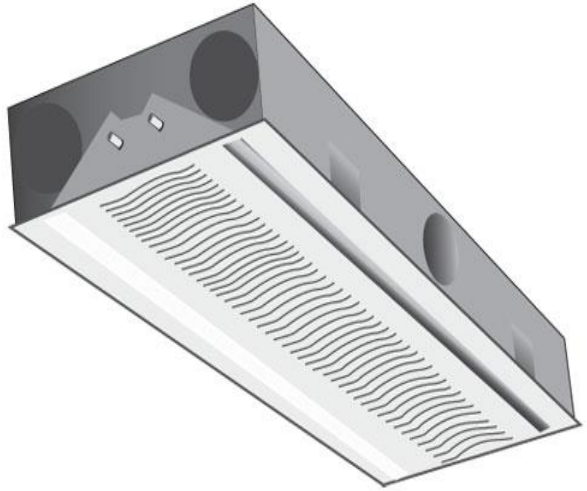
## New Technologies

- Chilled beams
- Radiant cooling

**Illustration**
1 Cooled air
2 Warm air
3 Cooling coil







MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

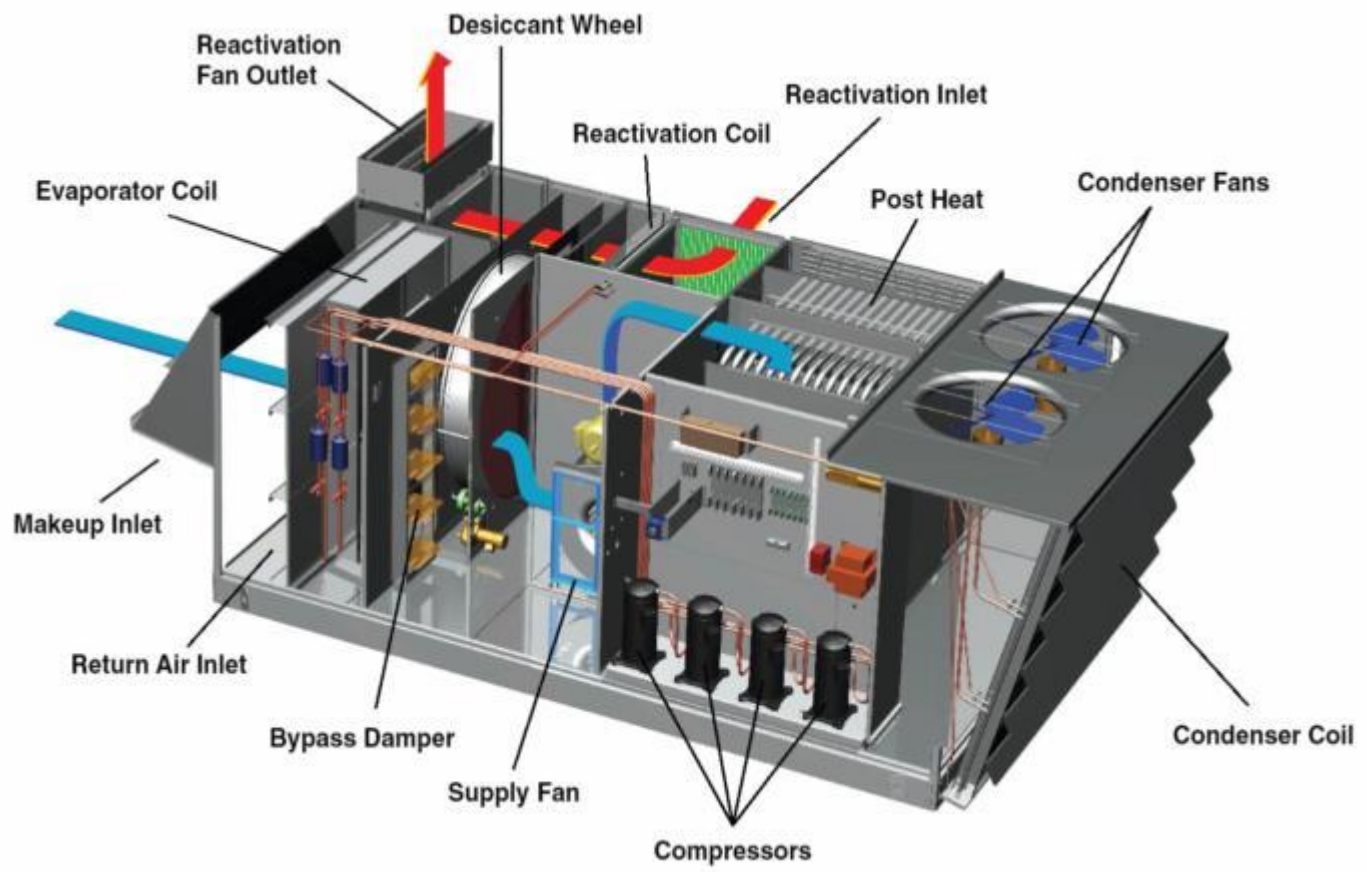
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Alternate Equipment

