Dynamic Response to Changing Energy Codes

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the energy practice of EYP Inc.

Dynamic Response to Changing Energy Codes

Learning Objectives

At the end of this presentation participants will be able to:

1. Recognize how code changes have impacted energy savings over time
2. Understand the various paths through the standard and tradeoffs
3. Identify the major changes between the ASHRAE 90.1-2004 Standard and the 2010 Standard
4. Identify strategies to go above and beyond the current 2010 standard
5. Understand future trends of Standard and Codes

Dynamic Response to Changing Energy Codes

Special Statements

- Not intended to be a comprehensive evaluation of how to meet new code requirements
- Will focus on the ASHRAE 90.1 path through IECC
- We are not code officials

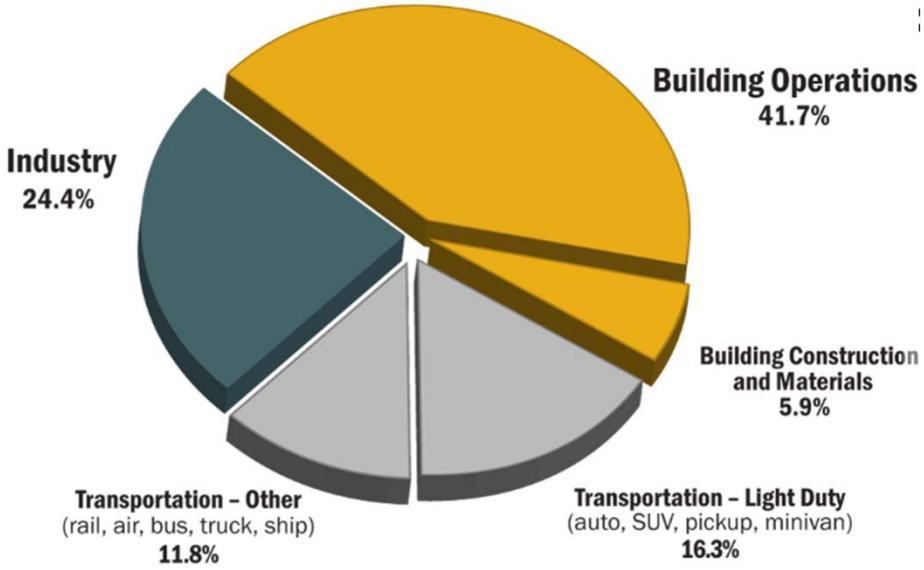
Talk Overview

- History
- Code Structure
- Key Changes
- Compliance Paths
- Measured Impact
- Case Study
- Future Requirements
- Conclusions and References

History

Energy Code Background

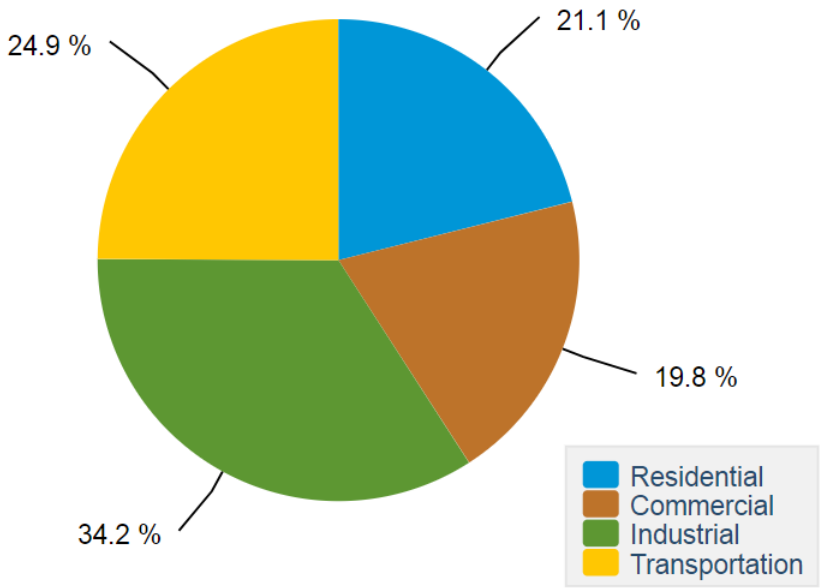
Energy Use



U.S. Energy Consumption by Sector

Source: ©2013 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2012).

Minnesota Energy Consumption by End-Use Sector, 2015



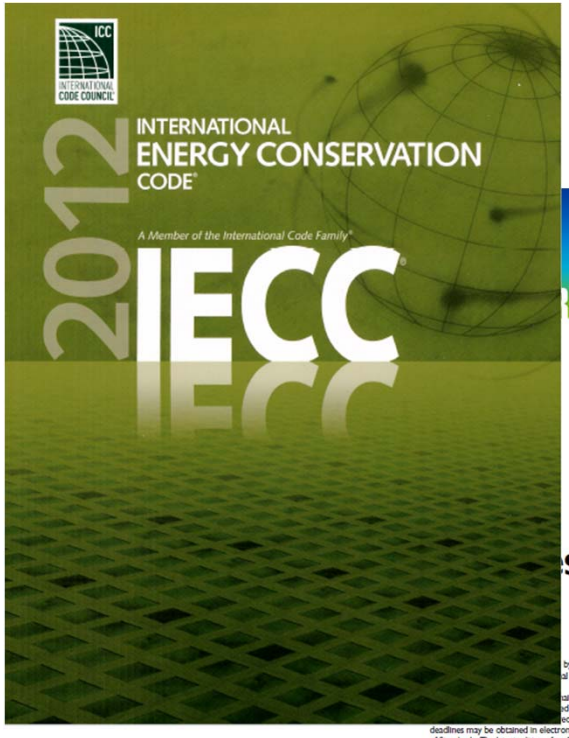
eia Source: Energy Information Administration, State Energy Data System

Energy Code Background

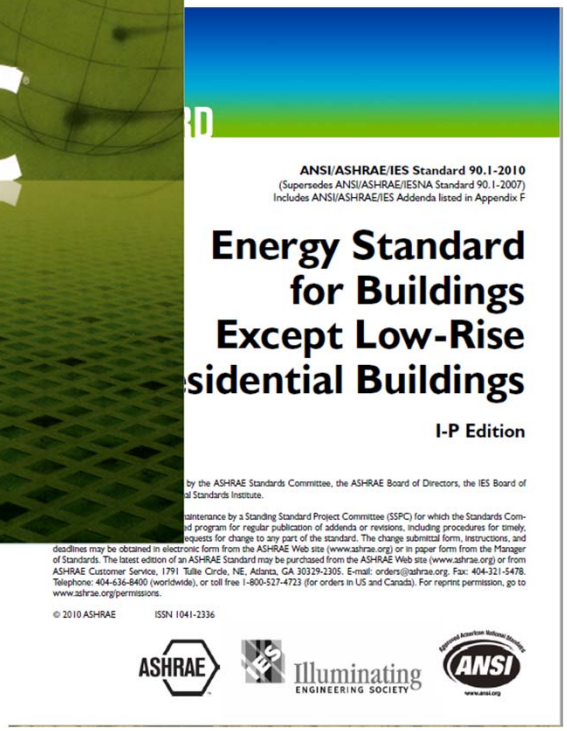
Impact of Changing Energy Codes

Energy Code Structure

- Minnesota has adopted IECC 2012 for both commercial and residential buildings
- IECC is the International Energy Conservation Code
- IECC references ASHRAE Standard 90.1-2010
- As a designer you may comply with either IECC 2012 or ASHRAE 90.1-2010
  - You must choose one in its entirety!
  - Today we will focus on ASHRAE 90.1-2010
- Minnesota also has State-specific amendments



Source: ICC, IECC (2012)



Source: ASHRAE (2010)

Energy Code Background

Scope

- Residential and Commercial Buildings
  - New Buildings and Systems
  - Existing Buildings
    - Additions: New *portions* of buildings and systems
    - Alterations: New systems and equipment in *existing* buildings
  - *Exceptions – limits to scope*
    - No Low-rise Residential - (in Standard 90.2)
    - Only for buildings using electricity or fossil fuel
    - Not for equipment and portions of building systems that use energy primarily for industrial, manufacturing or commercial processes

ASHRAE Standard 90.1 Structure

SECTIONS

1 Purpose
2 Scope
3 Definitions, Abbreviations, and Acronyms
4 *Administration and Enforcement*
5 Building Envelope
6 Heating, Ventilating, and Air-Conditioning (HVAC)
7 Service Water Heating
8 Power
9 Lighting
10 Other Equipment
11 *Energy Cost Budget (ECB) Method*
12 Normative References

