OREGON HOUSING & COMMUNITY SERVICES

Multifamily Energy Program

A Multifamily Overview of the 2019 Oregon Zero Energy Ready Commercial Code

Date: May 28, 2020, 10am – 12pm

Presenters: Mekha Abraham | OR-MEP

Blake Shelide | Oregon Department of Energy

OREGON HOUSING and COMMUNITY SERVICES

TRC

OREGON DEPARTMENT OF ENERGY

USING ZOOM WEBINAR

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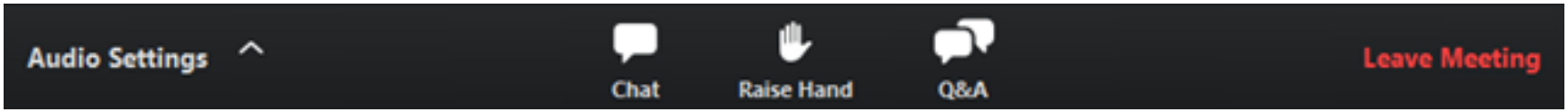

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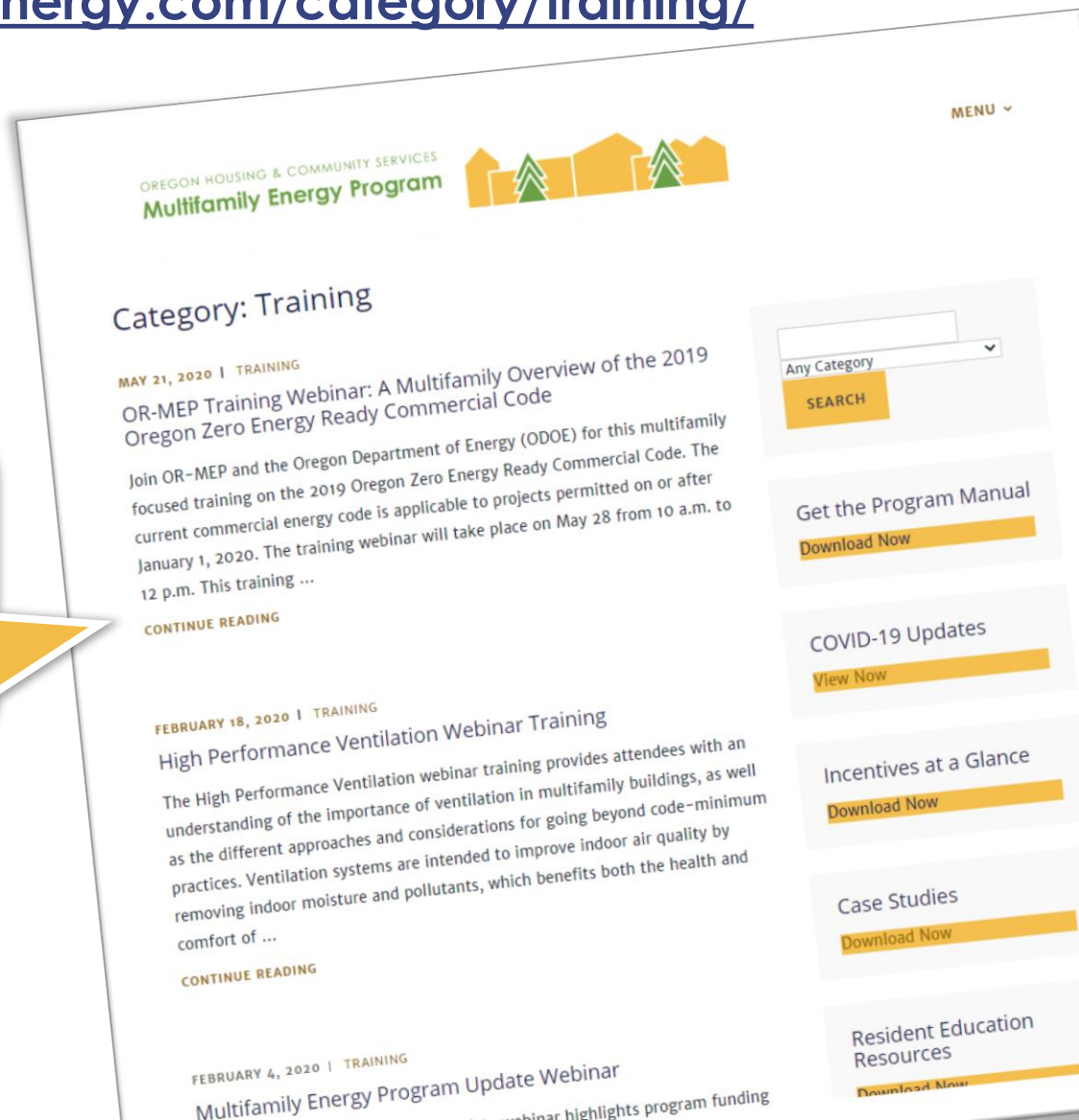


MEET THE TRAINER

Blake Shelide, PE

Facilities Engineer | Oregon Department of Energy

AGENDA

- **OR-MEP Introduction (Mekha)**
  - Key Energy Code Considerations for Program
- **2019 Code Overview (Blake)**
  - History / Timeline
  - What's Changed Since Last 2014 Code?
  - Compliance Options
  - Prescriptive Requirements by Building Component – Typical Multifamily Conditions

OR-MEP INTRODUCTION

- OR-MEP Overview + Program Pathways
- Key Energy Code Considerations for Program

ABOUT OR-MEP

The OHCS Multifamily Energy Program (OR-MEP) provides incentives for energy efficiency measures that results in ELECTRIC SAVINGS

Existing Building

New Construction

Qualifying Energy Efficiency Measures

The OHCS Multifamily Energy Program provides incentives for energy efficiency measures that results in electric savings, including the following:

PROGRAM PATHWAYS

PATH 1: MENU

Are you looking to improve a few elements of your property?

Select measures from a menu.

Incentive Range (per unit):
$15 - $1,300

PATH 2: BUNDLED

Are you planning to go beyond basic improvements?

Choose a bundle of measures for additional savings.

Incentive Range (per unit):
$200 - $1,500

PATH 3: WHOLE BUILDING

Are you looking to boost your incentive and efficiency?

Maximize savings through a customized whole building approach.

Incentive Range (per unit):
$500 - $3,000

Incentive ranges are estimates only based on current program activity.

For NC or Gut-Rehab project, knowledge of energy code requirements needed for baseline modeling in Whole Building Path.

WHOLE BUILDING PATH

New Construction

TIER	SAVINGS THRESHOLD	NEW CONSTRUCTION INCENTIVE
Tier 1	≥20% kWh savings compared to code baseline	$0.80 per kWh saved
Tier 2	≥25% kWh savings compared to code baseline	$0.90 per kWh saved
Tier 3	≥30% kWh savings compared to code baseline	$1.00 per kWh saved

For NC or Gut-Rehab project, knowledge of energy code requirements needed for baseline modeling in Whole Building Path.

OR-MEP NC WHOLE BUILDING PATH REQUIREMENTS – OREGON CODE BASELINE

The baseline energy use modeled should follow the energy code requirements of the specific project as follows:

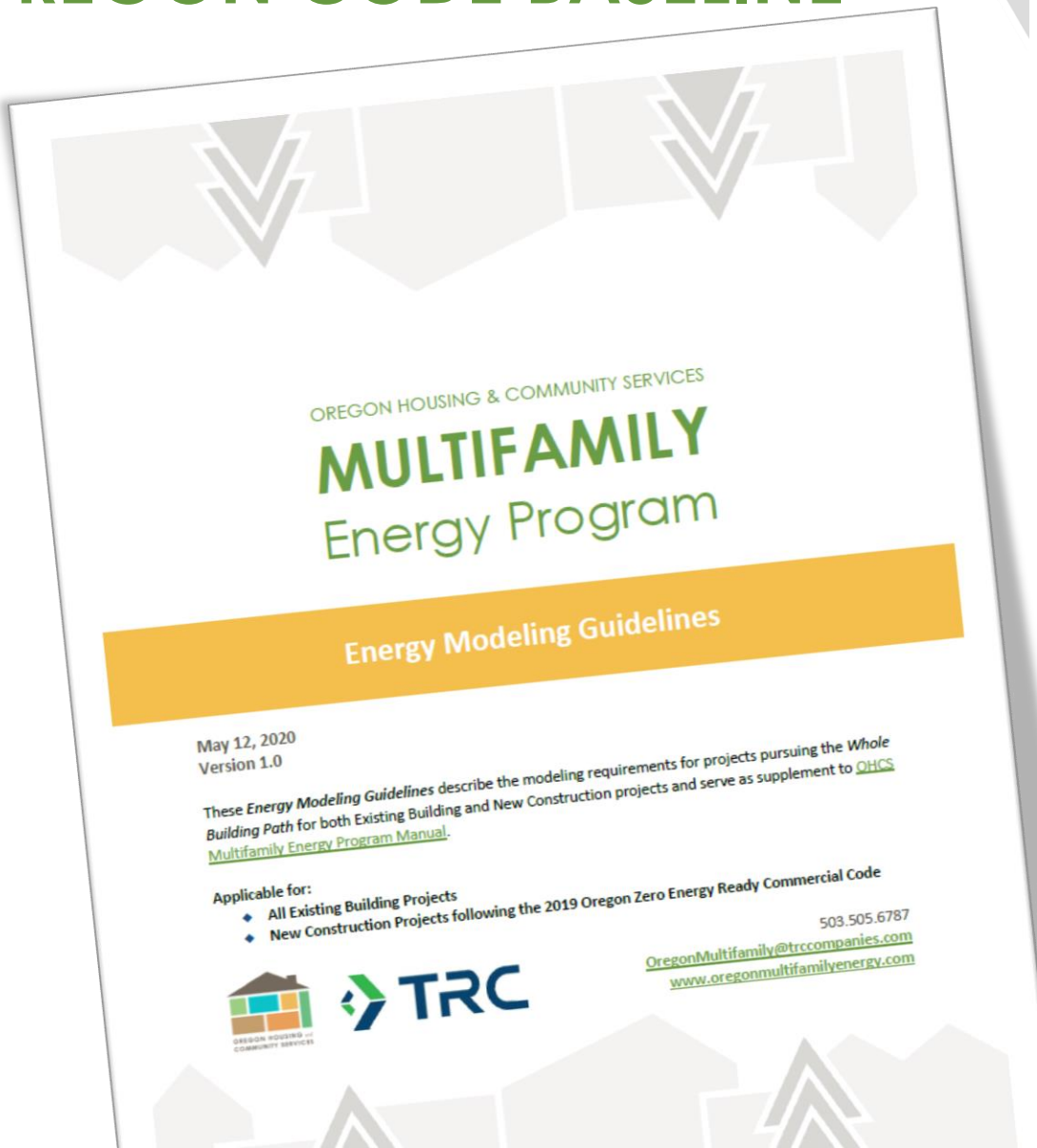
- **Project permitted on or after January 1, 2020 shall follow the 2019 Oregon Zero Energy Ready Commercial Code (Chapter 13 of the 2019 OSSC)[1].**
  - Part I – Commercial Energy Provisions: Part I applies to buildings constructed under the OSSC that are not Group R-2, R-3, or R-4 buildings, three stories and fewer above the finished grade. The construction standards are based on ASHRAE Standard 90.1-2016.
  - Part II – Multi-family Energy Provisions: Part II applies to Group R-2, R-3, and R-4[2] buildings three stories and fewer above the finished grade designed and constructed under the OSSC. The construction standards are based on 2018 International Energy Conservation Code

[1] Oregon Building Code Division: https://www.oregon.gov/bcd/codes-stand/Pages/energy-efficiency.aspx

[2] Refer to 2019 Oregon Structural Specialty Code, Chapter 3, Section 310 for complete Residential Group R definitions.

OR-MEP NC WHOLE BUILDING PATH REQUIREMENTS – OREGON CODE BASELINE

- Refer to OR-MEP Energy Modeling Guidelines for guidance on baseline energy code requirements.



OREGON HOUSING & COMMUNITY SERVICES

MULTIFAMILY
Energy Program

Energy Modeling Guidelines

May 12, 2020
Version 1.0

These *Energy Modeling Guidelines* describe the modeling requirements for projects pursuing the *Whole Building Path* for both Existing Building and New Construction projects and serve as supplement to OHCS Multifamily Energy Program Manual.

Applicable for:
- All Existing Building Projects
- New Construction Projects following the 2019 Oregon Zero Energy Ready Commercial Code

503.505.6787
OregonMultifamily@trccompanies.com
www.oregonmultifamilyenergy.com

TRC

OR-MEP NC WHOLE BUILDING PATH REQUIREMENTS – OREGON CODE BASELINE

OR-MEP Modeling Guidelines includes following table that summarizes the baseline code requirements for typical multifamily residential components, based on 2019 OZERCC prescriptive path compliance.[1]

Figure 1: Oregon Code Baseline Requirements per 2019 Oregon Zero Energy Ready Commercial Code

Building Component	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC)
Appliances		
Refrigerators	N/A - No Code Requirement Refer to Figure 5	
Dishwashers	N/A - No Code Requirement Refer to Figure 5	
Clothes Washers – In-Unit	N/A - No Code Requirement Refer to Figure 5	
Clothes Washers – Common Area	N/A - No Code Requirement Refer to Figure 5	
Domestic Hot Water		
Water Heater, Electric Resistance[3]	≤12kW, Resistance, ≥ 20 gallons and ≤ 55 gallons: EF = 0.960 – 0.0003V >12kW, Resistance, ≥ 20 gallons and ≤ 55 gallons: SL ≤ 0.3 + 27/Vm %/h	
Low Flow Shower Heads	N/A - No Code Requirement Use 2.0 GPM	
Low Flow Aerators	N/A - No Code Requirement Use 2.0 GPM	
Envelope[4]		
Above Grade Walls – Mass	Climate Zone 4 Insulation Min: R-11.4ci Assembly Max: U-0.090 Climate Zone 5 Insulation Min: R-13.3ci Assembly Max: U-0.080	Climate Zones 4 (Marine) + 5 Group R[5] Insulation Min: R-13.3ci Assembly Max: U-0.080 All Other Groups Insulation Min: R-11.4ci Assembly Max: U-0.090
Above Grade Walls – Metal Building	Climate Zone 4 + 5 Insulation Min R-0 + R-19ci Assembly Max: U-0.050	Climate Zones 4 (Marine) + 5 All Groups Insulation Min: R-13 + R-13ci Assembly Max: U-0.052

[1]This is provided for reference only and does not feature all code requirements that a project may be required to follow. Please refer to official published code documents for complete details.