- *Dedicated Outdoor Air Systems* **(DOAS)**
  - *Secondary air systems that regulate temperature, humidity, and gasses in buildings.*
- A **typical DOAS** configuration
  - *Shown to the right:*

- Typical DX-DOAS (Air Cooled)




MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

ICC INTERNATIONAL CODE COUNCIL

# Alternate Equipment

# DOAS… Economizer….or ERV?

- *Depends on your Air Exchange needs*

| Economizer | ERV | DOAS |
|---|---|---|
| Up to 15-20% | 20-65% | 65-100% |

| Supply | O/A | % O/A | Mixed | LAT | ERV Load Reduction | LAT w/ ERV |
|---|---|---|---|---|---|---|
| 8,000 | 0 | 0.00% | 75/62 | 52/51 | N/A | N/A |
| 8,000 | 1,000 | 12.50% | 77.5/64.3 | 55/54 | N/A | N/A |
| 8,000 | 1,500 | 18.75% | 79/65.5 | 56/55 | N/A | N/A |
| 8,000 | 2,000 | 25.00% | 80/66.6 | 57.7/56.3 | 7.1 tons | 54/53 |
| 8,000 | 2,500 | 31.25% | 81.2/67.6 | 59/57 | 8.0 tons | 54.53.5 |
| 8,000 | 3,000 | 37.50% | 82.5/69 | 61/58.4 | 9.6 tons | 54/53 |
| 8,000 | 4,000 | 50.00% | 85/71 | 64/61 | 12.4 tons | 56/55 |
| 8,000 | 5,600 | 70.00% | 89/74 | 69/64 | 17.5 tons | 57/56 |

*Assumptions:
75/62 return air temperature
95/78 ambient temperature

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Alternate Equipment

## New Technologies

- VRF (variable refrigerant flow)
- VRV (variable refrigerant volume)
- Evaporative Mesh

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Alternate Equipment

## Variable Refrigerant Flow

- VRF systems move refrigerant from one region in a building to another
- Allows you to “move” heat around the building
- These systems can adapt to several possible configurations
- Generally, is an outdoor condensing unit connected to multiple fan-coil units (FCUs) within the building.