SUBSECTION

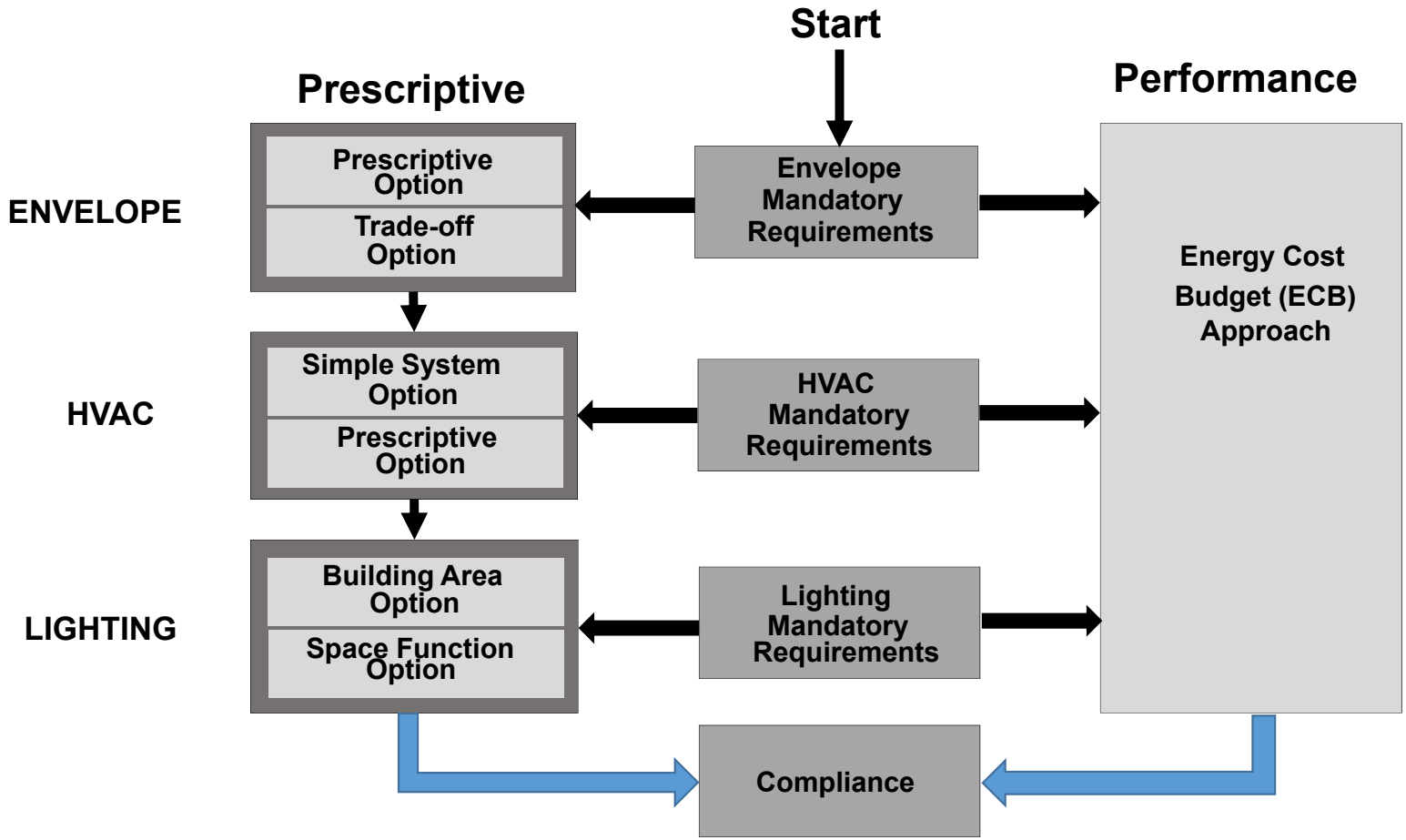
X.1 General
X.2 Compliance Paths
X.3 Simple Buildings or Systems
X.4 Mandatory Requirements
X.5 Prescriptive Requirements
X.6 Alternate Compliance Path
X.7 Submittals
X.8 Products

Compliance Paths

- **Prescriptive** – Comply with separate building envelope, HVAC, service water heating, power, lighting, and other equipment
  - Some trade-offs allowed
  - ComCheck is a prescriptive path
- **Performance** - Energy Cost Budget (ECB) & Total Building Performance (TBP) allowing trade-offs between systems
  - Requires energy modeling
- **Performance Rating Method** – Not currently an alternative compliance path; used to quantify building performance beyond standard
  - LEED
  - Utility program baselines

ASHRAE Standard 90.1 Structure

Paths to compliance



Key Changes

Summary of Updates

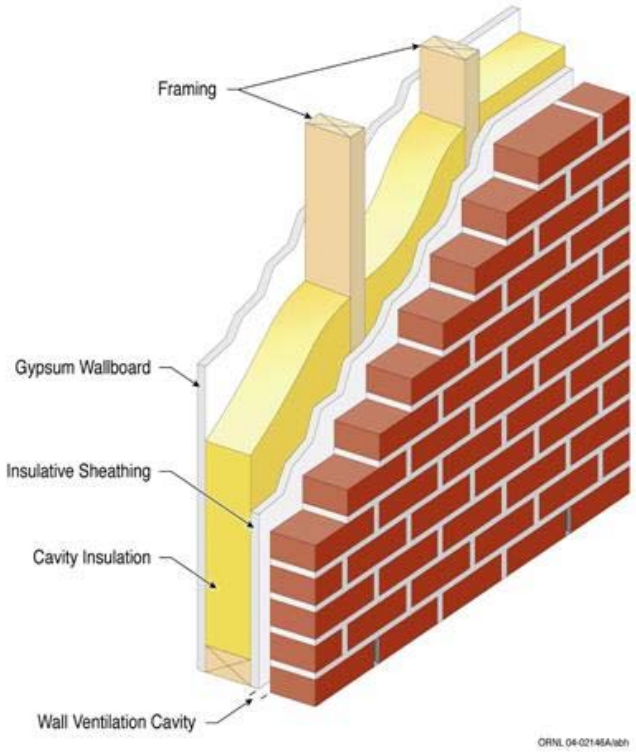
ASHRAE 90.1-2010

Building envelope	
roof/wall insulation	Major change
glazing	Major change
skylights	Major change
Heating, ventilation & air conditioning	
equipment control	Major change
required equipment	Major change
required efficiencies	Major change
Service hot water	No changes
Power/plug load control	Major change
Lighting	
controls	Major change
automatic daylighting controls	Major change
lighting design	Varies by space type
Motor efficiency	Minor change

Building Envelope

Summary of Changes

Design Feature	The Change
Increased insulation	Code level assembly insulation values increased: Walls: Steel Framed: R-11.9 to R-15.6 Mass Wall: R-9.6 to R-12.5 Roof: Metal deck: R-15.9 to R-20.83
Air leakage	The entire envelope shall be designed and constructed with a continuous air barrier

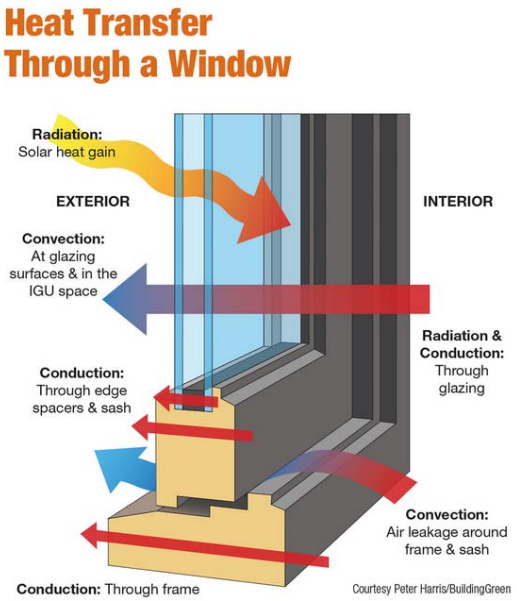


Further Resources:
ASHRAE RP-1365
BC Hydro

Building Envelope

Summary of Changes

Design Feature	The Change
Glazing	Broken out by window type: Curtainwall: U-0.45 Metal Frame: U-0.55 Nonmetal Frame: U-0.35 SHGC: 0.40 All 40% WWR
Skylights	No change in performance requirements Given certain criteria a minimum skylight fenestration area is required Not required for climate zones 6-8