OR-MEP NC BASELINE: KEY CODE CONSIDERATIONS | APPLIANCES

- **No code requirement for appliances.**
  - For energy modeling, defer to recommended values in OR-MEP Energy Modeling Guidelines or other industry accepted practices

Building Component	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC)
Appliances		
Refrigerators	N/A - No Code Requirement Refer to *Figure 5*	
Dishwashers	N/A - No Code Requirement Refer to *Figure 5*	
Clothes Washers – In-Unit	N/A - No Code Requirement Refer to *Figure 5*	
Clothes Washers – Common Area	N/A - No Code Requirement Refer to *Figure 5*	

OR-MEP NC BASELINE: KEY CODE CONSIDERATIONS | DHW

- **If electric DHW system, model baseline water heaters as electric resistance, with efficiency per code.**
- **No code requirement for low flow fixtures.**
  - For energy modeling, defer to recommended values in OR-MEP Energy Modeling Guidelines or other industry accepted practices

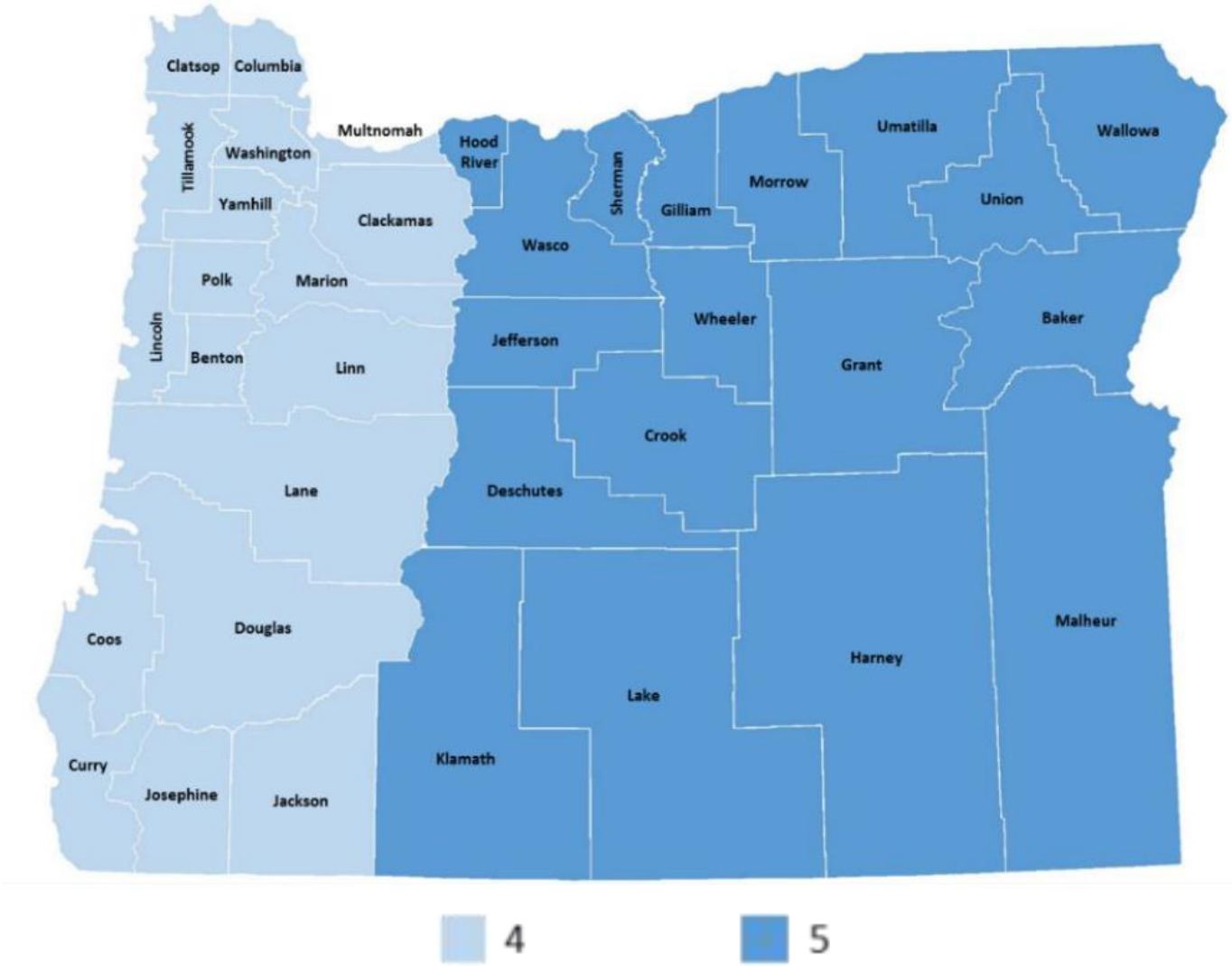
Building Component	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC)
Domestic Hot Water		
Water Heater, Electric Resistance[3]	≤12kW, Resistance, ≥ 20 gallons and ≤ 55 gallons: EF = 0.960 – 0.0003V >12kW, Resistance, ≥ 20 gallons and ≤ 55 gallons: SL ≤ 0.3 + 27/V_m %/h	
Low Flow Shower Heads	N/A - No Code Requirement Use 2.0 GPM	
Low Flow Aerators	N/A - No Code Requirement Use 2.0 GPM	

OR-MEP NC BASELINE: KEY CODE CONSIDERATIONS | ENVELOPE

- **Follow code requirement for each envelope component.**

Building Component	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC)
Envelope[3]		
Slab-on Grade Floors		
Unheated	**Climate Zone 4** Insulation Min: R-15 for 24 in. below Assembly Max: F-0.520 **Climate Zone 5** Insulation Min: R-20 for 24 in. below Assembly Max: F-0.510	**Climate Zones 4 (Marine) + 5** All Groups Insulation Min: R-10 for 24 in. below Assembly Max: F-0.54
Heated	**Climate Zone 4 + 5** Insulation Min: R-20 for 48 in. below Assembly Max: F-0.688	**Climate Zones 4 (Marine) + 5** All Groups Insulation Min: R-15 for 36 in. below + R-5 full slab Assembly Max: F-0.79 *(perimeter insulation)*, F-0.64 *(full slab insulation)*
Roofs		
Insulation entirely above deck	**Climate Zone 4 + 5** Insulation Min: R-30ci Assembly Max: U-0.032	**Climate Zones 4 (Marine) + 5** All Groups Insulation Min: R-30ci Assembly Max: U-0.032

OREGON CLIMATE ZONES



OR-MEP NC BASELINE: KEY CODE CONSIDERATIONS | HEATING & COOLING

- Model baseline electric heating system as electric resistance heaters.
- If cooling in proposed, refer to code for minimum equipment efficiencies for baseline modeling.

Building Component	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC)
Heating & Cooling		
Electric Heating System	Electric Resistance Heater[9]	Electric Resistance Heater[11]
Electric Cooling System	If cooling in proposed, refer to ASHRAE 90.1-2016 Tables 6.8 1-1 through 6.8.1-16 for minimum equipment efficiencies.	If cooling is proposed, refer to 2018 IECC Tables C403.3.2(1) through C403.3.2(9) for minimum equipment efficiencies.
HVAC Fan Systems	Fan Power[10]: Refer to ASHRAE 90.1-2016, Section 6.5.3. Fan Efficiency[11]: Fans shall have a fan efficiency grade (FEG) or 67 or higher.	Fan Power[12]: Refer to IECC 2018, Section C403.8. Fan Efficiency[13]: Fans shall have a fan efficiency grade (FEG) or 67 or higher.

OR-MEP NC BASELINE: KEY CODE CONSIDERATIONS | LIGHTING

- **Follow code requirement for lighting – *in unit, common area, lighting controls, and exterior***

Building Component	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC)
Lighting		
Apartment Lighting	Per ASHRAE 90.1-2016 Section 9.4.4 Dwelling Units: Not less than 75% of the permanently installed lighting fixtures shall use lamps with an efficacy of at least 55 lm/W or have a total luminaire efficacy of at least 45 lm/W.	Per 2018 IECC Section C405.1, dwelling units within multifamily buildings shall comply with Section R404.1, where: Not less than 90% of the permanently installed lighting fixtures shall contain only high-efficacy lamps.
Common Area Lighting	Building Area Method Per ASHRAE 90.1-2016 Tables 9.5.1, Multifamily = 0.68 W/sf Space by Space Method Refer to ASHRAE 90.1-2016 Tables 9.6.1 *(Refer to Figure 2 in these guidelines for ASHRAE 90.1-2016 LPD for common multifamily space types.)*	Building Area Method Per 2018 IECC, Table C405.3.2(1) Multifamily = 0.68 W/sf Space by Space Method Refer to 2018 IECC, Tab C405.3.2(2) *(Refer to Figure 2 in these guidelines for 2018 IECC LPD for common multifamily space types.)*

OR-MEP NC BASELINE: KEY CODE CONSIDERATIONS | VENTILATION

- **Follow code requirement for ventilation**
  - 2019 Oregon Mechanical Specialty Code, Chapter 4

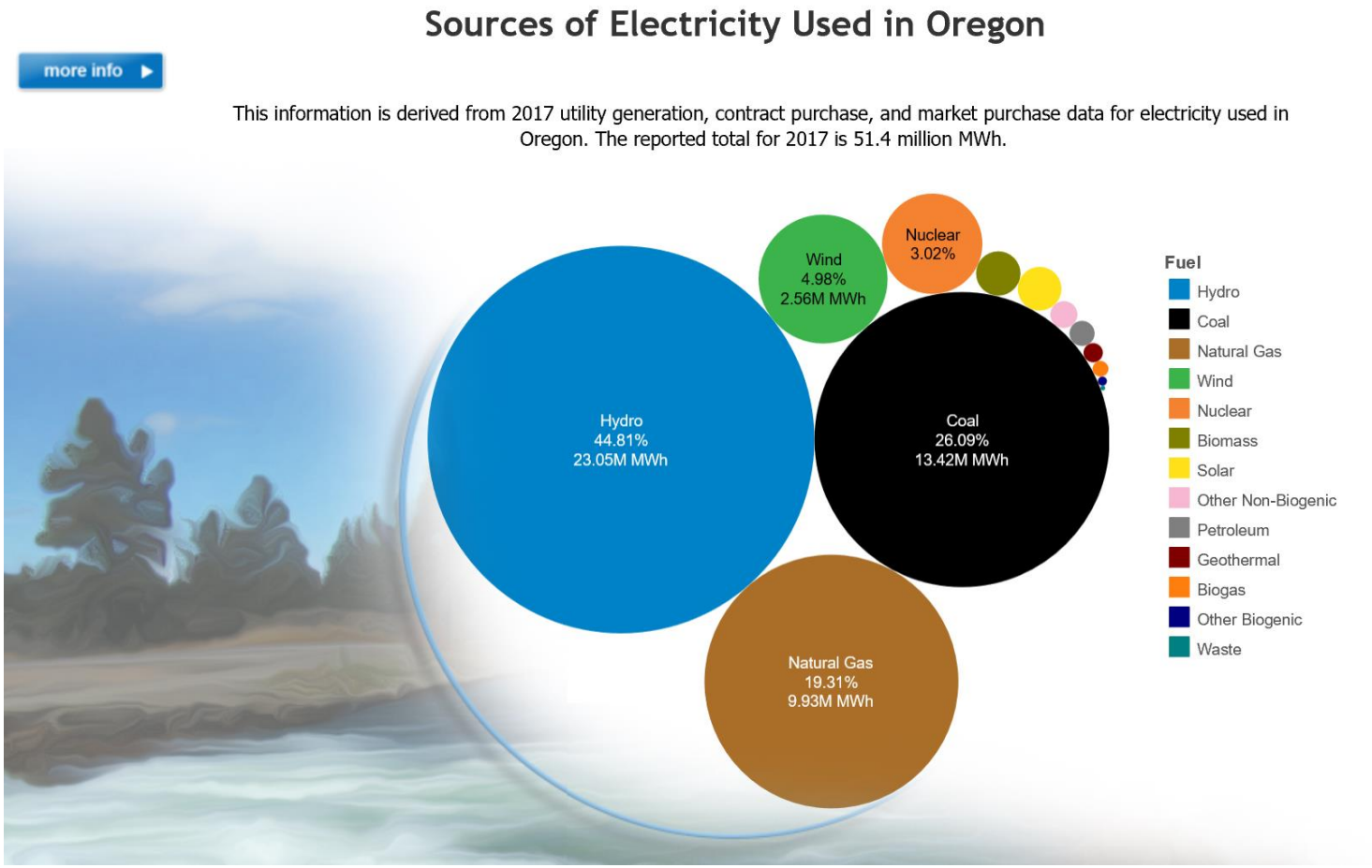
Building Component	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC)
Ventilation		
Apartment Ventilation	Minimum Ventilation Rates per 2019 Oregon Mechanical Specialty Code, Chapter 4	
Local Exhaust - Kitchen[9]	25 CFM, continuous 150 CFM, intermittent	
Local Exhaust – Bathrooms[10]	20 CFM, continuous 80 CFM, intermittent	
Outdoor Air for Dwelling Units	CFM = 0.01 x area (sf) + 7.5 x (1 + # of bedrooms)[10]	
Outdoor Air for Other Spaces[11]	No less than 0.06 CFM/ft^2	

QUESTION BREAK

OVERVIEW OF 2019 OREGON ZERO ENERGY READY COMMERCIAL CODE

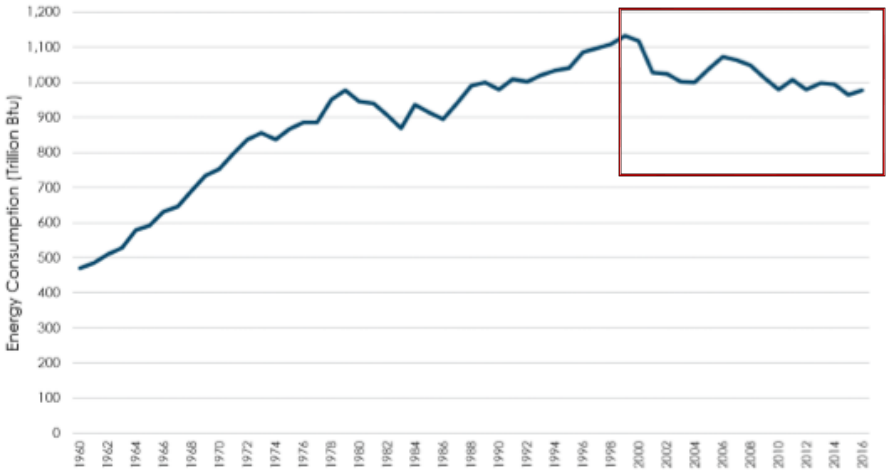
- History / Timeline
- What's Changed Since Last 2014 Code
- Compliance Options
- Prescriptive Requirements by Building Component – Typical Multifamily Conditions