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# VRF Application - Colorado Project

- Banking Facility
- Multi-Zone
- Pilot Program
- Client looking for 70%+ Savings

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# VRF Application - Colorado Project

- Mitsubishi City Multi R2 system
- 10 Zones
- 10 In-Ceiling FCU's
- Lockinvar Condensing Boilers

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# VRF Application - Colorado Project

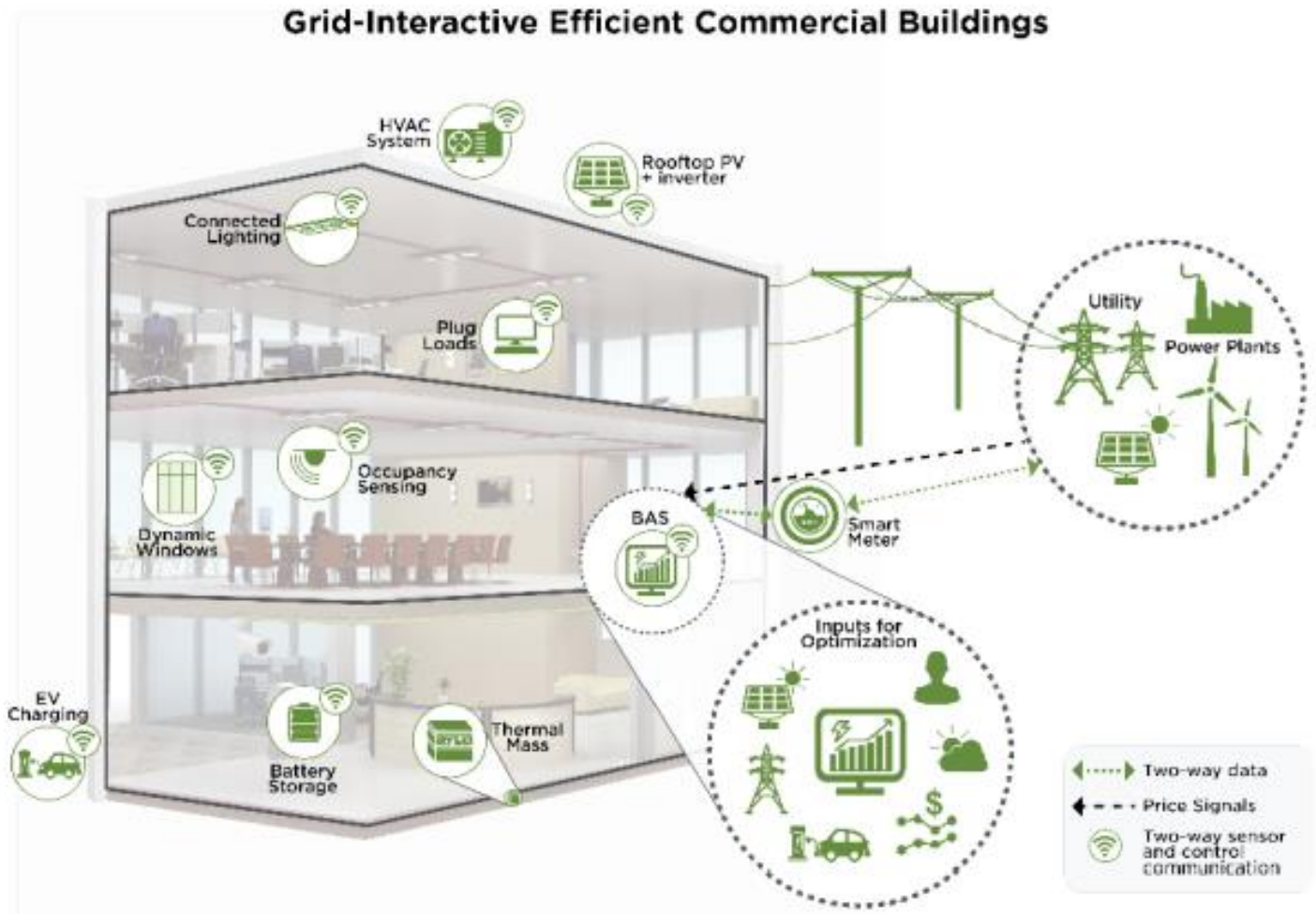
- Mitsubishi AE 200 Controller
- Web Enabled (Bank!!)
- BACnet MSTP
- Uses IP protocol to "communicate"