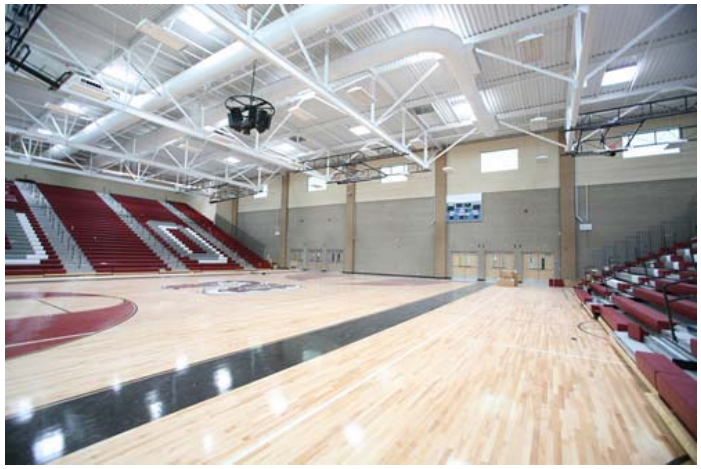
Building Envelope

A closer look…minimum skylight fenestration area

- A skylight is required in any *enclosed space* in a building that is four stories or less and:
  - 5,000 sq. ft. and greater, ≤ 4 stories
  - directly under a roof with a ceiling height over 15 ft
  - is one of the following spaces:

office	lobby	atrium
distribution / sorting area	non-refrigerated warehouse or storage	gymnasium / exercise center
convention center	automotive service	manufacturing
retail	concourse	transportation
	workshop	

- Example
- 5,000 sq. ft. gymnasium in a two story high school with a ceiling height of 20 feet
  - Skylights required?
    - ASHRAE 90.1–2004: NO
    - ASHRAE 90.1–2010: YES, unless you are in Minnesota



HVAC

Summary of Changes

Design Feature	The Change
Enclosed parking garage ventilation	CO sensor control will be required for garage ventilation fans to 50% flow
Single Zone VAV Controls	Large single zone VAV turn down to 50% supply flow on hydronic systems, 2/3 flow on DX
Ventilation Control	40 people/1000ft^2
Economizer control	Required for ≥54,000 Btu/h
Hydronic variable flow systems	> 10 hp pump systems to will require variable speed control to 50% flow
Supply air temperature reset	Reset SAT at least 25% of difference between DSAT and DRAT
Exhaust air energy recovery	heat recovery requirements based on percent OA and total supply air
Kitchen/dining facilities	require increased control or heat recovery if exhausting more than 5,000 cfm

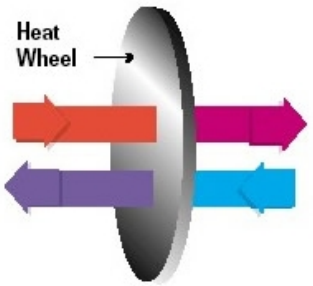
HVAC

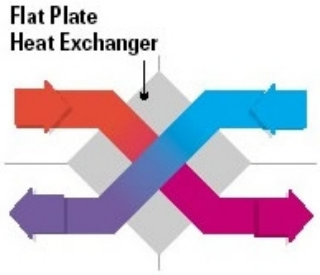
A closer look… exhaust air energy recovery

- Exhaust air energy recovery required when the following conditions are met:

Supply Air CFM		Outside Air %
Climate Zone		
6A	7	
≥5500	≥2500	30 - 40
≥4500	≥1000	40 - 50
≥3500	>0	50 - 60
≥2000	>0	60 - 70
≥1000	>0	70 - 80
>0	>0	> 80

- Example
- Air handling system providing 6,000 CFM of supply air, 35% outside air
  - Exhaust air energy recovery required?
    - YES with at least 50% effectiveness





HVAC

Summary of Changes

Design Feature	The Change
Lab Exhaust System	Lab exhaust requirements dropped from 15,000 cfm to 5,000 cfm
Improved DX cooling efficiencies	Code level DX cooling efficiencies increased 5%-15% depending on the size and heating type
Chiller efficiencies	Efficiencies similar, more emphasis on part load, two paths to compliance
VRF/VRV	Efficiencies added

HVAC

A closer look… chiller efficiencies

TABLE 6.8.1C Water Chilling Packages—Efficiency Requirements[a]

Equipment Type	Size Category	Units	Path A		Path B		Test Procedure[c]
			Full Load	IPLV	Full Load	IPLV	
Air-Cooled Chillers	<150 tons	EER	≥9.562	≥12.750	NA[d]	NA[d]	AHRI 550/590
	≥150 tons	EER	≥9.562	≥12.750	NA[d]	NA[d]	
Water-Cooled, Electrically Operated, Positive Displacement	<75 tons	kW/ton	≤0.780	≤0.630	≤0.800	≤0.600	
	≥75 tons and <150 tons	kW/ton	≤0.775	≤0.615	≤0.790	≤0.586	
	≥150 tons and <300 tons	kW/ton	≤0.680	≤0.580	≤0.718	≤0.540	
	≥300 tons	kW/ton	≤0.620	≤0.540	≤0.639	≤0.490	
Water-Cooled, Electrically Operated, Centrifugal	<150 tons	kW/ton	≤0.634	≤0.596	≤0.639	≤0.450	
	≥150 tons and <300 tons	kW/ton	≤0.634	≤0.596	≤0.639	≤0.450	
	≥300 tons and <600 tons	kW/ton	≤0.576	≤0.549	≤0.600	≤0.400	
	≥600 tons	kW/ton	≤0.570	≤0.539	≤0.590	≤0.400	

Service Hot Water and Power

Summary of Changes

Design Feature	The Change
Service hot water	No significant changes
Power	Automatic plug load control, automatic receptacle control, at least 50% of all 125 volt, 15 and 20 ampere, receptacles in private offices, open offices and computer classrooms shall be controlled by an automatic control device
Power – Elevators	Standby mode for ventilation fans and lighting Lighting efficacy of not less than 35 lumens/Watt
Motors	Small improvement in effeciency
Transformers	Efficiency requirements added for low voltage transformers

Lighting

Summary of Changes

Design Feature	The Change
Lighting control	Any automatic control device shall be manual on or only automatically on to 50% - exceptions apply
Space control	All controlled lighting shall have at least one control step between 30% and 70% in addition to all off, dual level switching is required
Parking garage lighting control	Parking garage lighting is required to have automatic control to reduce power of each luminaire by 30% when no activity is detected for 30 minutes
Automatic daylighting controls for primary sidelighted areas	When sidelighted area is equal to or exceeds 250 sf, the lamps must be controlled with a photosensor and contain at least one control step that is between 50% and 70% and another to no greater than 35%

Lighting

Summary of Changes

Design Feature	The Change
Automatic daylighting controls for toplighting	when the daylight area under the skylights or roof monitors exceeds 900 s.f., the lamps must be controlled with a photosensor and contain at least one control step that is between 50% and 70% and another to no greater than 35%
Lighting power densities using the space-by-space method	reduced lighting power densities for most spaces, average 13% reduction Incorporation of room cavity ratio (RCR), which allows for increased lighting power density allowances based on room geometry
Lighting power densities using the building area method	reduced lighting power densities for most spaces ~15% average reduction
Individual lighting power allowances for building exteriors	reduced lighting power allowances for most exterior areas zone allowance of additional 0-1300 Watts

Lighting

Summary of Changes

Common Space Types	ASHRAE/IES 90.1-2004 (W/SF)	ASHRAE/IES 90.1-2010 (W/SF)	RCR Threshold 90.1-2010
Office - Enclosed	1.1	1.11	8
Office - Open Plan	1.1	0.98	4
Conference/Meeting/ Multipurpose	1.3	1.23	6
Classroom/Lecture/ Training	1.4	1.24	4
Dining Area	0.9	0.65	4
Restrooms	0.9	0.98	8
Corridor/Transition	0.5	0.66	width <8ft
Active Storage	0.8	0.63	6
Electrical/Mechanical	1.5	0.95	6
Exercise Area	0.9	0.72	4

$$RCR = 2.5 \times \frac{Room\ Cavity\ Height \times room\ perimter\ length}{room\ area}$$