OREGON ELECTRICITY RESOURCE MIX

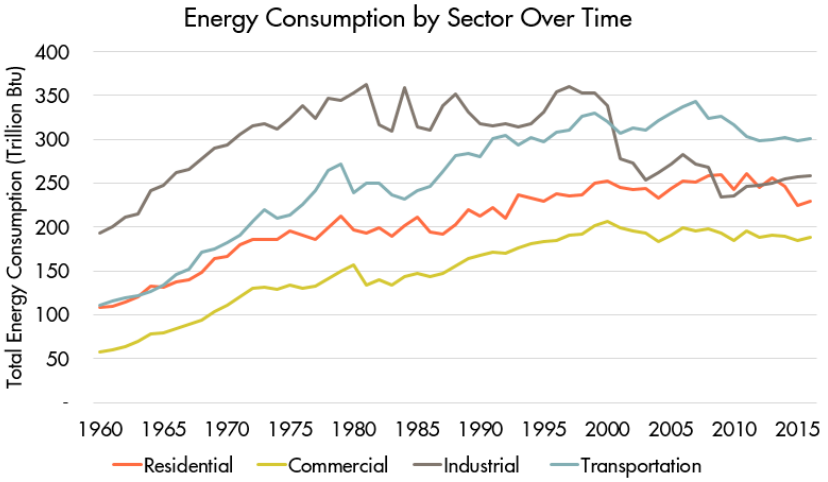


https://www.oregon.gov/energy/energy-oregon/Pages/Electricity-Mix-in-Oregon.aspx

ENERGY CONSUMPTION OVER TIME

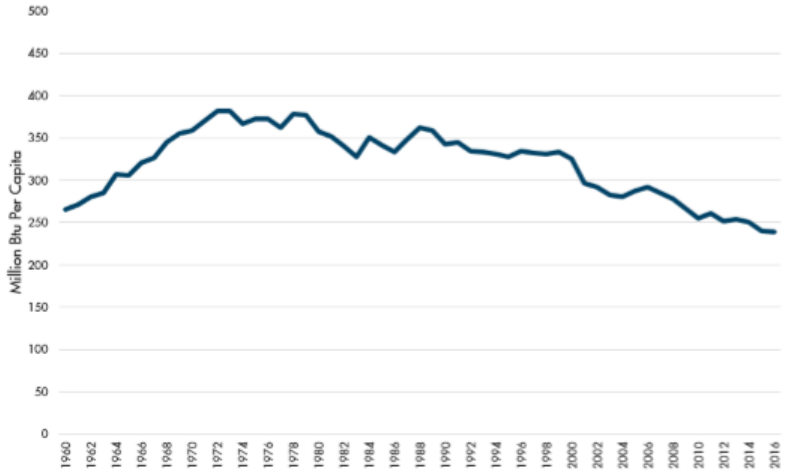


Oregon's Total Energy Consumption Over Time

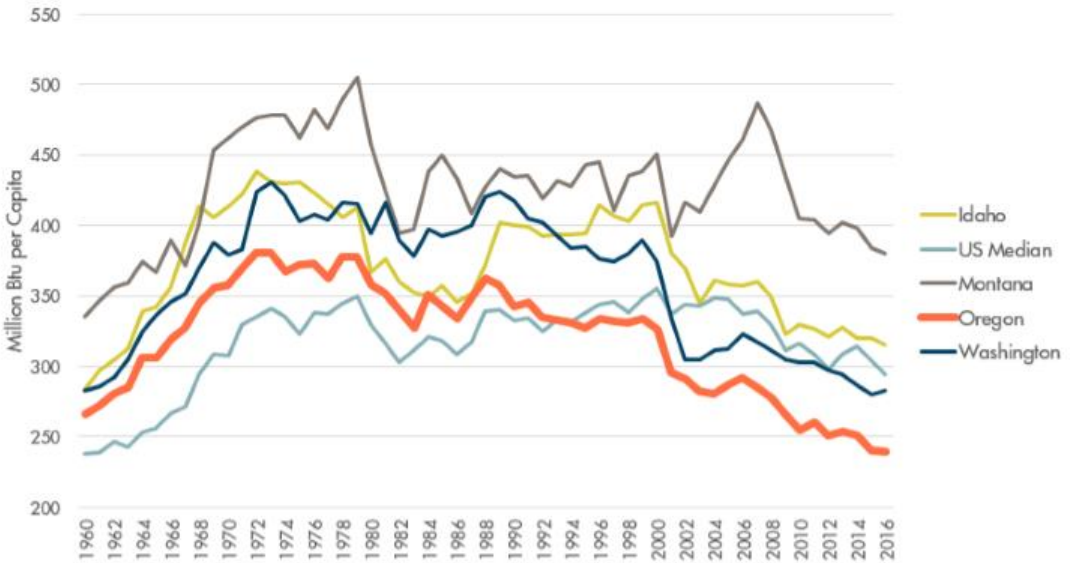


Oregon's Energy Consumption by Sector Over Time

PER CAPITA ENERGY CONSUMPTION OVER TIME



Oregon's Per Capita Energy Consumption Over Time



Oregon's Per Capita Energy Consumption Over Time Compared to Northwest States

ENERGY CONSUMPTION & OREGON'S ECONOMY

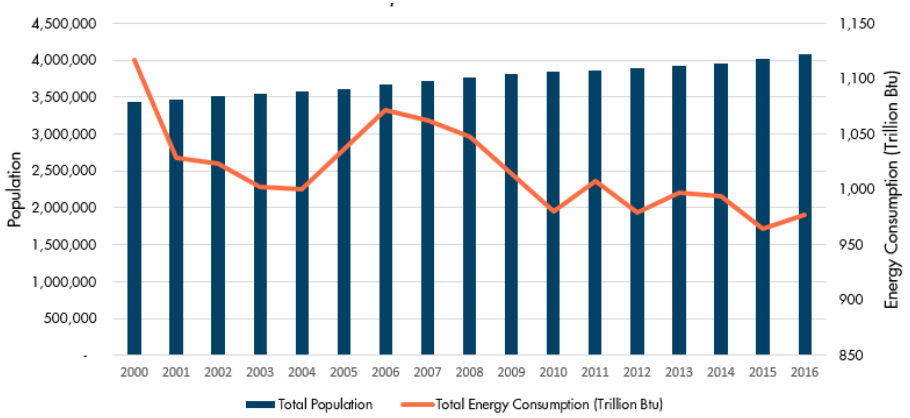
Oregon's Population and Energy Consumption: 2000-2016
Consumption axis starts at 850 TBtu

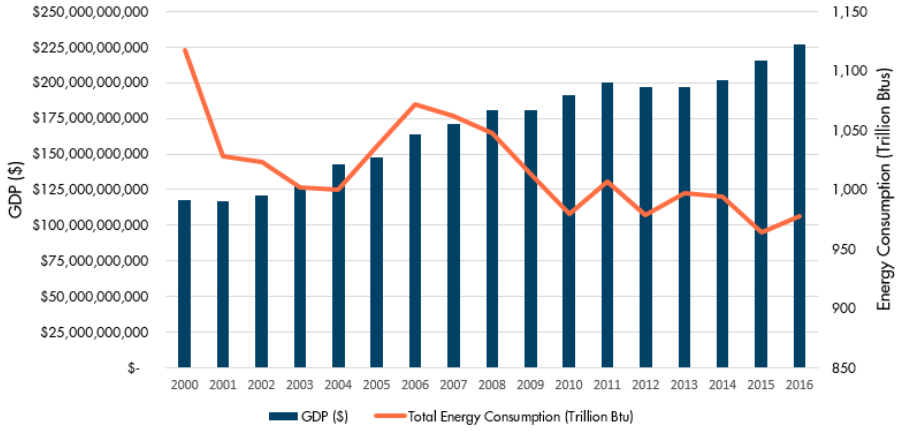
Between 2000 and 2016:

19%
Oregon Population

93%
Oregon GDP

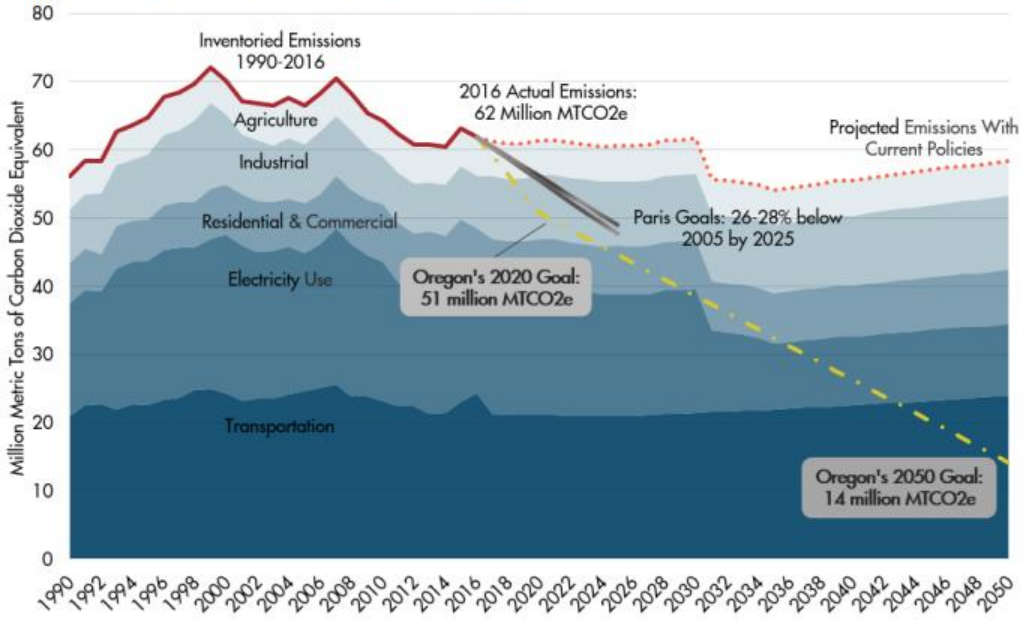
12.5%
Oregon Energy Use





OREGON GHG REDUCTION GOALS

Figure 2.6: Oregon's Projected GHG Emissions vs. Goals[20]



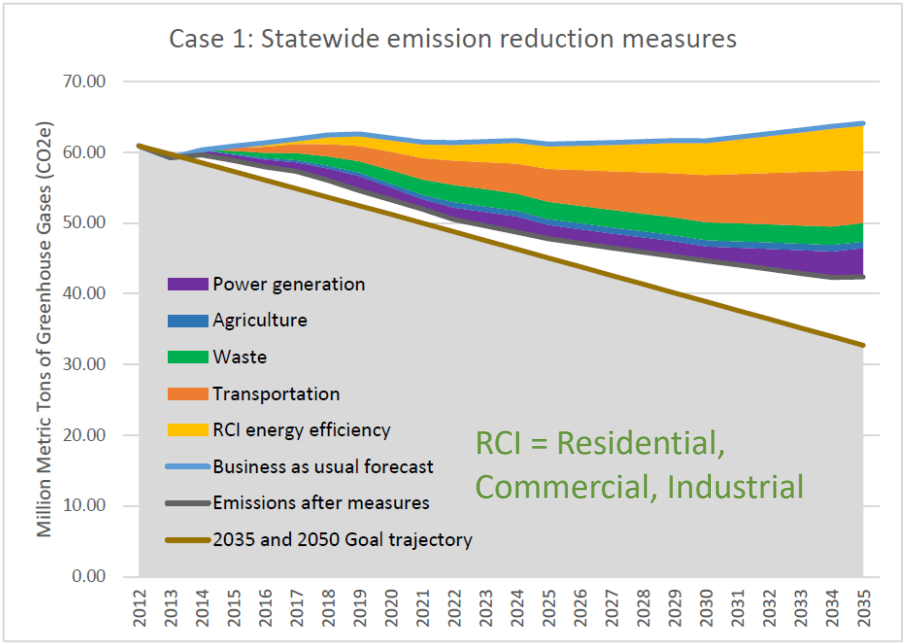
2007 House Bill 3543 set statewide statutory GHG reduction goals:

- **By 2010, arrest the growth of Oregon's greenhouse gas emissions and begin to reduce greenhouse gas emissions.**
- **By 2020, achieve greenhouse gas levels that are 10 percent below 1990 levels.**
- **By 2050, achieve greenhouse gas levels that are at least 75 percent below 1990 levels.**

BUILDINGS & OREGON GHG REDUCTION GOALS

What role do buildings play toward Oregon's broader goals?

- Improve the energy efficiency and reduce the associated GHG emissions of the new building stock
- Critical piece of broader greenhouse gas reduction goals
- Combined with many other generation and demand side efficiency and renewable initiatives, contribute to progress toward goals

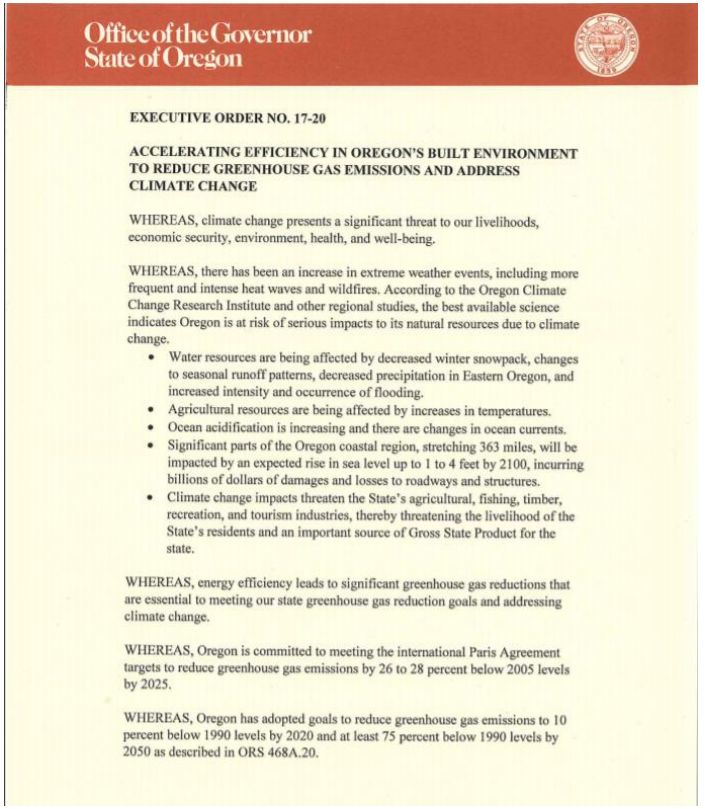


Oregon Global Warming Commission, Biennial Report to the Legislature 2015

EO 17-20 (ENERGY EFFICIENCY)

Three key sections:

1. Energy efficiency leadership in state owned/leased buildings – Governor directives to DAS and ODOE
2. Targets for state-wide building codes & appliance standards – Governor directives to DCBS-BCD and ODOE
3. Retrofits and affordable housing – Governor directives to PUC, HCS, ODOE



Office of the Governor
State of Oregon

EXECUTIVE ORDER NO. 17-20

ACCELERATING EFFICIENCY IN OREGON'S BUILT ENVIRONMENT TO REDUCE GREENHOUSE GAS EMISSIONS AND ADDRESS CLIMATE CHANGE

WHEREAS, climate change presents a significant threat to our livelihoods, economic security, environment, health, and well-being.

WHEREAS, there has been an increase in extreme weather events, including more frequent and intense heat waves and wildfires. According to the Oregon Climate Change Research Institute and other regional studies, the best available science indicates Oregon is at risk of serious impacts to its natural resources due to climate change.

- Water resources are being affected by decreased winter snowpack, changes to seasonal runoff patterns, decreased precipitation in Eastern Oregon, and increased intensity and occurrence of flooding.
- Agricultural resources are being affected by increases in temperatures.
- Ocean acidification is increasing and there are changes in ocean currents.
- Significant parts of the Oregon coastal region, stretching 363 miles, will be impacted by an expected rise in sea level up to 1 to 4 feet by 2100, incurring billions of dollars of damages and losses to roadways and structures.
- Climate change impacts threaten the State's agricultural, fishing, timber, recreation, and tourism industries, thereby threatening the livelihood of the State's residents and an important source of Gross State Product for the state.

WHEREAS, energy efficiency leads to significant greenhouse gas reductions that are essential to meeting our state greenhouse gas reduction goals and addressing climate change.

WHEREAS, Oregon is committed to meeting the international Paris Agreement targets to reduce greenhouse gas emissions by 26 to 28 percent below 2005 levels by 2025.

WHEREAS, Oregon has adopted goals to reduce greenhouse gas emissions to 10 percent below 1990 levels by 2020 and at least 75 percent below 1990 levels by 2050 as described in ORS 468A.20.

EO available: http://www.oregon.gov/gov/Documents/executive_orders/eo_17-20.pdf

WHY EFFICIENCY & ZERO EMISSION VEHICLES?

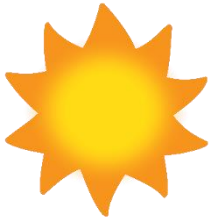
30%

- **About 30% of Oregon's greenhouse emissions can be traced to how much and what type of energy we use in our buildings**
- **Electricity and other energy consumption in residential and commercial buildings are a large greenhouse gas contributor**
- **Reducing energy use and increasing efficiency will help lower emissions from the built environment**

40%

- About 40% of Oregon's greenhouse gas emissions are from the transportation sector
- Transitioning to zero emission vehicles will result in emissions reductions in the transportation sector
- Supporting infrastructure and reducing EV costs will encourage adoption

EO 17-20 – DIRECTIVE 4A, 4B SOLAR AND EV READY



A. Solar Ready Building Construction. The appropriate advisory board(s) and the Department of Business and Consumer Services Building Codes Division (BCD) are directed to conduct code amendment of the state building code to require all newly constructed buildings will be ready for the installation of solar panels and related technologies by October 1, 2020 for residential structures and October 1, 2022 for commercial structures. BCD may establish limited specific exemptions to this solar-ready policy for buildings where solar applications are infeasible.

B. Electric Vehicle Ready Building Construction. The appropriate advisory board(s) and BCD are directed to conduct code amendment of the state building code to require that parking structures for all newly constructed residential and commercial buildings are ready to support the installation of at least a level 2 EV charger by October 1, 2022. BCD may establish limited specific exemptions related to types of parking lots, such as temporary parking lots.