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL

# Advance Control Integration




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Advance Control Integration

## Building Automation Systems

- **Grid Interactive**
- **Required in some jurisdictions**
- **Data Security Issues**
- **Possible to save large energy amounts**

| | |
|---|---|
| **Building Optimization** | Schedule Compliance<br>Remote Monitoring<br>Data Driven Logic Changes |
| **Demand Management** | HVAC Optimization<br>Demand Response<br>Load Shedding / Shifting |
| **Variances & Anomalies** | Energy Use Trends<br>Demand Spikes<br>Easter / Christmas |

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

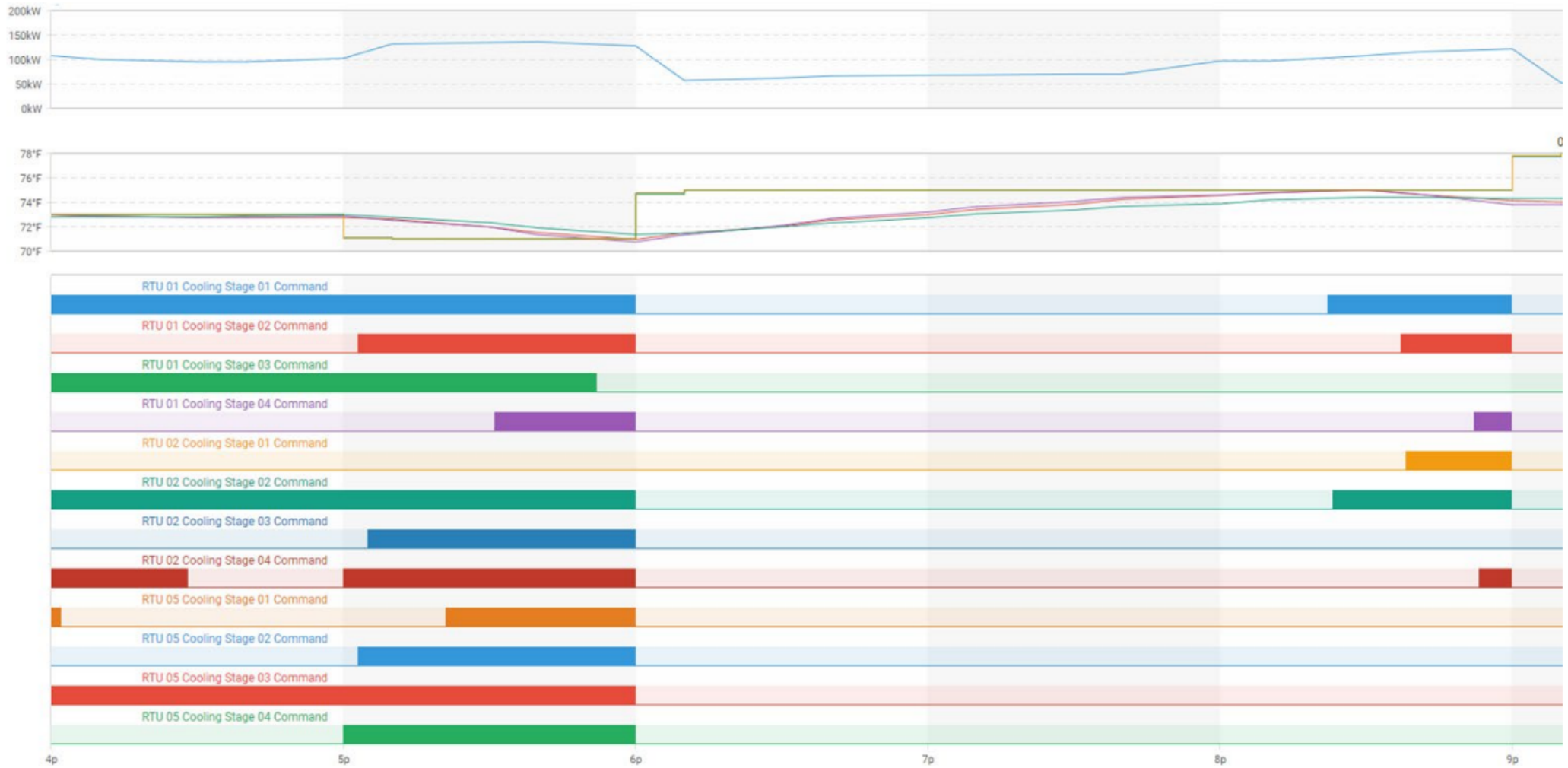
# Advance Control Integration


MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Advance Control Integration