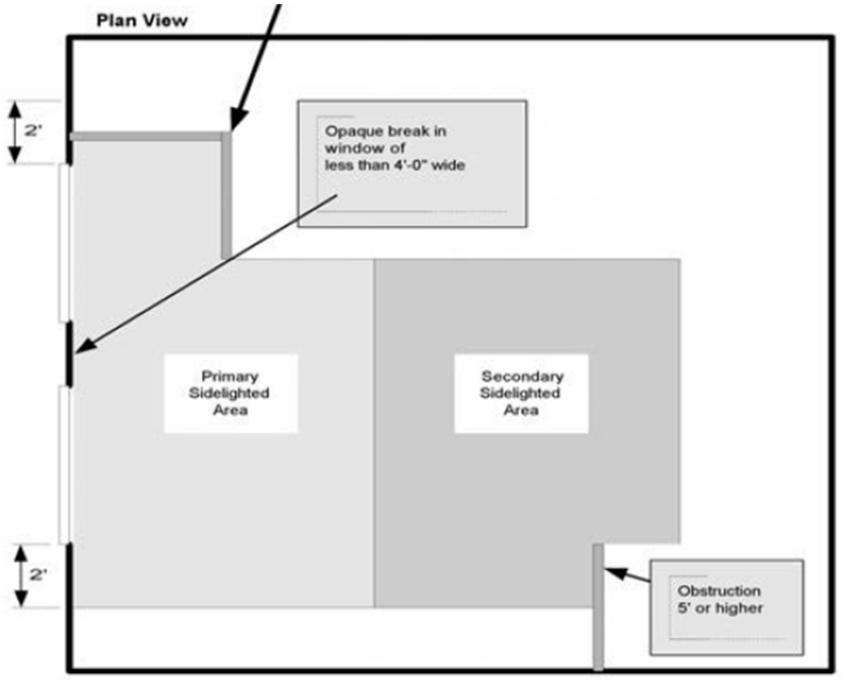
$$Room\ Cavity\ Height = Luminaire\ mounting\ height\ - Workplane$$

$$LPD\ increase = Base\ space\ LPD \times 0.20$$

Lighting

A closer look…automatic daylighting (side lighted)

- When primary sidelighted area in an enclosed space equals or exceeds 250 sf the lamps shall be controlled by at least one multi-level photocontrol. The multi-level photocontrol must reduce electric lighting in response to available light with at least one control step between 50% and 70% and another control step no greater than 35%.



Source: ASHRAE (2010)

Talk Overview

- History
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- Measured Impact
- Case Study
- Future Requirements
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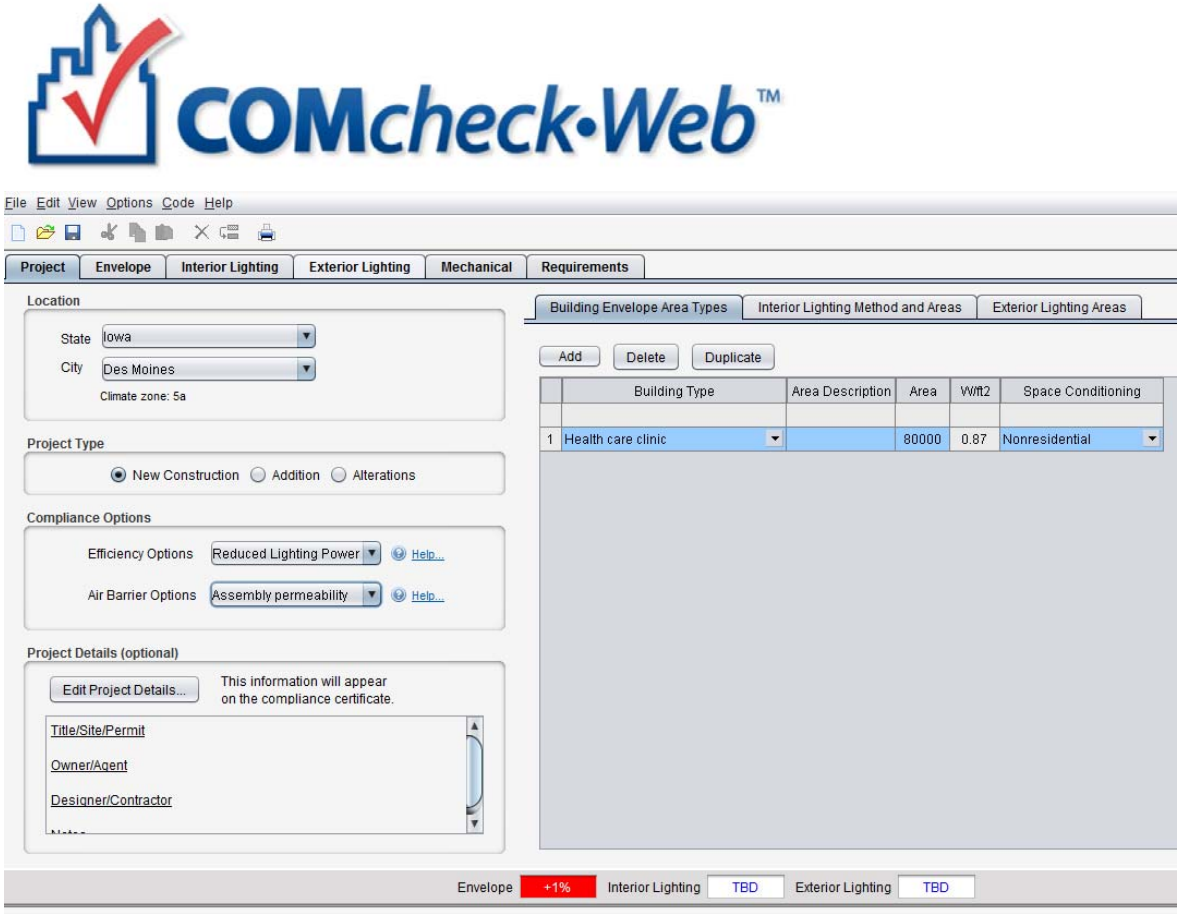
Prescriptive Path

Prescriptive Path

- Requires mandatory items be met
- Each discipline meets the their associated requirements



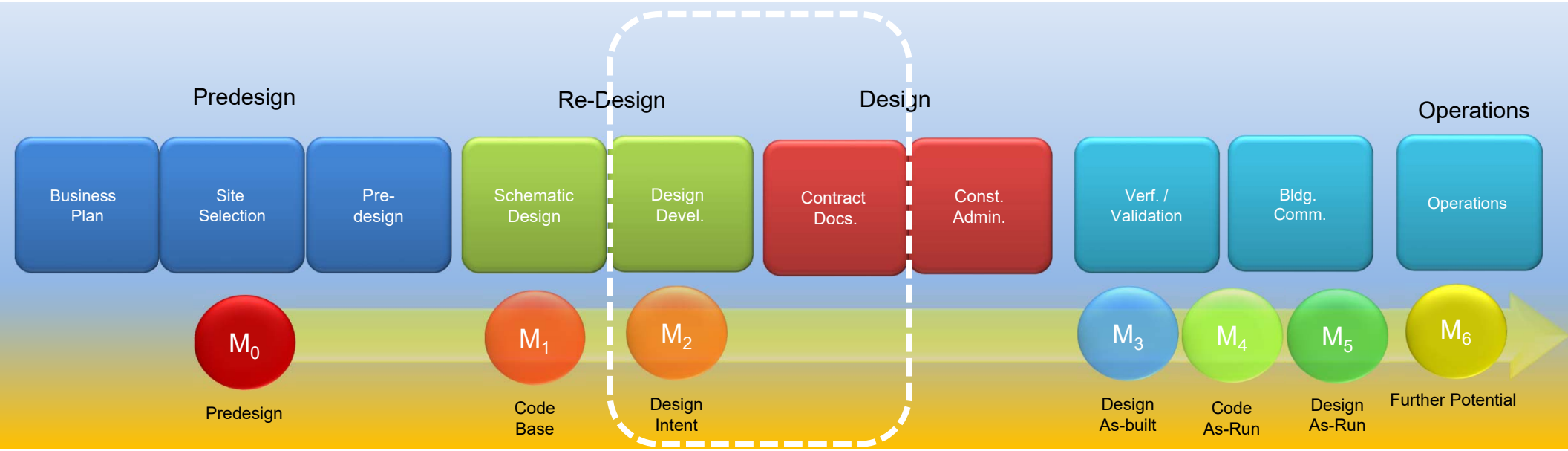
Performance Path

Performance Path

- Requires mandatory items be met
- Tradeoff amongst disciplines
- Facilitates integrated design