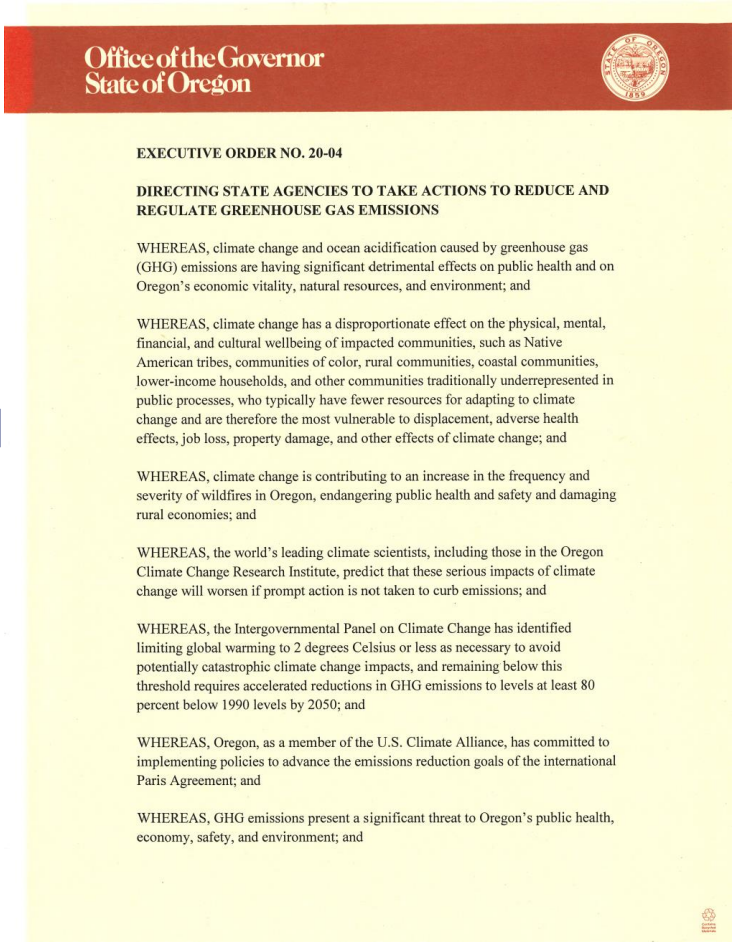
EXECUTIVE ORDER 17-20
COMMERCIAL ENERGY CODE

D. Increasing Energy Efficiency in Commercial Construction. The appropriate advisory board(s) and BCD are directed to conduct code amendment of the state building code to require, by October 1, 2022, that newly constructed commercial buildings, averaged across building types, will exceed International Energy Conservation Code and ASHRAE 90.1 by achieving at least equivalent performance levels with the measurable prescriptive energy efficiency portions of the most current version of ASHRAE 189.1 that are construction-related.

EO 20-04 GREENHOUSE GAS EMISSIONS

Additional directives for state agencies, including BCD and ODOE to take action to reduce GHG emissions

- Directive 6: 60% reduction in new building annual site consumption of energy (excluding transportation and appliances) by 2030, from a 2006 baseline



Office of the Governor
State of Oregon

EXECUTIVE ORDER NO. 20-04

DIRECTING STATE AGENCIES TO TAKE ACTIONS TO REDUCE AND REGULATE GREENHOUSE GAS EMISSIONS

WHEREAS, climate change and ocean acidification caused by greenhouse gas (GHG) emissions are having significant detrimental effects on public health and on Oregon's economic vitality, natural resources, and environment; and

WHEREAS, climate change has a disproportionate effect on the physical, mental, financial, and cultural wellbeing of impacted communities, such as Native American tribes, communities of color, rural communities, coastal communities, lower-income households, and other communities traditionally underrepresented in public processes, who typically have fewer resources for adapting to climate change and are therefore the most vulnerable to displacement, adverse health effects, job loss, property damage, and other effects of climate change; and

WHEREAS, climate change is contributing to an increase in the frequency and severity of wildfires in Oregon, endangering public health and safety and damaging rural economies; and

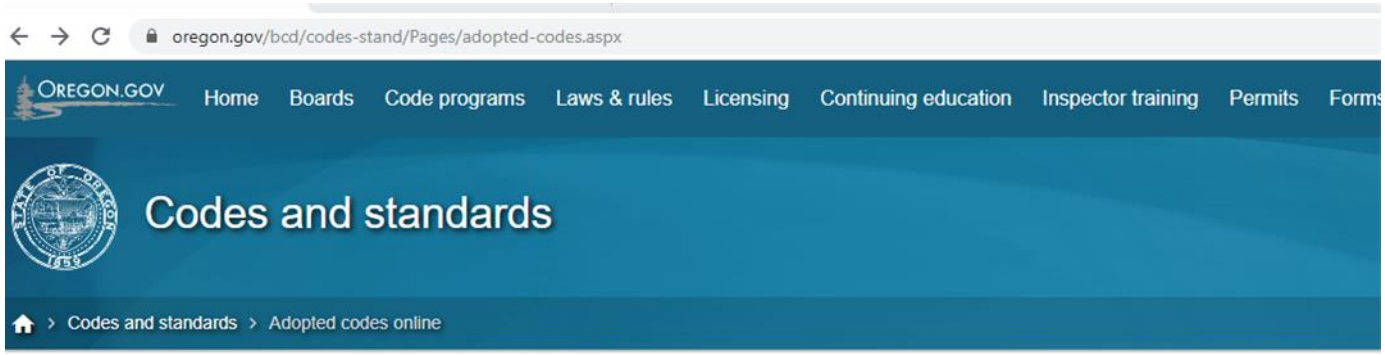
WHEREAS, the world's leading climate scientists, including those in the Oregon Climate Change Research Institute, predict that these serious impacts of climate change will worsen if prompt action is not taken to curb emissions; and

WHEREAS, the Intergovernmental Panel on Climate Change has identified limiting global warming to 2 degrees Celsius or less as necessary to avoid potentially catastrophic climate change impacts, and remaining below this threshold requires accelerated reductions in GHG emissions to levels at least 80 percent below 1990 levels by 2050; and

WHEREAS, Oregon, as a member of the U.S. Climate Alliance, has committed to implementing policies to advance the emissions reduction goals of the international Paris Agreement; and

WHEREAS, GHG emissions present a significant threat to Oregon's public health, economy, safety, and environment; and

CURRENT OREGON ENERGY CODE



2019 Oregon Zero Energy Ready Commercial Code

Effective Oct. 1, 2019

Construction provisions:

Commercial: ASHRAE Standard 90.1.

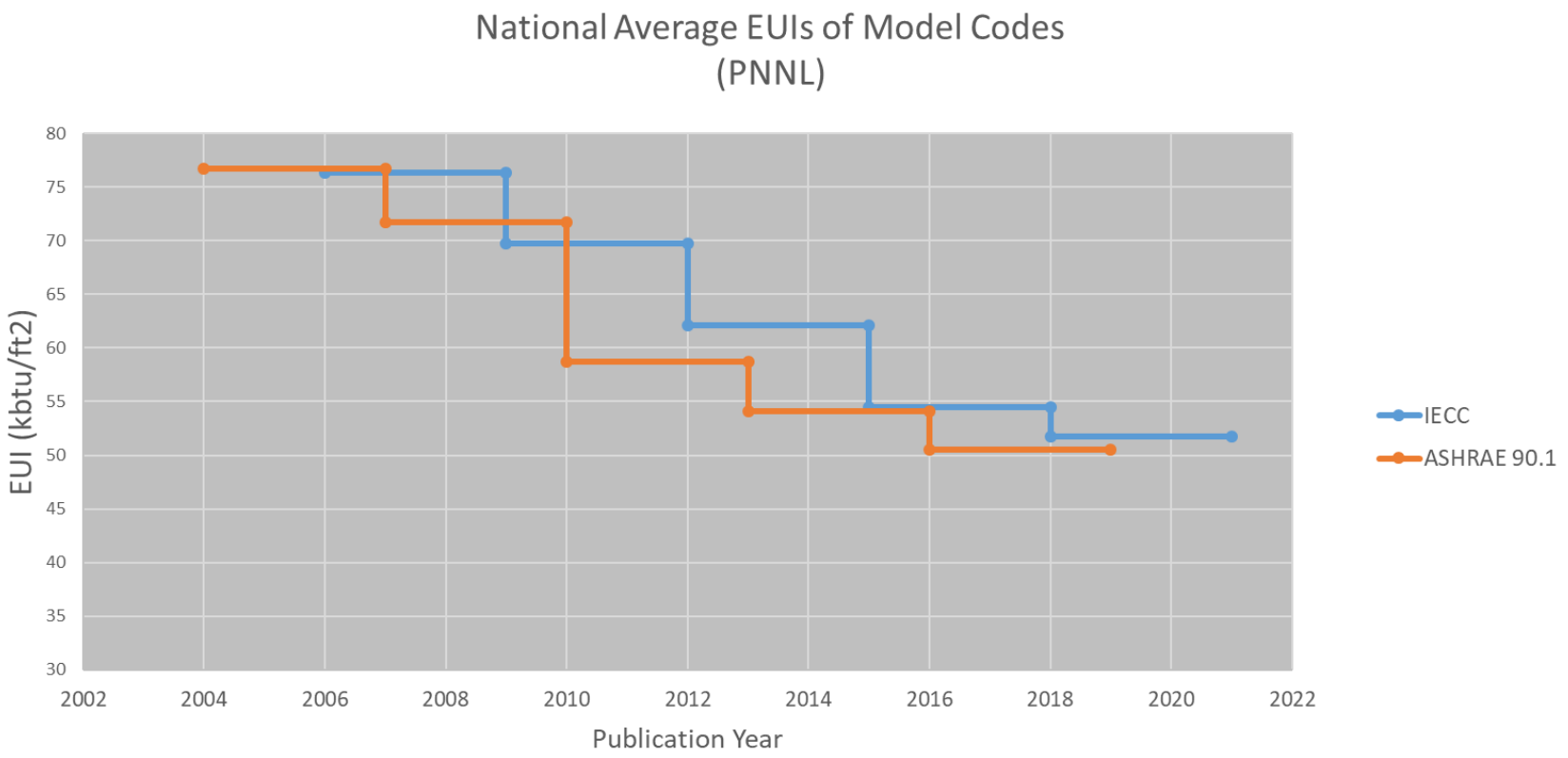
Multi-family: 2018 International Energy Conservation code

- https://www.oregon.gov/bcd/codes-stand/Pages/adopted-codes.aspx
- **Read only versions of both 90.1 and IECC 2018 are available**

WHY 90.1?

- Quicker, less resource-intensive development
  - streamlined adoption (more buildings under advanced code)
- More predictable
- Comprehensive cost analysis
- Consensus-based process for updating ASHRAE with technical committees and working groups
- Supported (COMcheck)
- Keeps Oregon an efficiency leader by putting plan in place to update with ASHRAE 90.1
- Lessens time burden on officials and volunteers to adopt new code
- Federal declaration/certification is straightforward

COMMERCIAL ENERGY CODE



Note: 2018 IECC is an estimate of reduction vs. 2015

2019 Oregon Energy Code Updates

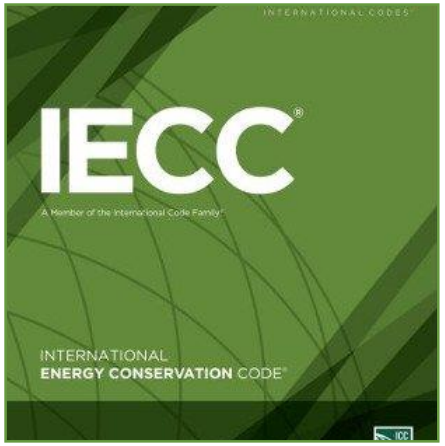
OREGON
DEPARTMENT OF
ENERGY

OR CODE COMPLIANCE PATHWAYS

90.1-2016* Current

90.1-2019 TBD

Statewide Alternative Method (SAM) 19-01 allows IECC 2018



State of Oregon
Building Codes Division
Better Buildings for Oregon

Statewide Alternate Method
October 2019

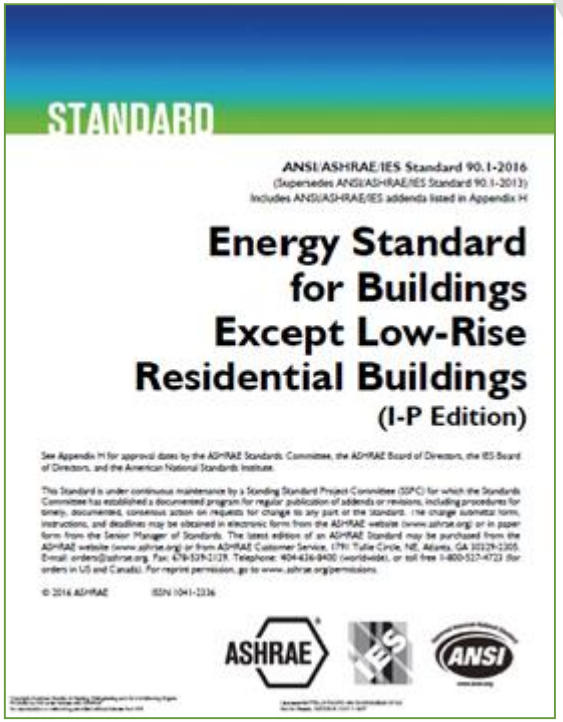
No. 19-01 **(Ref.: ORS 455.060)**

2018 International Energy Conservation Code

**Includes several administrative amendments*

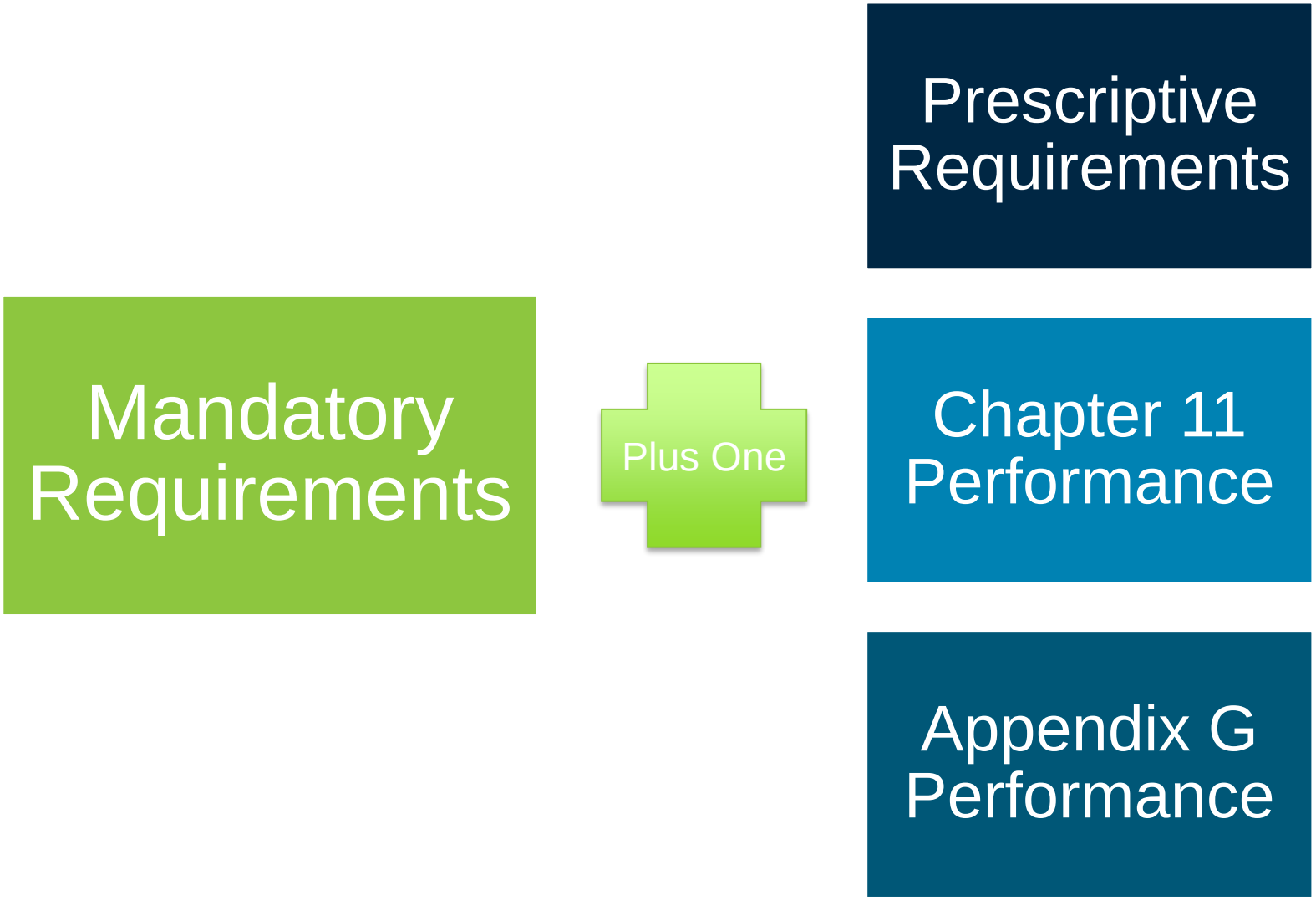
90.1-2016 CHAPTER ORGANIZATION

- 1 Purpose
- 2 Scope
- 3 Definitions, Abbreviations & Acronyms
- 4 Administration & Enforcement
- 5 Building Envelope
- 6 Heating, Ventilating & Air Conditioning
- 7 Service Water Heating
- 8 Power
- 9 Lighting
- 10 Other Equipment
- 11 Energy Cost Budget Method
- 12 Normative References
- Normative Appendices A-H