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

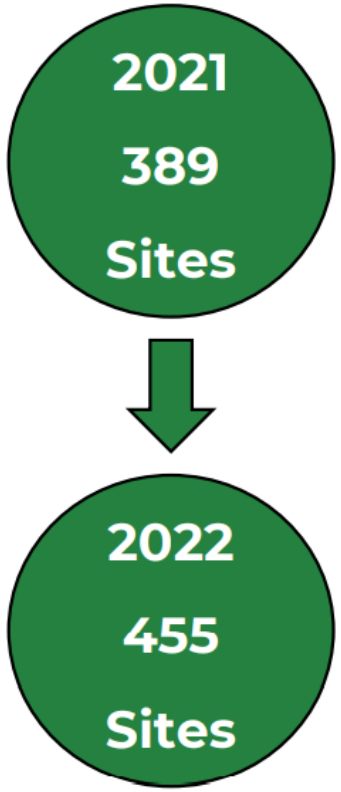
# Advance Control Integration

## Demand Flexibility

### Demand Response

- **Benefits:**
  - Grid Demand Relief
  - Correlation with higher TOU periods
  - Direct payments from utilities
- **Risks**
  - Building Comfort
  - Longer Duration Events and Performance
- **Process**
  - Pre-cool
  - Event: Disable HVAC Compressors
  - Zones resume cooling if temps hit 75
  - Post event: Set points return to normal

**Delivers >$300k Value Annually***




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Advance Control Integration

## Demand Flexibility

### Load Shifting

#### HVAC Staging

- **Avoiding Coincidental Peaks by delaying compressors**
- **Benefits:** Lower energy usage and decreased peak demand charges
  - 5-10kW monthly peak demand save
  - 1-3% kWh Save