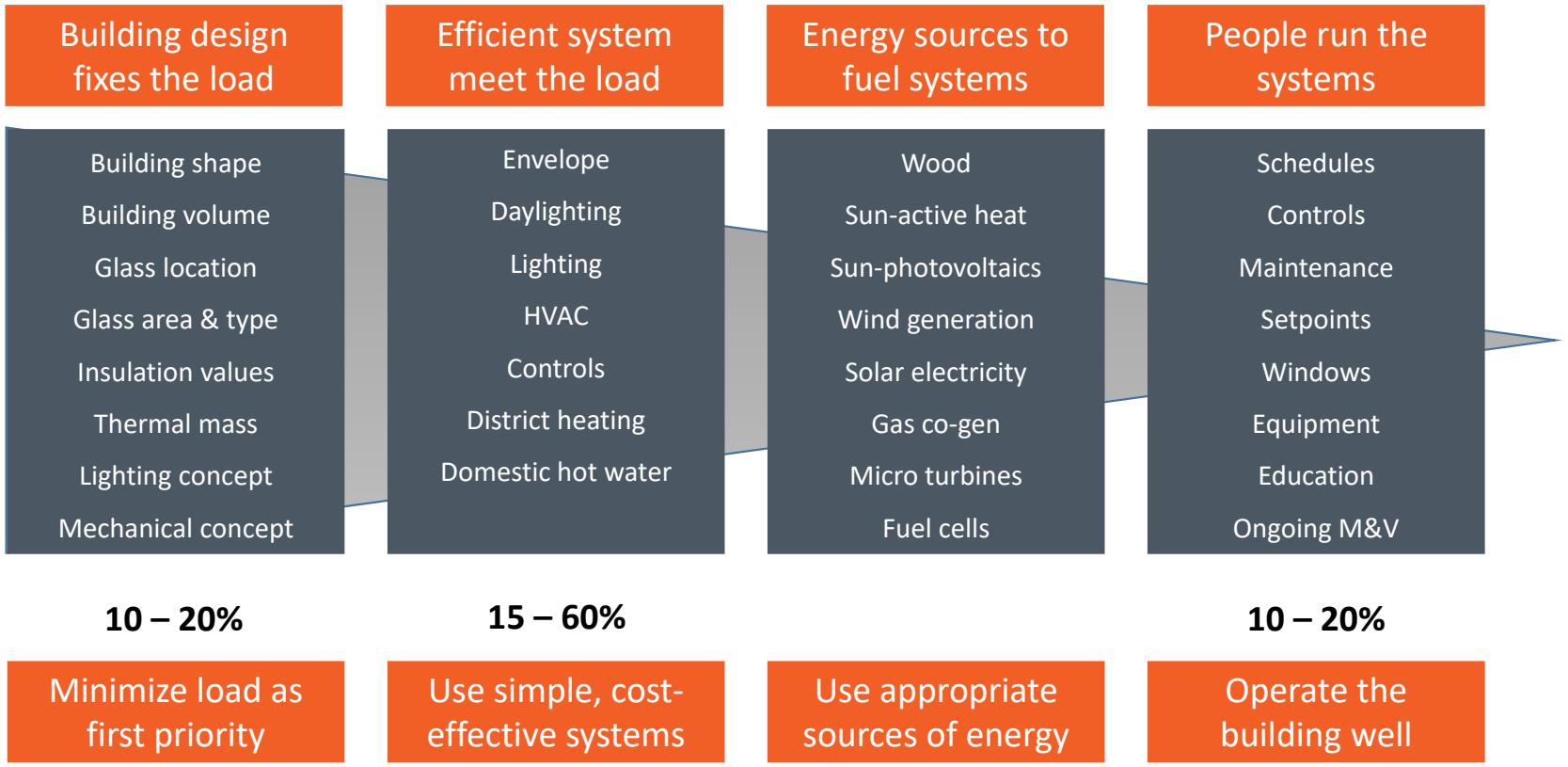
Performance Path

Evaluation throughout project



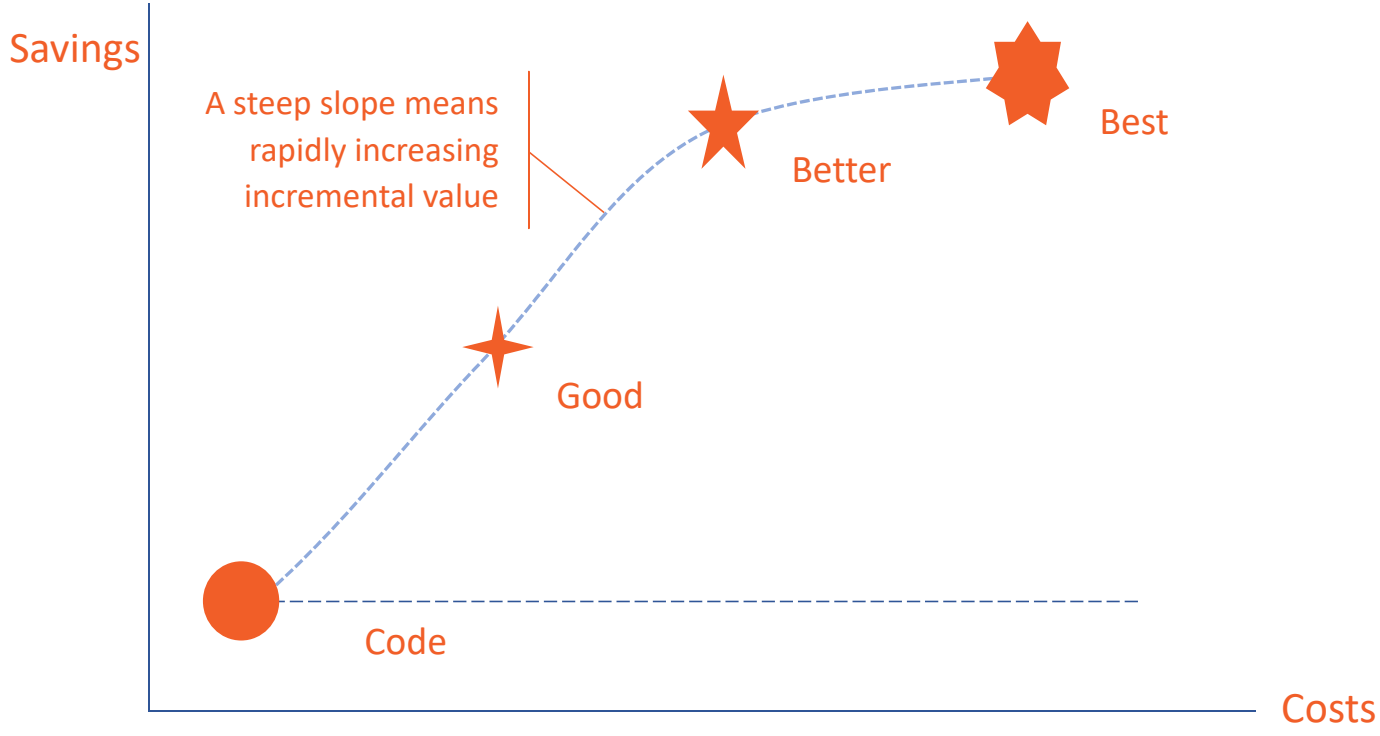
Meeting the Performance Path

Energy Impacts



Going Beyond Code

Spending the Right Amount in Each Category of Savings

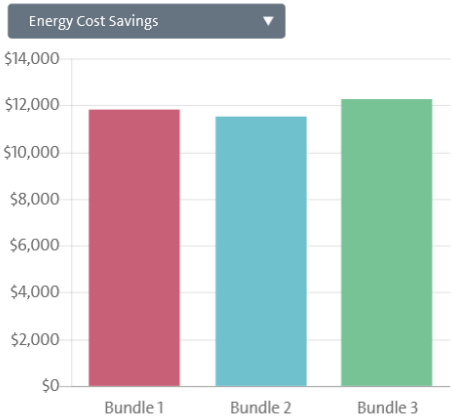


Going Beyond Code

Early Energy Modeling – Analyzing more with less

A Scenario A ▼ Calculate

Savings vs Baseline	1 Bundle 1	2 Bundle 2	3 Bundle 3
Energy Cost Savings	$11,838 25%	$11,537 25%	$12,238 26%
Peak Electric Savings (kW)	22.5 20%	21.1 19%	23.5 21%
Electric Savings (kWh)	82,790 25%	79,830 24%	84,670 25%
Gas Savings (Therm)	1,900 35%	1,994 37%	2,097 39%
Incremental First Cost	$63,438	$60,819	$78,561
Projected Incentive	$11,314	$11,000	$12,160
Net Incremental First Cost	$52,124	$49,819	$66,401
Payback with Incentive (yr)	4.4	4.3	5.4
Energy Use Intensity (kBtu/ft²/yr)	58.0	58.0	56.7