Compared to 2014 OEESC: https://www.oregon.gov/bcd/codes-stand/code-adoption/Documents/19energy-ashrae90.1-guide.pdf

THREE PATHS THROUGH 90.1



TWO PERFORMANCE PATHS IN 90.1

Chapter 11 Performance

- **Energy Cost Budget Method (ECB) - Chapter 11**
  - Used for minimum code compliance for buildings that do not meet 90.1 prescriptive requirements
  - Requires no greater energy cost than a building that meets those prescriptive requirements

Appendix G Performance

- **Performance Rating Method - Appendix G**
  - Previously used to rate building performance "beyond code".
    - » LEED, EPACT tax credits, utility programs, ASHRAE Standard 189.1, IgCC
  - % improvement = 100 x (baseline – proposed) ÷ baseline

IECC ALSO HAS A PERFORMANCE PATH

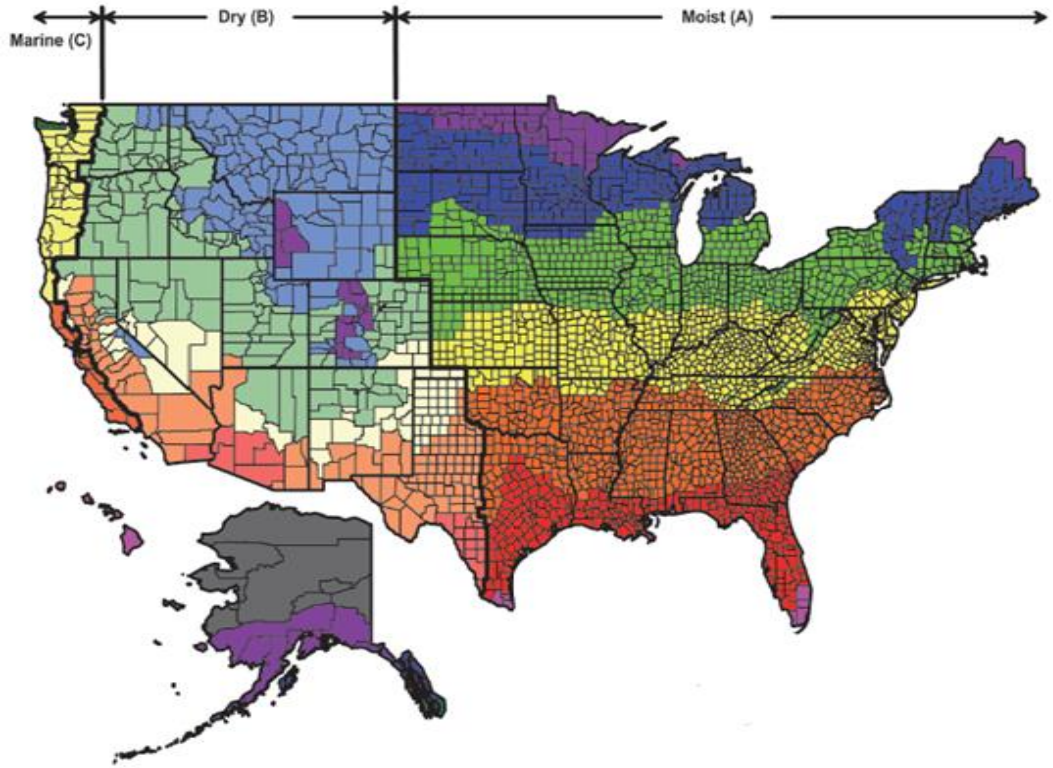
C401.2 Application. Commercial buildings shall comply with one of the following:

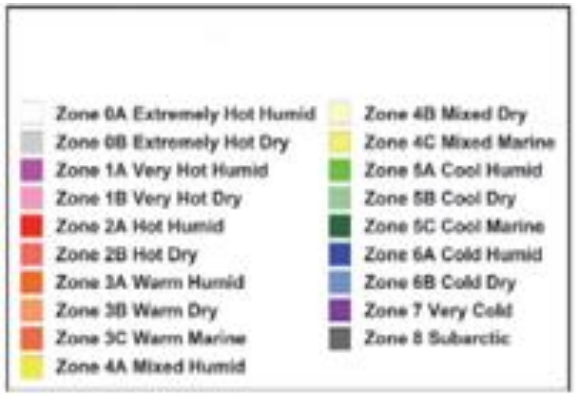
1. The requirements of ANSI/ASHRAE/IESNA 90.1.
2. The requirements of Sections C402 through C405 and C408. In addition, commercial buildings shall comply with Section C406 and tenant spaces shall comply with Section C406.1.1.
3. The requirements of Sections C402.5, C403.2, C403.3 through C403.3.2, C403.4 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.

GENERAL UPDATES

UPDATED CLIMATE ZONE MAP

- Aligns with new ASHRAE Standard 169-2013
- No climate zone changes for Oregon, but may impact other work you do across the country





ENVELOPE

SECTION 5 – ENVELOPE
ASHRAE 90.1-2016

Table 5.5-4 Building Envelope Requirements for CLIMATE ZONE 4C

Opaque Elements	*Nonresidential*		*Residential*		Semiheated	
	Assembly Maximum	Insulation Min. *R-Value*	Assembly Maximum	Insulation Min. *R-Value*	Assembly Maximum	Insulation Min. *R-Value*
Roofs						
Insulation entirely above deck	~~U-0.048~~ U-0.032	~~R-20 c.i.~~ R-30 c.i.	~~U-0.048~~ U-0.032	~~R-20 c.i.~~ R-30 c.i.	U-0.093	~~Exempt c.i.~~ R-10 c.i.
Metal building[a]	~~U-0.055~~ U-0.037	~~R-13 + R-13~~ R-19 + R-11 *Ls* or R-25 + R-8 *Ls*	~~U-0.055~~ U-0.037	~~R-19~~ R-19 + R-11 *Ls* or R-25 + R-8 *Ls*	U-0.082	~~R-13 + R-13~~ R-19
Attic and other	~~U-0.027~~ U-0.021	~~R-38~~ R-49	~~U-0.027~~ U-0.021	~~R-38~~ R-49	U-0.034	~~R-38~~ R-30
Walls, above Grade						
Mass	~~U-0.150~~ U-0.104	~~R-11.4 c.i.~~ R-9.5 c.i.	U-0.090	~~R-13.3 c.i.~~ R-11.4 c.i.	U-0.580	NR
Metal building	~~U-0.060~~ U-0.060	~~R-13 + R-5.6 c.i.~~ R-0 + R-15.8 c.i	~~U-0.060~~ U-0.050	~~R-13 + R-5.6 c.i.~~ R-0 + R-19 c.i.	U-0.162	R-13
Steel-framed	U-0.064	R-13 + R-7.5 c.i.	U-0.064	R-13 + R-7.5 c.i	U-0.124	R-13
Wood-framed and other	U-0.064	R-13 + R-3.8 c.i. or ~~R-21~~ R-20	U-0.064	R-13 + R-3.8 c.i. or ~~R-21~~ R-20	U-0.089	R-13
Walls, below Grade						
Below-grade wall	C-0.119	R-7.5 c.i.	~~C-0.119~~ C-0.092	~~R-7.5 c.i.~~ R-10 c.i.	C-1.140	NR
Floors						
Mass	~~U-0.074~~ U-0.057	~~R-10 c.i.~~ R-14.6 c.i.	~~U-0.064~~ U-0.051	~~R-12.5 c.i.~~ R-16.7 c.i.	U-0.107	~~Exempt c.i.~~ R-6.3 c.i.
Steel-joist	~~U-0.033~~ U-0.038	R-30	~~U-0.033~~ U-0.038	R-30	U-0.052	~~R-30~~ R-19
Wood-framed and other	U-0.033	R-30	U-0.033	R-30	U-0.051	~~R-30~~ R-19
Slab-On-Grade Floors						
Unheated	~~F-0.730~~ F-0.520	~~NR~~ R-15 for 24 in.	~~F-0.540~~ F-0.520	~~R-10~~ R-15 for 24 in.	F-0.730	NR
Heated	~~F-0.860~~ F-0.843	~~R-15~~ R-20 for 24 in.	~~F-0.860~~ F-0.688	~~R-15 for 24 in.~~ R-20 for 48 in.	F-0.900	~~R-15 for 24 in.~~ R-10 for 24 in.

SECTION 5 – ENVELOPE
ASHRAE 90.1-2016

Table 5.5-4 Building Envelope Requirements for CLIMATE ZONE 4C

Opaque Doors									
Swinging	~~U-0.70~~ U-0.370			~~U-0.70~~ U-0.370			~~U-0.70~~ U-0.370		
Nonswinging	~~U-0.50~~ U-0.310			~~U-0.50~~ U-0.310			~~U-0.50~~ U-0.360		
Fenestration	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*	Assembly Max. U	Assembly Max. *SHGC*	Assembly Min. *VT/SHGC*
~~Fixed, operable, and doors with greater than 50% glazing~~	~~U-0.35 for all frame types~~								
Vertical Fenestration, 0% to ~~30%~~ 40% of Wall	(for all frame types)								
Nonmetal framing, all	~~0.35~~ 0.31	~~0.40~~ 0.36	1.10	~~0.35~~ 0.31	~~0.40~~ 0.36	1.10	0.51	NR	NR
Metal framing, fixed	~~0.45~~ 0.38			~~0.45~~ 0.38			0.73		
Metal framing, operable	0.46			0.46			0.81		
Metal framing, entrance door	~~0.80~~ 0.68			~~0.80~~ 0.68			0.77		
Skylight, 0% to 3% of Roof									
All types	~~U-0.60~~ U-0.50	0.40	NR	~~U-0.60~~ U-0.50	0.40	NR	1.15	NR	NR

The following definitions apply: c.i. = *continuous insulation* (see Section 3.2). FC = filled cavity (see Section A2.3.2.5). *Ls = liner system* (see Section A2.3.2.4). NR = no (insulation) requirement.

a. When using the *R-value* compliance method for *metal building roofs*, a thermal spacer block is required (see Section A2.3.2).

Vertical Fenestration,
0% to ~~30%~~ 40% of Wall

SECTION 5 – ENVELOPE
ASHRAE 90.1-2016

Table 5.5-5 Building Envelope Requirements for CLIMATE ZONE 5B

Opaque Elements	*Nonresidential*		*Residential*		Semiheated	
	Assembly Maximum	Insulation Min. *R-Value*	Assembly Maximum	Insulation Min. *R-Value*	Assembly Maximum	Insulation Min. *R-Value*
Roofs						
Insulation entirely above deck	~~U-0.048~~ U-0.032	~~R-20 c.i.~~ R-30 c.i.	~~U-0.048~~ U-0.032	~~R-20 c.i.~~ R-30 c.i.	U-0.063	~~Exempt c.i.~~ R-15 c.i.
Metal building[a]	~~U-0.055~~ U-0.037	~~R-13 + R-13~~ R-19 + R-11 *Ls* or R-25 + R-8 *Ls*	~~U-0.055~~ U-0.037	~~R-19~~ R-19 + R-11 *Ls* or R-25 + R-8 *Ls*	U-0.082	~~R-13 + R-13~~ R-19
Attic and other	~~U-0.027~~ U-0.021	~~R-38~~ R-49	~~U-0.027~~ U-0.021	~~R-38~~ R-49	U-0.034	~~R-38~~ R-30
Walls, above Grade						
Mass	~~U-0.150~~ U-0.090	R-11.4 c.i.	~~U-0.090~~ U-0.800	R-13.3 c.i.	U-0.151[b]	~~Exempt c.i.~~ R-5.7 c.i.[b]
Metal building	~~U-0.069~~ U-0.050	~~R-13 + R-5.6 c.i.~~ R-0 + R-19 c.i	~~U-0.069~~ U-0.050	~~R-13 + R-5.6 c.i.~~ R-0 + R-19 c.i.	U-0.094	~~R-13~~ R-0 + R-9.8 c.i.
Steel-framed	~~U-0.064~~ U-0.055	R-13 + R-10 c.i.	~~U-0.064~~ U-0.055	R-13 + ~~R-7.5 c.i.~~ R-10 c.i.	U-0.084	~~R-13~~ R-13 + R-3.8 c.i.
Wood-framed and other	~~U-0.064~~ U-0.051	R-13 + R-7.5 c.i. or ~~R-21~~ R-19 + R-5 c.i.	~~U-0.064~~ U-0.051	R-13 + R-7.5 c.i. or ~~R-21~~ R-19 + R-5 c.i.	U-0.089	R-13
Walls, below Grade						
Below-grade wall	C-0.119	R-7.5 c.i.	~~C-0.119~~ C-0.092	~~R-7.5ci.~~ R-10 c.i.	C-1.140	NR
Floors						
Mass	~~U-0.074~~ U-0.057	~~R-10ci~~ R-14.6 c.i.	~~U-0.064~~ U-0.051	~~R-12.5ci~~ R-16.7 c.i.	U-0.107	~~Exempt c.i.~~ R-6.3 c.i.
Steel-joist	~~U-0.038~~ U-0.038	R-30	~~U-0.038~~ U-0.038	R-30	U-0.052	~~R-30~~ R-19
Wood-framed and other	U-0.033	R-30	U-0.033	R-30	U-0.051	~~R-30~~ R-19
Slab-On-Grade Floors						
Unheated	~~F-0.730~~ F-0.520	~~NR~~ R-15 for 24 in.	~~F-0.540~~ F-0.510	~~R-10~~ R-20 for 24 in.	F-0.730	NR
Heated	~~F-0.860~~ F-0.688	~~R-15 for 24 in.~~ R-20 for 48 in.	~~F-0.860~~ F-0.688	~~R-15 for 24 in.~~ R-20 for 48 in.	F-0.900	~~R-15 for 24 in.~~ R-10 for 24 in.