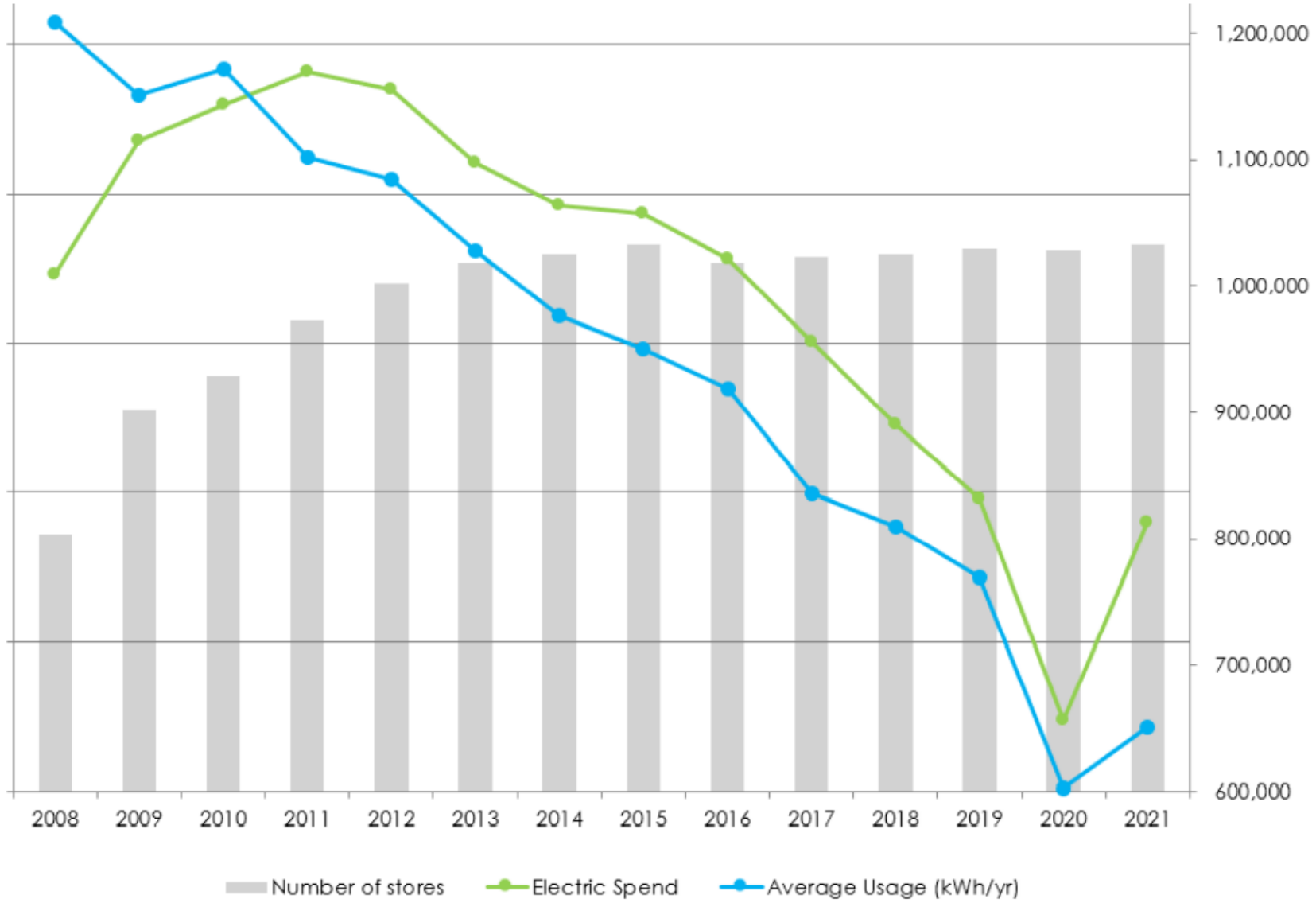
#### Optimized Start

- **Issue:** Morning Start up creating Demand Spikes
  - Units Ramp up simultaneously at Store Open to meet space temps
- **Resolution:**
  - Logic focused at Zone Level
  - Monitor delta b/t current and Occupied Temp
  - Calculated to hit Occupied Temp
- **Benefits:**
  - Avoids creating Morning Peak Demand Spikes

MEEA MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA Good Life. Great Resources. DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION ICC INTERNATIONAL CODE COUNCIL