Strategy Selection

Tab by Area | Tab by Category | No Tabs | Filter | Synced with B

Mechanical | **Architectural** | Lighting | Plug Loads | Service Water Heating

Strategy	Savings vs Proposed: Electric Peak kW	Electric kWh	Gas Therm	Energy Cost	Inc. Cost	Payback yrs	Bundles
Glazing high solar gain w/ argon, metal frame	0.3	207	226	$206	$6,318	30.7	1 2 3
Glazing medium solar gain w/ argon, metal frame	0.7	690	176	$231	$7,447	32.2	1 2 3
Glazing medium solar gain, improved metal frame	0.7	691	207	$257	$8,520	33.2	1 2 3
Glazing medium solar gain triple pane, metal frame	1.1	994	283	$361	$13,968	38.7	1 2 3

Code Impact

Energy Savings

National Energy Savings for 90.1-2010

- PNNL Progress Indicator
- 8 building types
  - 17 subcategories
- Target of 30% savings over 90.1-2004

National-weighted Energy Savings	With Receptacle Loads	Without Receptacle Loads
Site Energy	25.5%	32.6%
Energy Cost	24.0%	30.1%

Source: PNNL Progress Indicator

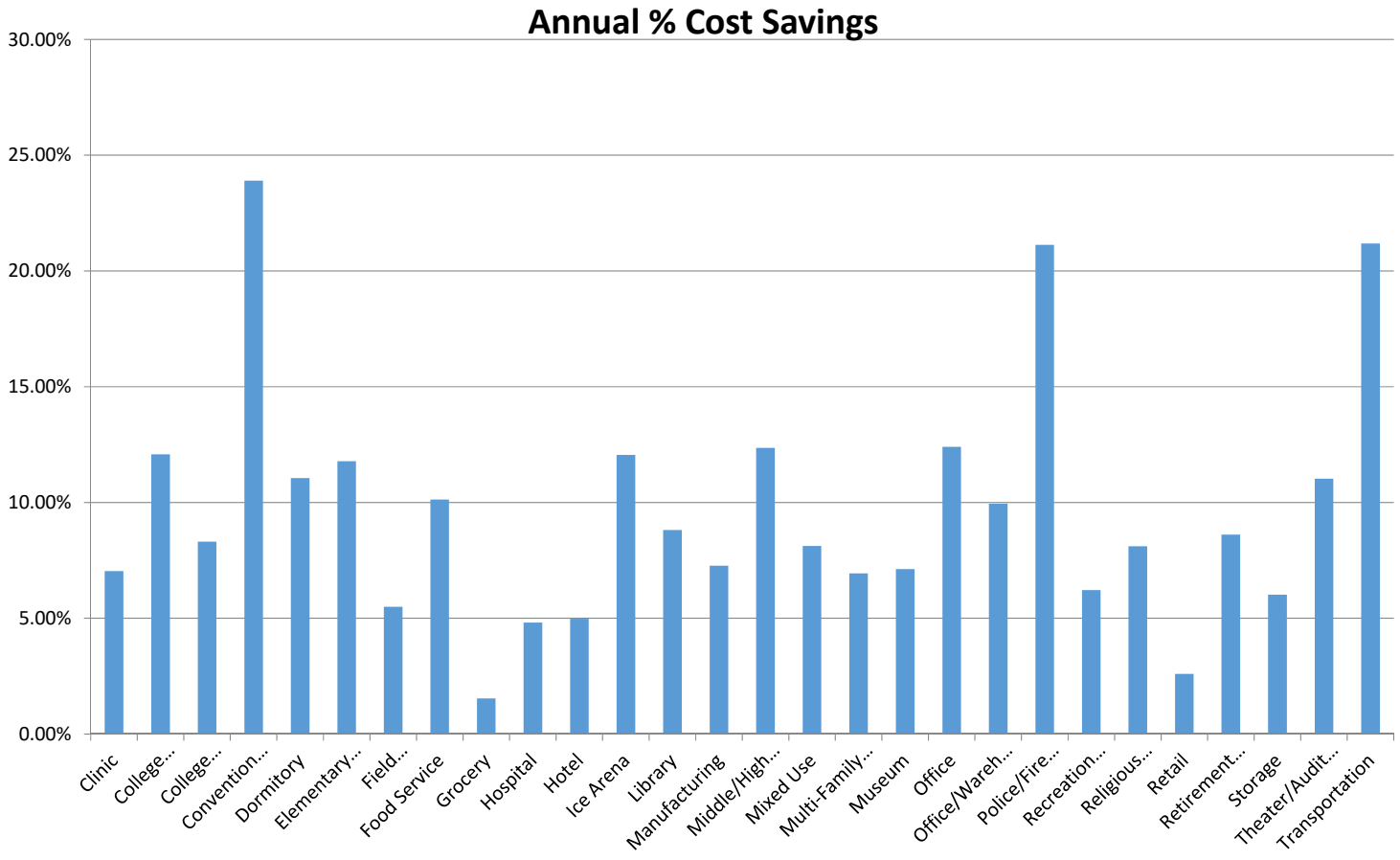
Energy Savings

Minnesota Energy Savings for 90.1-2010

- Compared projects using 2004 standard to 2010
- 226 projects evaluated
  - 34 building types
  - ~27,000,000 sf
- Results:
  - 8.8% Annual Cost Savings
  - 7.4% Energy Saving
  - 9.7% Annual kW Savings
  - 10.9% Annual kWh Savings
  - 5.2% Annual Gas Savings