SECTION 5 – ENVELOPE
ASHRAE 90.1-2016

Table 5.5-5 Building Envelope Requirements for CLIMATE ZONE 5B

Opaque Doors									
Swinging	~~U-0.70~~ U-0.370			~~U-0.70~~ U-0.370			U-0.370		
Nonswinging	~~U-0.50~~ U-0.310			~~U-0.50~~ U-0.310			U-0.360		
Fenestration	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. *VT/SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. *VT/SHGC***	**Assembly Max. U**	**Assembly Max. *SHGC***	**Assembly Min. *VT/SHGC***
~~Fixed, operable, and doors with greater than 50% glazing~~	~~U-0.35 for all frame types~~								
Vertical Fenestration, 0% to ~~30%~~ 40% of Wall	(for all frame types)								
Nonmetal framing, all	~~0.35~~ 0.31	~~0.40~~ 0.38	1.10	~~0.35~~ 0.31	~~0.40~~ 0.38	1.10	0.45	NR	NR
Metal framing, fixed	~~0.45~~ 0.38			~~0.45~~ 0.38			0.62		
Metal framing, operable	0.46			0.46			0.70		
Metal framing, entrance door	~~0.80~~ 0.68			~~0.80~~ 0.68			0.77		
Skylight, 0% to 3% of Roof									
All types	~~U-0.60~~ U-0.50	0.40	NR	~~U-0.60~~ U-0.50	0.40	NR	0.98	NR	NR

- ASHRAE 90.1-2016 and the 2018 IECC have many similarities for envelope insulation requirements

- But, there are some differences…

A FEW DIFFERENCES BETWEEN 90.1-2016 AND 2018 IECC ENVELOPE

Above Grade Walls	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016, Residential)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC, Group R)
Mass	**Climate Zone 4** Insulation Min: R-11.4ci Assembly Max: U-0.090 **Climate Zone 5** Insulation Min: R-13.3ci Assembly Max: U-0.080	**Climate Zones 4 (Marine) + 5** **Insulation Min: R-13.3ci** **Assembly Max: U-0.080** -
Steel-Framed	**Climate Zone 4** Insulation Min: R-13 + R-7.5ci Assembly Max: U-0.064 **Climate Zone 5** **Insulation Min: R-13 + R-10ci** **Assembly Max: U-0.055**	**Climate Zones 4 (Marine) + 5** Insulation Min: R-13 + R-7.5ci Assembly Max: U-0.064
Wood Framed and Other	**Climate Zone 4** Insulation Min: R-13 + R-3.8ci or R-20 Assembly Max: U-0.064 **Climate Zone 5** Insulation Min: R-13 + R-7.5ci or R-19 + R-5ci **Assembly Max: U-0.051**	**Climate Zones 4 (Marine) + 5** **Insulation Min: R-13 + R-7.5ci or R-20 + R-3.8ci** Assembly Max: U-0.064 -

A FEW DIFFERENCES BETWEEN 90.1-2016 AND 2018 IECC ENVELOPE

Below Grade Walls	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016, Residential)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC, Group R)
Below Grade Walls	**Climate Zone 4 + 5** **Insulation Min: R-10ci** **Assembly Max: C-0.092**	**Climate Zones 4 (Marine) + 5** Insulation Min: R-7.5ci Assembly Max: C-0.119
Floors	**Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016, Residential)**	**Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC, Group R)**
Mass	**Climate Zone 4 + 5** **Insulation Min: R-16.7ci** **Assembly Max: U-0.051**	**Climate Zones 4 (Marine) + 5** Insulation Min: R-12.5ci Assembly Max: U-0.064
Steel Joist	**Climate Zone 4 + 5** Insulation Min: R-30 Assembly Max: U-0.038	**Climate Zones 4 (Marine) + 5** Insulation Min: R-30 **Assembly Max: U-0.033**
Wood-framed and Other	**Climate Zone 4 + 5** Insulation Min: R-30 Assembly Max: U-0.033	**Climate Zones 4 (Marine) + 5** Insulation Min: R-30 Assembly Max: U-0.033

A FEW DIFFERENCES BETWEEN 90.1-2016 AND 2018 IECC ENVELOPE

Slab-on Grade Floors	Part 1 – Commercial Energy Provisions (4+ stories, ASHRAE 90.1-2016, Residential)	Part II – Multi-family Energy Provisions (≤ 3 stories, 2018 IECC, Group R)
Unheated	**Climate Zone 4** Insulation Min: R-15 for 24 in. below Assembly Max: F-0.520 **Climate Zone 5** Insulation Min: R-20 for 24 in. below Assembly Max: F-0.510	**Climate Zones 4 (Marine) + 5** Insulation Min: R-10 for 24 in. below Assembly Max: F-0.54
Heated	**Climate Zone 4 + 5** Insulation Min: R-20 for 48 in. below Assembly Max: F-0.688	**Climate Zones 4 (Marine) + 5** Insulation Min: R-15 for 36 in. below + R-5 full slab Assembly Max: F-0.79 (perimeter insulation), F-0.64 (full slab insulation)

VESTIBULES

- **Both 90.1-2016 and 2018 IECC require vestibules, but have slightly different exceptions**

ASHRAE 90.1-2016 vestibule exceptions

Exceptions to 5.4.3.4

1. *Building entrances* with revolving *doors*.
2. *Doors* not intended to be used as a *building entrance*.
3. *Doors* opening directly from a *dwelling unit*.
4. *Building entrances* in *buildings* located in Climate Zone 1 or 2.
5. *Building entrances* in *buildings* that are located in Climate Zone 3, less than four stories above *grade*, and less than 10,000 ft^2 in *gross conditioned floor area*.
6. *Building entrances* in *buildings* that are located in Climate Zone 0, 4, 5, 6, 7, or 8 and are less than 1000 ft^2 in *gross conditioned floor area*.
7. *Doors* that open directly from a *space* that is less than 3000 ft^2 in area and is separate from the *building entrance*.
8. *Semiheated spaces*.
9. Enclosed elevator lobbies for *building entrances* directly from parking garages.

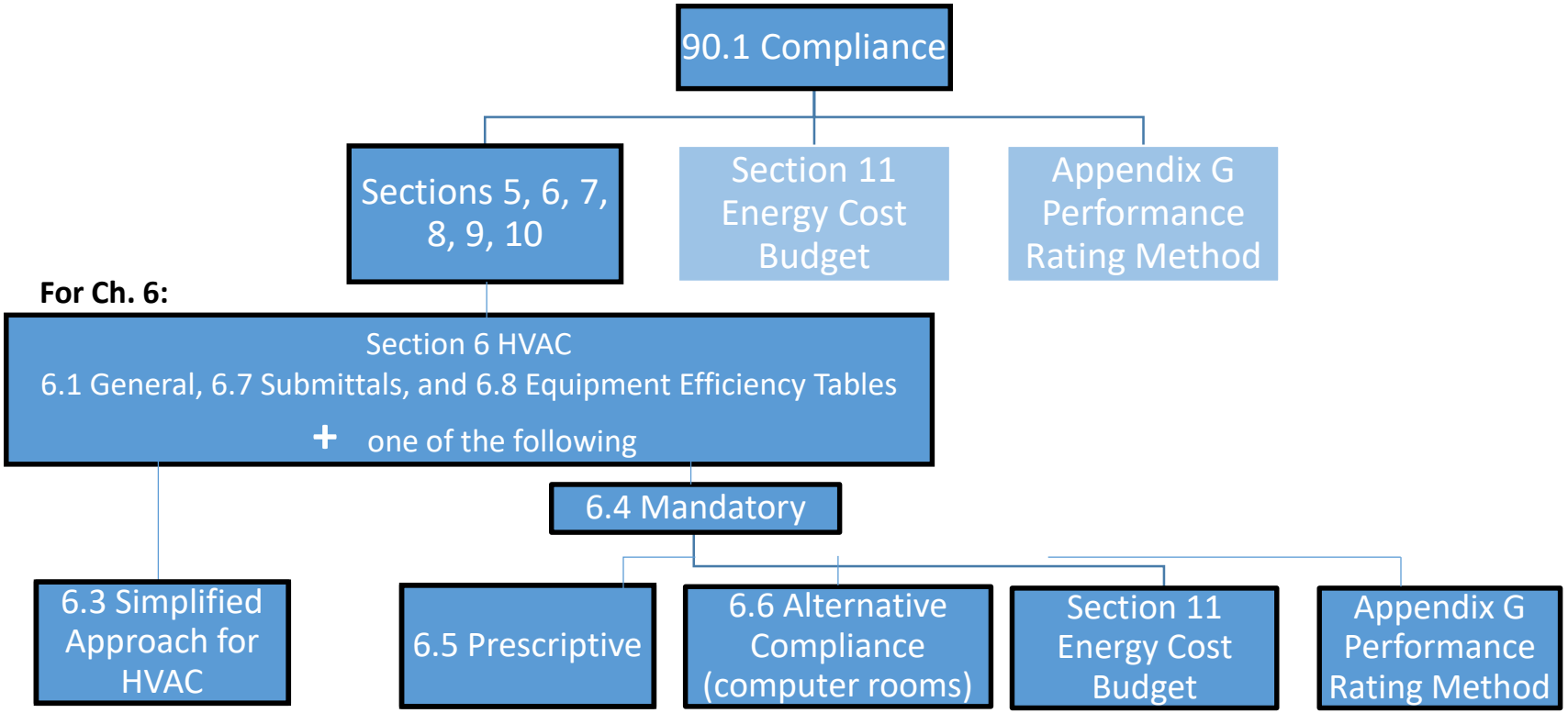
2018 IECC Vestibule exceptions

Exceptions: Vestibules are not required for the following:

1. Buildings in *Climate Zones* 1 and 2.
2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. Doors that have an air curtain with a velocity of not less than 6.56 feet per second (2 m/s) at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or

HVAC

CHAPTER 6 HVAC COMPLIANCE PATHS



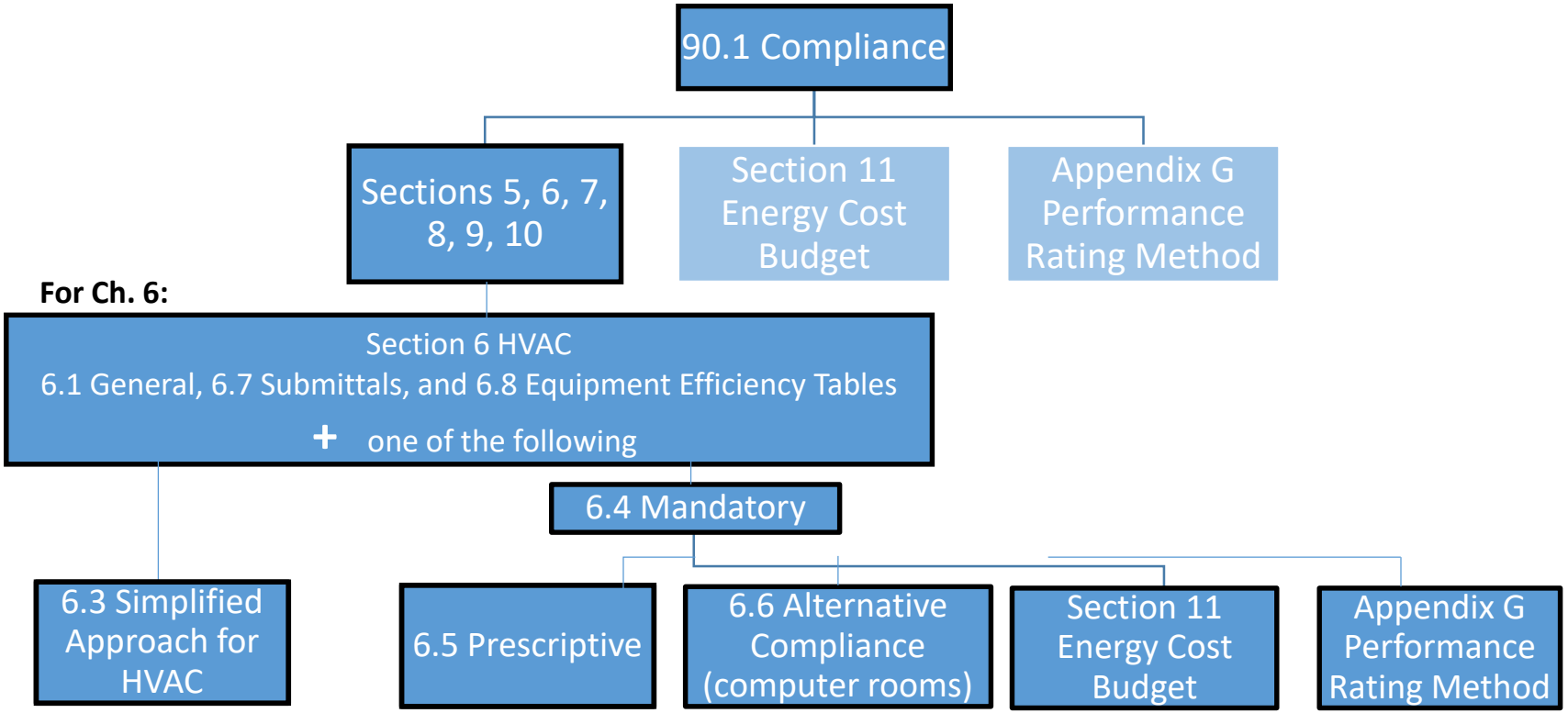
OREGON DEPARTMENT OF ENERGY

Simplified Path

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.3	N/A

- Available if systems and building meet certain criteria
  - 2 stories or fewer
  - Floor area < 25,000 ft^2
  - Each HVAC system complies with a list of requirements in 6.3.2 (ALL must be met)
- 6.3.2 contains a host of requirements including
  - Single zone HVAC
  - Supply fan variable flow
  - Cooling and heating with packaged or SS that meets efficiency tables
  - Economizer if required by other sections
  - Electric resistance heat limitations for heat pumps
  - Piping and ductwork insulation in accordance with other sections
  - + some others

CHAPTER 6 HVAC COMPLIANCE PATHS



OREGON DEPARTMENT OF ENERGY

6.4 – Mandatory Provisions

EQUIPMENT EFFICIENCIES

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.1, Tables 6.8.1-x	503.2.3, Tables 503.2.3(x)

- General updates across multiple types of equipment
- These are pretty much the same as federal minimums
- Efficiency increases for some packaged AC/heat pumps, terminal AC/ heat pump units, boilers, VRF
- New efficiency table for DOAS units
- Previous Oregon code was mostly from 90.1-2013

LOAD CALCULATIONS

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.2	503.2.1

- Similar requirement for calculation of heating and cooling loads for the purpose of sizing systems and equipment to be done in accordance with ANSI/ASHRAE/ACCA Standard 183
- New general requirement for pump differential pressure (head) to be determined in accordance with generally accepted engineering standards.