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

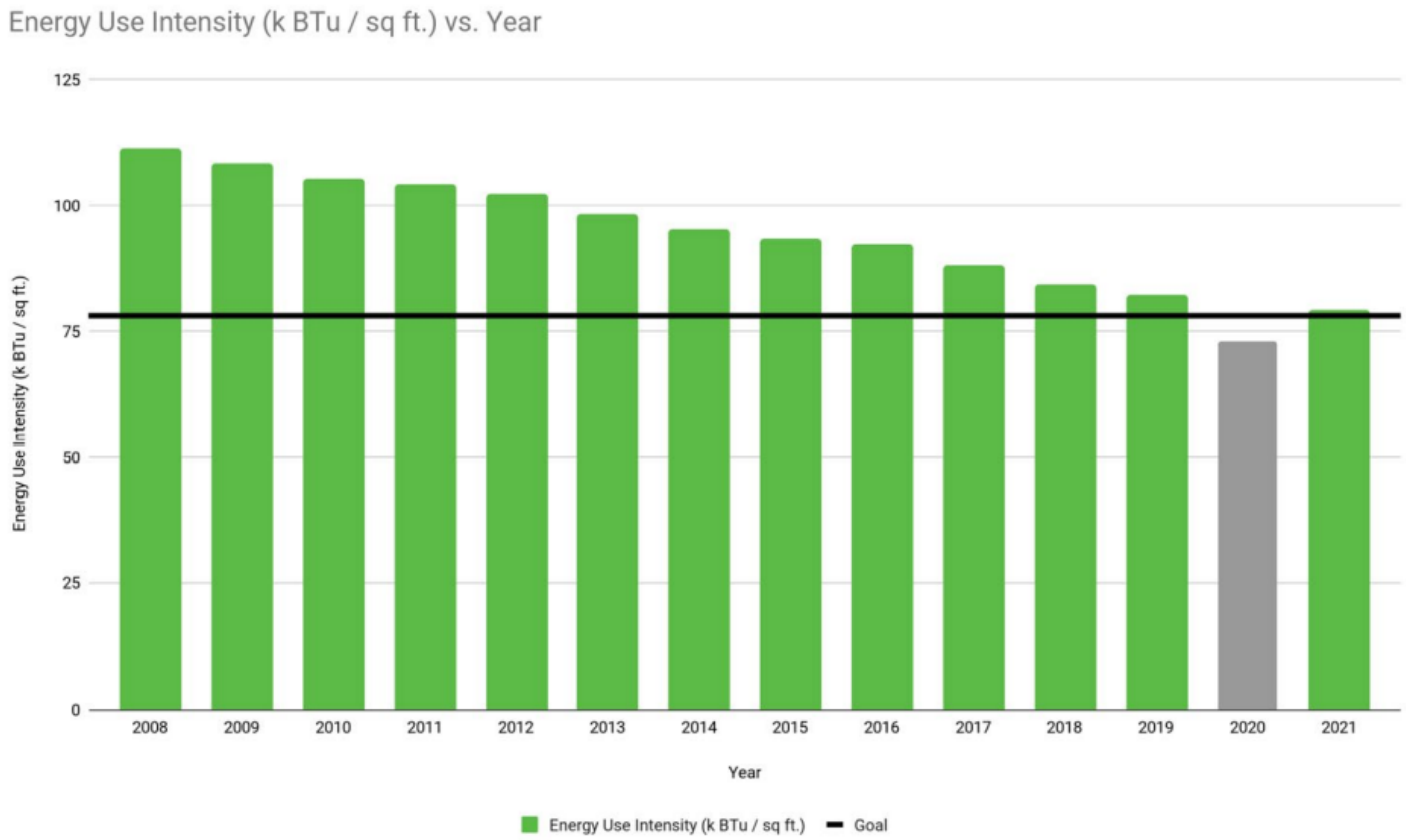
NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Advance Control Integration

2021 Progress:

**29%**




MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Upcoming Events

**10/11-14** Duct & Envelope Tightness (DET) Verifier Train the Trainer, in-person (NDEE Lincoln)

**10/27-28** DET Certification, in-person (NDEE Lincoln)

Sign up here:
https://www.mwalliance.org/nebraska-energy-codes-training-program

MEEA
MIDWEST ENERGY EFFICIENCY ALLIANCE

NEBRASKA
Good Life. Great Resources.
DEPT. OF ENVIRONMENT AND ENERGY

NEBRASKA CODE OFFICIALS ASSOCIATION
ICC
INTERNATIONAL CODE COUNCIL

# Thank you! Questions?

Matt Belcher, Verdatek Solutions
matt@verda-solutions.com
Cell: (314) 749-4189

Corie Anderson, MEEA
canderson@mwalliance.org