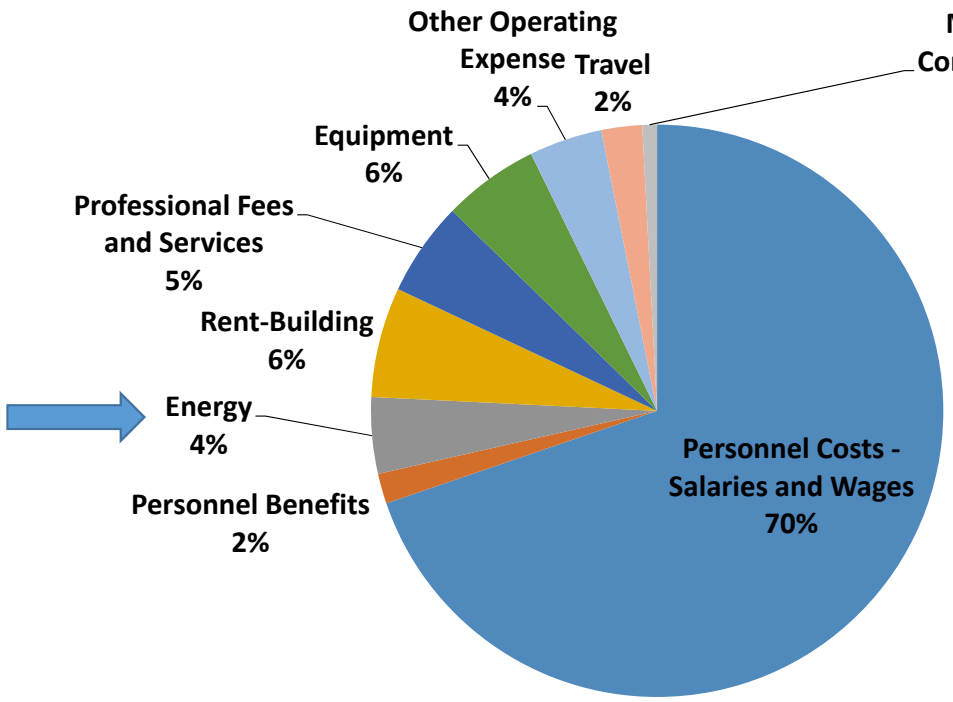
Energy Savings

Minnesota Energy Savings for 90.1-2010



Energy Savings

Sample Annual Operating Budget



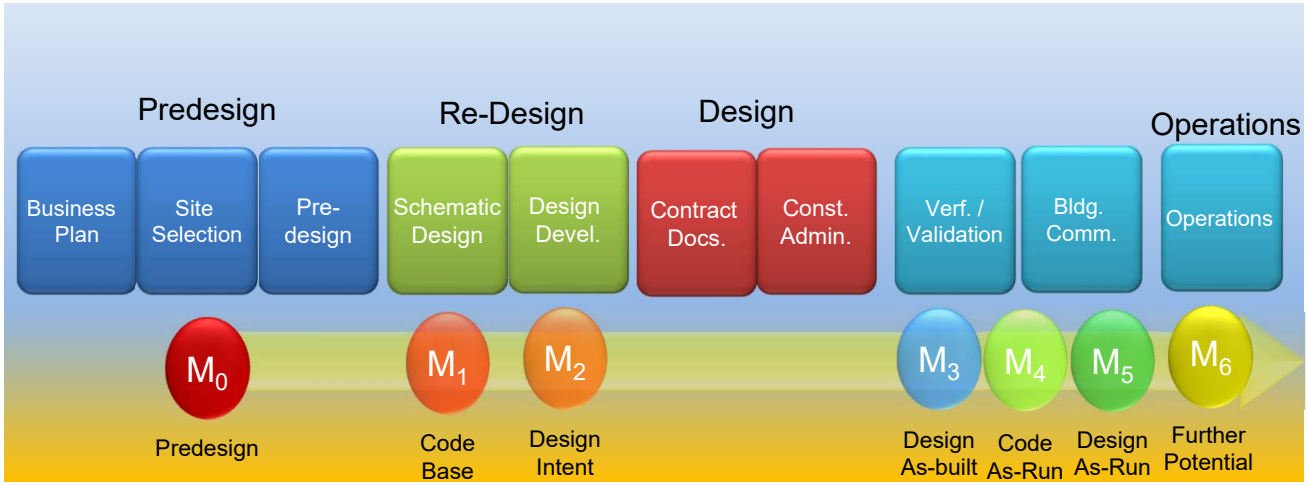
- Improve worker productivity
- Reduce glare
- Increase passive solar heat
- Enhanced productive daylit space
- Higher occupancy rates
- Higher lease and sales rates
- Longer life equipment
- Reduced equipment run times
- Empowered operating staff with data to drive performance

Case Study

Case Study

Dynamic Energy Design

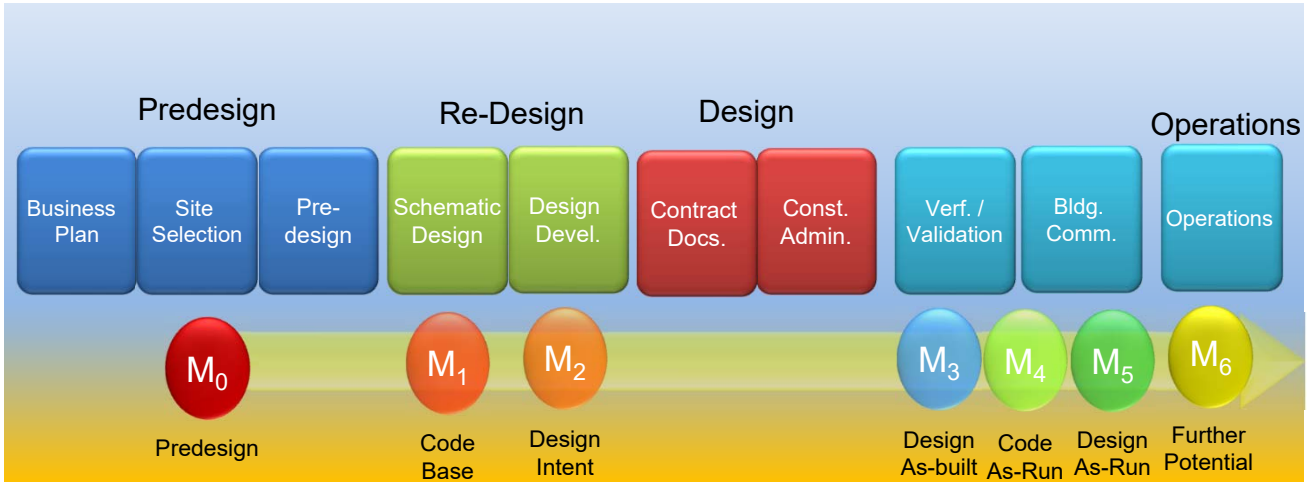
- Office building
- Very large financial corporation
- Stand-alone systems
- High performance goals



Case Study

Dynamic Energy Design

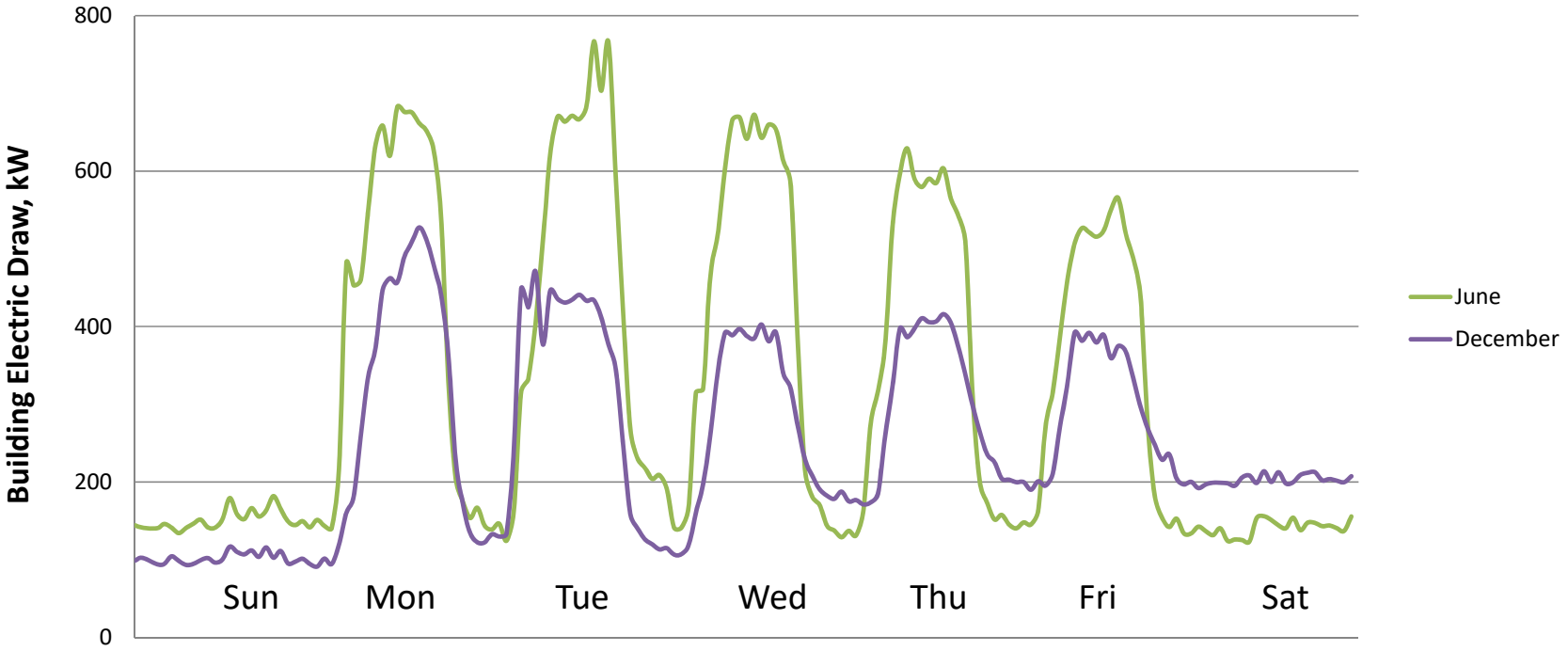
- Insulation
- Thermal glass
- Lighting controls
- LEDs
- Low flow fans
- Thoughtful control sequences
- Energy recovery
- High efficiency boilers and chillers
- Integrated to operation



Case Study

Dynamic Energy Design

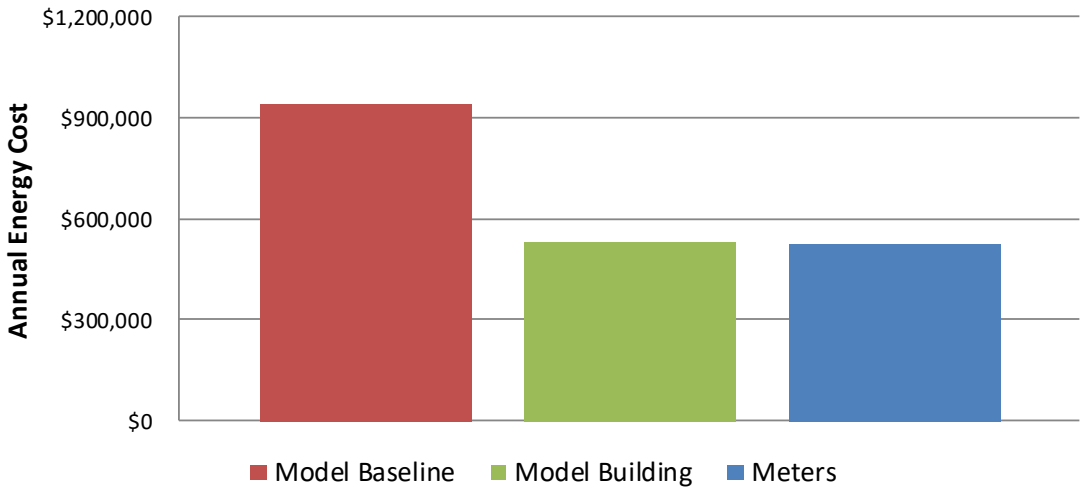
- Energy management



Case Study

Dynamic Energy Design

- Verified energy cost savings
- 44% compared to baseline
- $0.80 per square foot
- How can that saved money be used for the business?
- How motivating to maintain the savings!