ZONE THERMOSTATIC CONTROLS

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.1	503.2.4.1

- Similar requirement for individual zone thermostatic control
- Dwelling units permitted to be considered a single zone
- Same exception for independent perimeter systems that are designed to offset building envelope loads only, are permitted to serve one or more zones

DEAD BAND / SETPOINT OVERLAP RESTRICTION

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.2, 6.4.3.1.2	503.2.4.2

- Similar requirements
- Where used to control both heating and cooling, zone thermostatic controls shall be ***capable and configured to*** a 5F deadband
- Where heating and cooling are controlled by separate zone thermostatic controls, provide means to prevent heating setpoint from exceeding the cooling setpoint

"Capable and configured to" change throughout the code

OREGON DEPARTMENT OF ENERGY

OFF HOUR CONTROLS

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.3	503.2.4.3, 503.2.4.4, 503.2.4.7

- Automatic Shutdown
  - Time schedule controls (7 day) **OR** occupant sensor **OR** timer (up to 2 hours) **OR** security system interlock
  - Exception for Residential occupancies to allow for controls that start/stop the system under two different time schedules per week
- Setback controls
  - 2014 OEESC: specified setback capabilities down to 55F (heating) or up to 85F (cooling)
  - 90.1-2016: capable and configured to 10F below heating setpoint and 5F above cooling setpoint (or to prevent high humidity levels)
- Optimum start controls
  - 2014 OEESC: general requirement for optimum start
  - 90.1-2016: systems with setback controls and DDC shall have optimum start.
    - **Requires algorithm to be a function of difference between space T, occupied setpoint, OAT, and time until occupancy**
- Zone Isolation – similar requirements, some new exception language

HOTEL HVAC - OFF HOUR CONTROLS

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.3.5	N/A

Hotel/Motel Guestroom HVAC

- If > 50 guest rooms, controls capable of and configured to:
  - Unoccupied: within 30 minutes of guest leaving, automatically raise/lower setpoint by 4F
  - Unrented and unoccupied: setpoints automatically reset to 80F or higher cooling and 60F or lower heating
  - Unrented and unoccupied determined by either
    - Continuously unoccupied for up to 16 hours
    - Networked guest room control system indicates room is unrented and is unoccupied for 30 minutes

OFF HOUR CONTROLS

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.3.5	N/A

- Hotel/Motel Guestroom Ventilation
  - Within 30 minutes of all occupants leaving the guest room, turn off ventilation and exhaust fans or use isolation devices to shut off outdoor air to the guest room and exhaust air from the guest room. Daily OA purge is allowed for 60 minutes or 1 air change

- Captive key card systems can be used to comply with setpoint and ventilation requirements

OREGON DEPARTMENT OF ENERGY

SHUTOFF DAMPER CONTROLS, LEAKAGE

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.4.2-3	503.2.4.5

New

- OA intake and exhaust equipped with motorized dampers that will automatically shut when system or spaces are not in use
- Capable of and configured to automatically shut off during warm-up, cool down, and setback (unless ventilation reduces energy or code-required)
- Leakage performance requirements of **10 cfm/ft^2** motorized, 20 cfm/ft^2 non-motorized <3 stories
- Exceptions
  - Gravity dampers okay for exhaust and relief in buildings <3 stories
  - Gravity dampers okay in systems with design OA <=300 cfm
  - Unconditioned space ventilation and exhaust
  - Systems serving Type 1 kitchen exhaust

Previous

- OA supply, exhaust, and relief need Class I motorized damper
- Maximum leakage **4 cfm/ft^2** at 1" wg tested in accordance with AMCA 500D
- Exceptions:
  - Gravity dampers okay if <= 300 cfm
  - Relief dampers integral to packaged equipment
  - Type I grease exhaust

VENTILATION FAN CONTROLS

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.4.4	N/A

- Fans with motors > 0.75 hp shall have automatic controls complying with 6.4.3.3.1 to turn off fans when not required, unless they are intended to operate continuously
- Controls can be time schedules, occupant sensors, manual timer, or security system interlock

ENCLOSED PARKING GARAGE VENTILATION

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.4.5	503.2.5.3

Requirements are mostly similar

90.1-2016: automatically detect contaminant levels and reduce flow by

- Staging fans or
- Modulating fan airflow

to rates 50% or less of design capacity as long as acceptable contaminant levels are maintained

- Contaminant and levels not defined
- Exceptions:
  - Garages <30,000 ft^2 with no mechanical cooling or heating
  - hp ratio > 1,500 ft^2/hp with no mechanical cooling or heating
  - Where not permitted by AHJ

2014 OEESC:

- Group S-2 only
- Same 30,000 ft^2 threshold
- Specified contaminant (CO) and ppm to maintain
- Minimum ventilation rate specified

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HEAT PUMP AUXILIARY HEAT CONTROL

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.5	503.2.4.1.1

- Similar requirements
- Requires heat pumps with internal resistance heat to have controls that prevent supplemental heater operation when the heat pump alone can meet the load
  - during both steady-state operation and setback recovery
  - Supplemental heat is okay during defrost cycles

DEMAND CONTROLLED VENTILATION

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.8	503.2.5.1

- Similar requirements
- Continues to apply to spaces > 500 ft^2, with design occupancy for ventilation of >= 25 people per 1000 ft^2 and served by systems with either
  - Air-side economizer
  - Automatic modulating control of OA damper, or
  - Design OA flow > 3000 cfm
- Slightly different exceptions. 90.1-2016 exceptions are:

Exceptions to 6.4.3.8

1. *Systems* with exhaust air *energy* recovery complying with Section 6.5.6.1.
2. Multiple-zone *systems* without *DDC* of individual zones communicating with a central *control* panel.
3. *Systems* with a design outdoor airflow less than 750 cfm.
4. *Spaces* where >75% of the *space* design outdoor airflow is required for *makeup air* that is exhausted from the *space* or *transfer air* that is required for *makeup air* that is exhausted from other *spaces*.
5. *Spaces* with one of the following occupancy categories as defined in ASHRAE Standard 62.1: correctional cells, daycare sickrooms, science labs, barbers, beauty and nail salons, and bowling alley seating.

HEATED OR COOLED VESTIBULES

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.9	N/A

- Automatic off required for vestibule heating when outside air temperature > 45F
- Maximum 60F heating setpoint, minimum 85F cooling setpoint
- Exceptions: if energy used to condition the vestibule is from site-recovered energy or transfer air that would otherwise be exhausted

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DDC Requirements

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.10	N/A

- DDC required for certain applications and qualifications

Table 6.4.3.10.1 *DDC* Applications and Qualifications

Building Status	Application	Qualifications
New *building*	Air-handling *system* and all zones served by the *system*	Individual *systems* supplying more than three zones and with fan *system* bhp of 10 hp and larger
	Chilled-water plant and all coils and *terminal* units served by the *system*	Individual plants supplying more than three zones and with design cooling capacity of 300,000 Btu/h and larger
	Hot-water plant and all coils and *terminal* units served by the *system*	Individual plants supplying more than three zones and with design heating capacity of 300,000 Btu/h and larger
Alteration or addition	Zone *terminal* unit such as *VAV* box	Where existing zones served by the same air-handling, chilled-water, or hot-water *system* have *DDC*
	Air-handling *system* or fan coil	Where existing air-handling *systems* and fan coils served by the same chilled- or hot-water plant have *DDC*
	New air-handling *system* and all new zones served by the *system*	Individual *systems* with fan *system* bhp of 10 hp and larger and supplying more than three zones and more than 75% of zones are new
	New or upgraded chilled-water plant	Where all chillers are new and plant design cooling capacity is 300,000 Btu/h and larger
	New or upgraded hot-water plant	Where all *boilers* are new and plant design heating capacity is 300,000 Btu/h and larger

DDC Requirements

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.10	N/A

- Where DDC IS required, certain capabilities are required:

6.4.3.10.2 DDC Controls

Where *DDC* is required by Section 6.4.3.10.1, the *DDC system* shall be capable of and configured with all of the following, as required, to provide the *control* logic required in Section 6.5:

a. Monitoring zone and *system demand* for fan pressure, pump pressure, heating, and cooling.

b. Transferring zone and *system demand* information from zones to air *distribution system* controllers and from air *distribution systems* to heating and cooling plant controllers.

c. Automatically detecting those zones and *systems* that may be excessively driving the *reset* logic and generate an alarm or other indication to the *system* operator.

d. Readily allowing operator removal of zones from the *reset* algorithm.

CHW Plant Monitoring

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.11	N/A

For electric motor-driven CHW plants

- In new buildings
- New plants in existing buildings

Monitoring and measurement for energy use and efficiency (kW/ton) is required for all chiller plants over a certain capacity, which for Oregon climate zones is:

- Water-cooled CHW plants: > 1500 tons peak cooling capacity
- Air-cooled CHW plants: > 860 tons peak cooling capacity

Economizer Fault Detection and Diagnosis

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.3.12	N/A

Air cooled DX units with an economizer installed in accordance with 6.5.1 shall include fault detection and diagnostics (FDD) with a host of required sensors and capabilities

6.4.3.12 Economizer Fault Detection and Diagnostics (FDD)

Air-cooled direct-expansion cooling units listed in Tables 6.8.1-1 and 6.8.1-2, where an *air economizer* is installed in accordance with Section 6.5.1, shall include a fault detection and diagnostics (FDD) *system* complying with the following:

a. The following temperature sensors shall be *permanently installed* to monitor *system* operation:
   1. *Outdoor air*
   2. Supply air
   3. Return air, where required for economizer *control*

b. The *system* shall have the capability of displaying the value of each sensor.

c. The FDD *system* or unit *controls* shall be capable of and configured to provide *system* status by indicating the following:
   1. Free cooling available
   2. Economizer enabled
   3. Compressor enabled
   4. Heating enabled
   5. Mixed-air low-limit cycle active

d. The FDD *system* or unit *controls* shall have provisions to manually initiate each operating mode so that the operation of compressors, economizers, fans, and the heating *system* can be independently tested and verified.

e. The FDD *system* shall be capable of and configured to detect the following faults:
   1. Air temperature sensor failure/fault
   2. Not economizing when the unit should be economizing
   3. Economizing when the unit should not be economizing
   4. Damper not modulating
   5. Excess *outdoor air*

f. The FDD *system* shall be capable of and configured to report faults to a fault management application or *DDC system* accessible by operating or *service* personnel, or annunciated locally on zone *thermostats*.

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HVAC Duct Insulation

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.4.1.2	503.2.7

New - 90.1-2016

- Based on location, heating and/or cooling
- Generally increased from R-5 to R-6 for unconditioned space
- Exterior requirement will depend on system type and CZ

Old - 2014 OEESC:

- Unconditioned spaces: R-5
- Exterior: R-8
- Exceptions
  - When inside equipment
  - Inside/outside duct DT <15F

Table 6.8.2 Minimum Duct Insulation R-Value[a]

Climate Zone	Duct Location		
	Exterior [b]	*Unconditioned Space* and Buried Ducts	*Indirectly Conditioned Space* [c,d]
Supply and Return Ducts for Heating and Cooling			
0 to 4	R-8	R-6	R-1.9
5 to 8	R-12	R-6	R-1.9
Supply and Return Ducts for Heating Only			
0 to 1	None	None	None
2 to 4	R-6	R-6	R-1.9
5 to 8	R-12	R-6	R-1.9
Supply and Return Ducts for Cooling Only			
0 to 6	R-8	R-6	R-1.9
7 to 8	R-1.9	R-1.9	R-1.9

a. Insulation *R-values*, measured in h·ft^2·°F/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where portions of the *building envelope* are used as a *plenum* enclosure, *building envelope* insulation shall be as required by the most restrictive condition of Section 6.4.4.1 or Section 5, depending on whether the *plenum* is located in the *roof*, *wall*, or *floor*. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a *mean temperature* of 75°F at the installed thickness.

b. Includes attics above insulated ceilings, parking garages and crawl *spaces*.

c. Includes return air plenums with or without exposed *roofs* above.

d. Return ducts in this duct location do not require insulation.

HVAC Piping Insulation

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.4.4.1.3	503.2.8

No changes. Old and new requirements (heating) are:

Table 6.8.3-1 Minimum *Piping* Insulation Thickness Heating and Hot Water Systems[a,b,c,d,e] (Steam, Steam Condensate, Hot-Water Heating and Domestic Water *Systems*)

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		≥Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft^2·°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350	0.32 to 0.34	250	4.5	5.0	5.0	5.0	5.0
251 to 350	0.29 to 0.32	200	3.0	4.0	4.5	4.5	4.5
201 to 250	0.27 to 0.30	150	2.5	2.5	2.5	3.0	3.0
141 to 200	0.25 to 0.29	125	1.5	1.5	2.0	2.0	2.0
105 to 140	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r\{(1 + t/r)^{K/k} - 1\}$, where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu·in/h·ft^2·°F]; and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. These thicknesses are based on *energy efficiency* considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.

c. For *piping* smaller than 1.5 in. and located in partitions within *conditioned spaces*, reduction of these thicknesses by 1 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.

d. For direct-buried heating and hot-water *system piping*, reduction of these thicknesses by 1.5 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.

e. The table is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having *thermal resistance* greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per metre than a steel pipe of the same size with the insulation thickness shown in the table.

6.5 – Prescriptive Path

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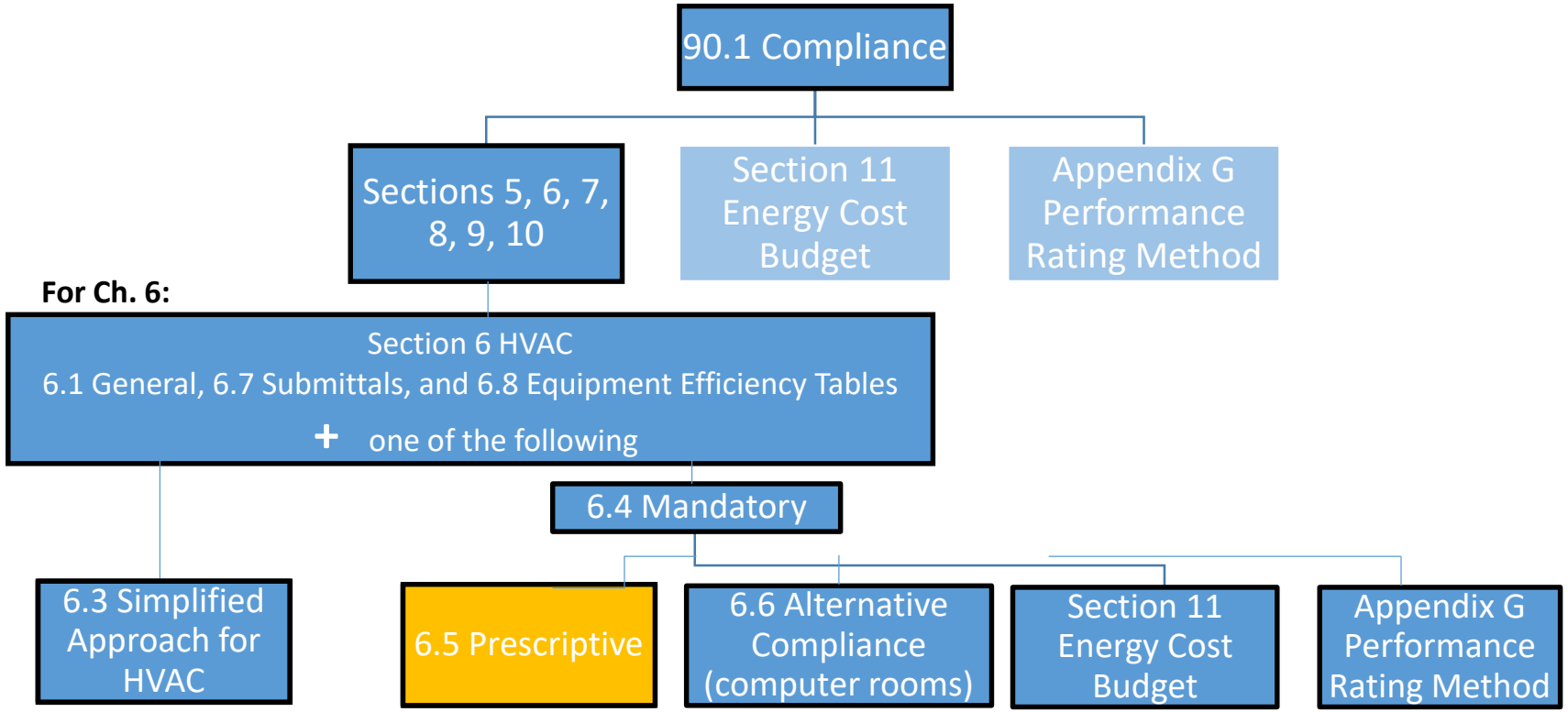
CHAPTER 6 HVAC COMPLIANCE PATHS



OREGON DEPARTMENT OF ENERGY

Economizers

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.1	503.3.1, 503.4.1

- Same general threshold for economizer requirement (capacity ≥ 54,000 btu/hr)
- Multiple exceptions, including:

6. *Systems* that serve *residential spaces* where the *system* capacity is less than five times the requirement listed in Table 6.5.1-1.