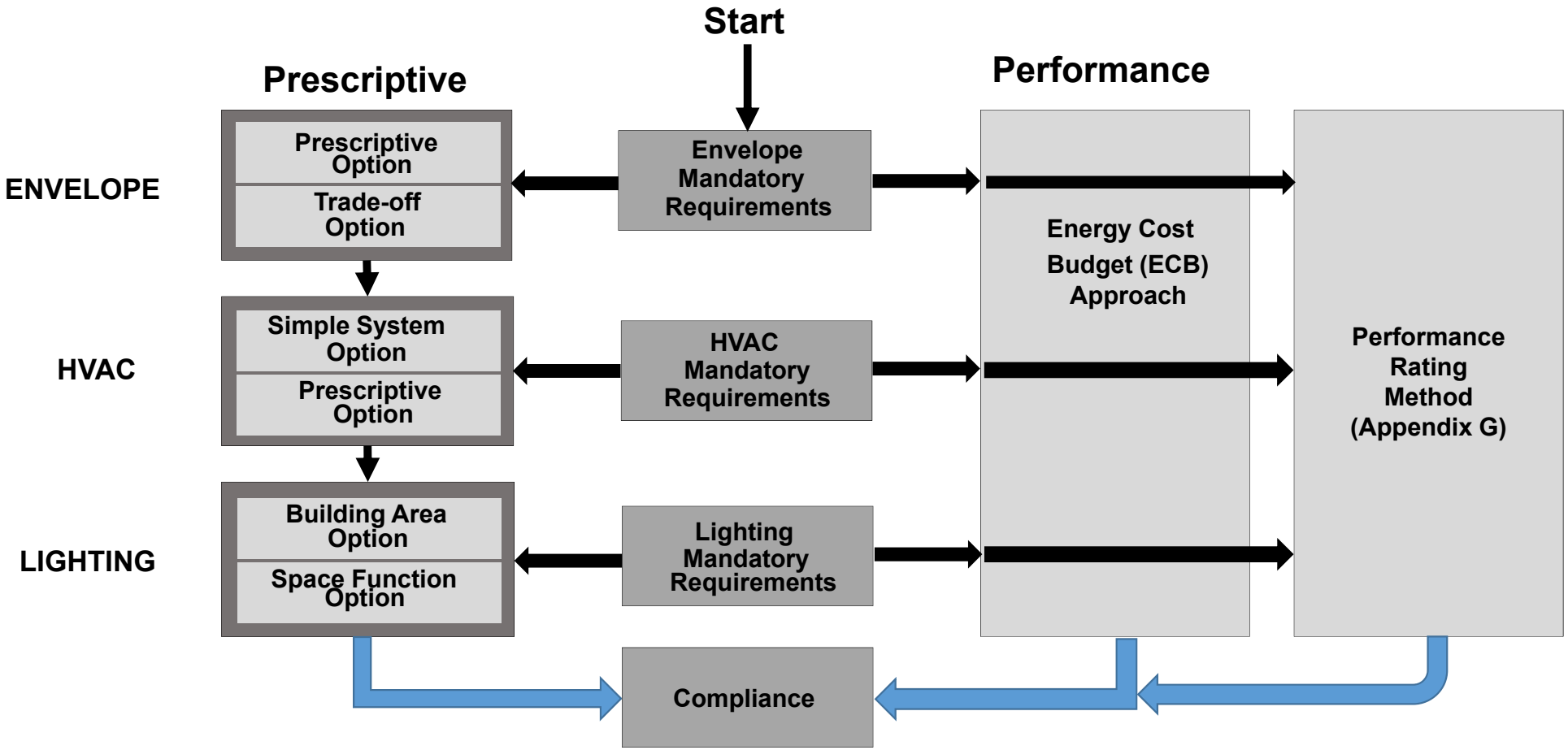
Future Code Requirements

What's On The Horizon

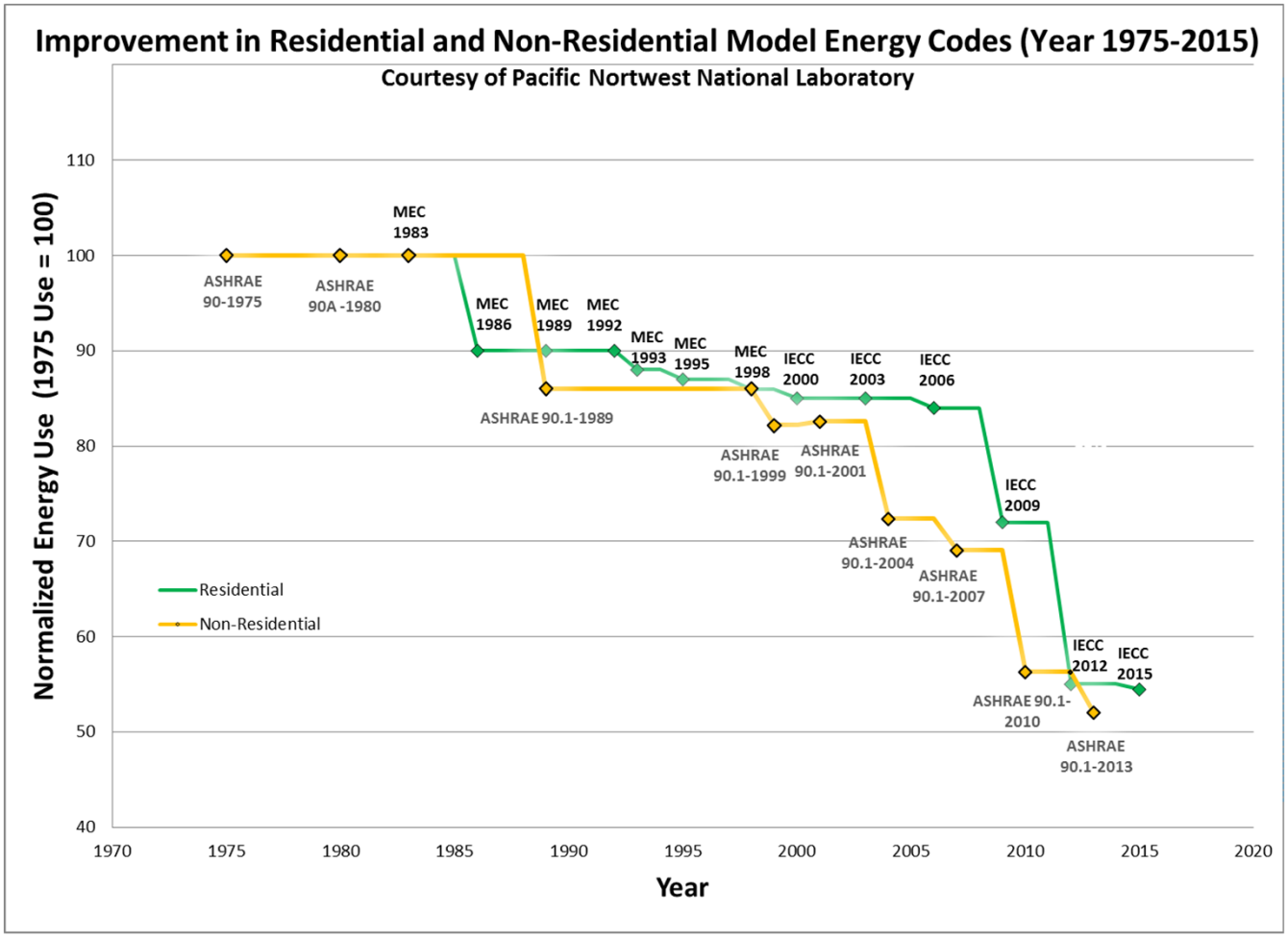
- Reduced interior and exterior lighting
- Lighting controls
- Elevator efficiencies
- Efficiency requirements for DOAS systems
- Water efficiency?
- Coordination with 90.4 – Data Centers

What's On The Horizon

Addendum BM – Performance rating method as a compliance path



Future Codes



Resources

Where can I go for help?

- User's Manual
- ASHRAE Interpretations
- ASHRAE Errata
- Get involved – committees, submit CMPs

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Thank You

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