Table 6.5.1-1 Minimum Fan-Cooling Unit Size for which an Economizer Is Required

Climate Zone	Cooling Capacity for which an Economizer Is Required
0A, 0B, 1A, 1B	No economizer requirement
2A, 2B, 3A, 4A, 5A, 6A, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	≥54,000 Btu/h

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Economizers

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.1	503.3.1, 503.4.1

- New efficiency improvement alternative to economizers
- Other exceptions related to specific scenarios:
  - Chilled-water cooling systems without a fan or that use induced airflow, where the total capacity of these systems is less than 1,000,000 Btu/h in Climate Zone 4; less than 1,400,000 Btu/h in Climate Zones 5
  - Non-particulate air treatment
  - Hospitals and processes with humidity requirements
  - Condenser heat recovery is present
  - Smaller residential systems
  - Low load or load operating hours
  - Supermarkets with affected open refrigeration

Table 6.5.1-2 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling *Efficiency*

Climate Zone	*Efficiency* Improvement[a]
2A	17%
2B	21%
3A	27%
3B	32%
3C	65%
4A	42%
4B	49%
4C	64%
5A	49%
5B	59%
5C	74%
6A	56%
6B	65%
7	72%
8	77%

a. If a unit is rated with an *IPLV*, *IEER*, or *SEER*, then to eliminate the required economizer, th minimum cooling *efficiency* of the HVAC unit must be increased by the percentage show If the HVAC unit is only rated with a full-load metric like *EER* cooling then these must increased by the percentage shown.

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Air Economizers – Capacity and Control

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.1.1.2	N/A

- Control through mixed-air-temperature-only is not allowed (except for single-zone systems)
- Capable and configured to require high-limit shut-off
- Sensor calibration and accuracy requirements

Table 6.5.1.1.3 High-Limit Shutoff *Control* Settings for *Air Economizers*[b]

Control Type	Allowed Only in Climate Zone at Listed *Set Point*	Required High-Limit *Set Points* (Economizer Off when):	
		Equation	Description
Fixed dry-bulb temperature	0B, 1B, 2B, 3B, 3C, 4B, 4C, 5B, 5C, 6B, 7, 8	$T_{OA} > 75°F$	*Outdoor air* temperature exceeds 75°F
	5A, 6A	$T_{OA} > 70°F$	*Outdoor air* temperature exceeds 70°F
	0A, 1A, 2A, 3A, 4A,	$T_{OA} > 65°F$	*Outdoor air* temperature exceeds 65°F
Differential dry-bulb temperature	0B, 1B, 2B, 3B, 3C, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	$T_{OA} > T_{RA}$	*Outdoor air* temperature exceeds return air temperature
Fixed enthalpy with *fixed* dry-bulb temperature	All	$h_{OA} > 28$ Btu/lb[a] or $T_{OA} > 75°F$	*Outdoor air* enthalpy exceeds 28 Btu/lb[a] of dry air[a] or *outdoor air* temperature exceeds 75°F
Differential enthalpy with *fixed* dry-bulb temperature	All	$h_{OA} > h_{RA}$ or $T_{OA} > 75°F$	*Outdoor air* enthalpy exceeds return air enthalpy or *outdoor air* temperature exceeds 75°F

a. At altitudes substantially different than sea level, the *fixed* enthalpy limit shall be set to the enthalpy value at 75°F and 50% rh. As an example, at approximately 6000 ft elevation, the *fixed* enthalpy limit is approximately 30.7 Btu/lb.
b. Devices with selectable rather than adjustable *set points* shall be capable of being set to within 2°F and 2 Btu/lb of the *set point* listed.

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Integrated Economizer Control

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.1.3	N/A

- Economizer interlocked with mechanical cooling to provide partial cooling even when some mechanical cooling is required.
- Units with economizers must also have:
  - Interlocking to limit OA damper closing for frost protection until leaving air temperature is less than 45F
  - > 65,000 btu/hr units that control the capacity of mechanical cooling based on occupied space temperature shall have minimum 2 stages of cooling
  - All other DX units that control space temperature by modulating airflow to the space shall comply with:

Table 6.5.1.3 DX Cooling Stage Requirements for Modulating Airflow Units

Rating Capacity, Btu/h	Minimum Number of Mechanical Cooling Stages	Minimum Compressor Displacement[a]
≥65,000 and <240,000	3	≤35% of full load
≥240,000	4	≤25% full load

a. For mechanical cooling stage *control* that does not use variable compressor displacement the percent displacement shall be equivalent to the mechanical cooling capacity reduction evaluated at the full load rating conditions for the compressor.

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Fan System Power Limitation

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.3.1.1, 6.5.3.1.2	503.2.10.1, 503.2.10.2

- Still applies to systems with total fan system motor nameplate hp > 5
- Same Fan Power Limitation equation

Table 6.5.3.1-1 Fan Power Limitation[a]

	Limit	Constant Volume	Variable Volume
Option 1: Fan *system* motor nameplate hp	Allowable *motor nameplate hp*	$hp \le cfm_S \times 0.0011$	$hp \le cfm_S \times 0.0015$
Option 2: Fan *system* bhp	Allowable fan *system* bhp	$bhp \le cfm_S \times 0.00094 + A$	$bhp \le cfm_S \times 0.0013 + A$

  - Pressure drop adjustments:
    - Credits mostly the same (change for ERV credit)
    - New deductions required for systems without central cooling, heating, or with central electric resistance heat
- Still requirement to select fan motor no larger than the first available motor size greater than the bhp, with indication of bhp on design documents
  - Same exceptions as before, plus **new exception for fans with nameplate < 1 hp**

Fan Efficiency

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.3.1.3	N/A

- Fans shall have a fan efficiency grade (FEG) of 67 or higher
- Total efficiency of the fan at design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan
- Number of exceptions
  - Individual fans ≤ 5hp that are not part of a group operating as functional equivalent of a single fan
  - Multiple fans in series or parallel (fan arrays) that have combined nameplate ≤ 5hp
  - Fans that are part of equipment under 6.4.1.1
  - Powered wall/roof ventilators
  - Fans outside the scope of the applicable standard AMCA 205
  - Emergency applications

Fan Control

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.3.2.1	503.2.10.3

New

- Required to vary fan speed as a function of load for:
  - DX: units ≥ **65,000 btu/hr**, for any fan size
  - CHW/Evap: Required for any capacity and ≥ **$^1/_4$ hp** fans
- If DX/CHW unit capacity is controlled based on space T, minimum 2 stages
- If units control space temperature by modulating airflow to the space, shall have modulating airflow
- Low speed required during low-cooling, ventilation operation
- Exceptions: < 1 hp, CHW/evap, and if not used for ventilation and cycles with load, also exceptions to accommodate minimum ventilation

Previous

- Required to vary fan speed (2-speed or VFD) for:
  - DX: single zone units with capacity ≥ **110,000 btu/hr**
    - Reduce to 66% airflow
  - Without DX: fan systems > 8,000 cfm
    - Reduce to 60% airflow
- VAV fan ≥ 10 hp control with VFD

Temperature Control	Typical Zones	Minimum fan speed	Fan power at min speed	Fan control
Space T by modulating airflow	Multiple	≤ 50%	≤ 30%	Modulating
Capacity based on room T	Single	≤ 66%	≤ 40%	Two-speed, Multi-speed or Modulating

VAV Static Pressure Sensor Location

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.3.2.2	N/A

- Required to locate static pressure sensors such that the setpoint is ≤ 1.2” wg, with accommodation for major duct splits
  - Exception: systems with VAV setpoint re-set

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VAV Setpoint Reset

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.3.2.3	503.4.2

New

- Static pressure reset required for systems with total power > 5 hp (if DDC and individual zones reporting to central panel) based on zone requiring the most pressure
- Clarification for control requirements and requirement for alarms for zones that excessively drive reset logic **(faulty zones)**

Previous

- Static pressure reset required for systems with total power > 10 hp (if DDC and individual zones reporting to central panel) based on zone requiring the most pressure

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Fractional Horsepower Fan Motors

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.3.6	503.2.10.4

- Requirement for fans with $^{1}/_{12} \leq$ horsepower < 1 motors to be ECM or have a minimum motor efficiency of 70%
- Also required to have means to adjust motor speed for either balancing or remote control (belt-driven fans may use sheave-adjustment for balancing)
- Exceptions
  - Motors in airstream that operating only when providing heating
  - Motors installed in space-conditioning equipment under 6.4.1
  - Fire-pump electric motors, capacitor-start, capacitor-run, and capacitor-start/induction-run small motors
- Previous similar requirements only applied to series fan-powered terminal unit fans

Ventilation Design

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.3.7	N/A

Requires one of the following for OA ventilation systems:

- Design ventilation limited to 135% of the required minimum OA rate (larger or 62.1, exhaust, or other applicable codes/standards.
- Dampers, ductwork, and controls required to allow the system to supply no more than the required minimum OA rate with a single set-point adjustment
- System includes exhaust air energy recovery in compliance with other parts of 90.1

Pipe Sizing

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.4.6	N/A

- Applies to CHW and condenser water piping
- Maximum flow rates shall not exceed the value provided for the given pipe size and operating hours
- Increased maximum values (allowances) for variable flow/variable speed systems
- Exceptions
  - Piping sections not in the critical circuit at design conditions (and not expected to be in critical circuit for more than 30% of operating hours)
  - Other piping systems with same or less total pressure drop than values in table as applied to standard weight steel pipe

Chilled Water Coil Selection

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.4.7	N/A

- Minimum 15F water temperature delta T
- Minimum 57F LWT at design conditions

Exceptions

1. Coils with an air-side pressure drop exceeding 0.70 in. of water when rated at 500 fpm face velocity and dry conditions (no condensation).
2. Individual fan-cooling units with a design supply airflow rate 5000 cfm and less.
3. Constant-air-volume systems.
4. Coils selected at the maximum temperature difference allowed by the chiller.
5. Passive coils (no mechanically supplied airflow).
6. Coils with design entering chilled-water temperatures of 50°F and higher.
7. Coils with design entering air dry-bulb temperatures of 65°F and lower.

Heat Rejection Equipment – Fan Speed Control

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.5.2	503.4.4

- Fan speed control required for motors (or array of motors) ≥ 5 hp (compared to 7.5 previously)
- Must result in fan motor demand reduction to ≤ 30% of design wattage at 50% design airflow
- Fan speed modulated based on leaving fluid temperature or condensing temperature/pressure of heat rejection device

Exceptions

- Condenser fans serving multiple refrigerant circuits or fluid cooling circuits
- Condenser fans serving flooded condensers

Energy Recovery

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.6.1	503.2.6

New

- For systems operating < 8000 hours/yr, no requirement
- For systems operating ≥ 8000 hours/yr, based on cfm and OA %. If cfm exceeds value, energy recovery is required

Previous

- Required for systems ≥ 5,000 cfm and ≥ 70% OA

Table 6.5.6.1-2 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Greater than or Equal to 8000 Hours per Year

	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
Climate Zone	Design Supply Fan Airflow Rate, cfm							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	≥120
0A, 1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	≥140	≥120	≥100	≥80
4A, 5A, 6A, 6B, 7, 8	≥200	≥130	≥100	≥80	≥70	≥60	≥50	≥40

NR—Not required

Energy Recovery

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.6.1	503.2.6

- Result is some cases that would have required ERV before may not now, and vice versa
- Recovery system effectiveness ≥ 50%
- Number of exceptions
  - Lab systems meeting 6.5.7.3
  - Systems serving uncooled spaces that are heated to < 60°F
  - Where > 60% of outdoor heating energy is provided from site-recovered or site solar energy
  - Cooling energy recovery in climate zones 3c, **4c, 5b,** 5c, 6b, 7, and 8
  - Where sum of airflow rates exhausted and relieved within 20 ft of each other is < 75% of the design outdoor airflow
  - Systems requiring dehumidification that employ energy recovery in series with the cooling coil
  - Systems operating < 20 hrs/week at outdoor air % in Table 6.5.6.1-1

Heat Recovery for Service Water Heating

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.6.2	503.4.5.4

- Same threshold as before, required when:
  - Heat rejection capacity > 6,000,000 btu/hr AND service water heating load > 1,000,000 btu/hr
  - Previously design reheat was included in the 1,000,000 threshold, but now it only includes service water heating capacity
- New requirement for 24 hours/day facility operation before requirement applies
- Heat recovery minimum capacity smaller of:
  - 60% of peak heat rejection load (increased from 30% in previous code)
  - Preheat of peak service hot water draw to 85F
- New exception for facilities that provide condenser heat recovery for space heat
- Similar exception for when > 60% (previously 25%) of service water heating energy is provided from site-recovered or site solar energy

Door Switches

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.5.10	N/A

- New requirement for controls that will, when door is open:
  - Disable heating or adjust setpoint to 55F within 5 minutes
  - Disable cooling or adjust setpoint to 90F within 5 minutes

- Exceptions:
  - Entries with automatically closing devices
  - Spaces with no thermostat
  - Alterations to existing buildings
  - Loading docks

OREGON DEPARTMENT OF ENERGY

Submittals / Completion

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
6.7	503.2.9

New

- Construction documents shall require that :
  - within 90 days after system acceptance, record drawings and O&M manual delivered to owner
  - All HVAC systems be balanced with generally accepted engineering standards, and air and hydronic systems first balanced to minimize losses and then to meet design flow conditions
  - Written TAB report be provided to owner for zones > 5000 ft^2
  - Buildings > 50,000 ft^2 conditioned area, except warehouses and semiheated spaces, detailed **Cx instructions** for HVAC systems shall be provided by designer in plans and specs
- General requirement for requirements to be on the plans, but building official shall not require copies of any reports or drawings

Previous

- Requirement to provide a means for system balancing
- Requirement to construction documents specify delivery of O&M manual to building owner

7 – Service Water Heating

Service Water Heating

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
Chapter 7.4	504

- Requirements for temperature controls for storage temperature adjustment
- Pipe insulation
  - 2014 OEESC: 1” for all recirculating and externally heated piping, 0.5” for first 8 feet of non-recirculating systems
  - ASHRAE 90.1-2016
    - insulation required for recirculating and externally heated piping, first 8 feet of non-recirculating system and branch piping
    - Pipe insulation thickness is dependent on fluid temperature and pipe diameter. Mostly 1” required for most common applications, but could be more for hotter water and larger pipes

Service Water Heating

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
Chapter 7.4	504

- 90.1 requires automatic controls (via time switch or other) to turn off temperature maintenance during extended periods of non-utilization. 2014 OEESC had similar requirement, but required demand sensing controls and systems < 100,000 btu/hr were exempted
- Similar requirement for heat traps for non-recirculating systems
- Similar requirements for pool heaters on/off, pool covers, and time switch for pool heaters and pumps
- 90.1-2016 does not contain same previous Oregon requirement for indoor pool heat recovery
- 90.1 max temperature to public facility restrooms = 110F (it was 120F in OEESC)

High Capacity Service Water Heating

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
7.5.3	504

- Large service water heating systems with total installed input capacity ≥ 1,000,000 Btu/hr are required to have:
  - Weighted average thermal efficiency ≥ 90%
  - So some units can be non-condensing, but requires some to be condensing

- Exceptions
  - Where 25% of annual service water heating requirement is provided by solar or site-recovered energy
  - **Equipment is installed in individual dwelling units**
  - Individual gas water heaters with input capacity < 100,000 btu/hr

OREGON DEPARTMENT OF ENERGY

8 - Power

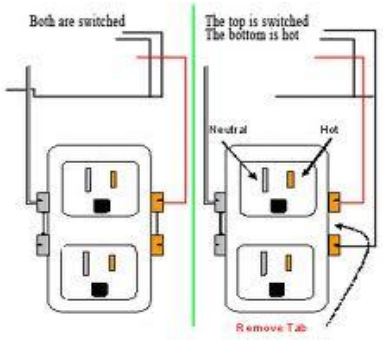
SECTION 8 – 8.4.2
AUTOMATIC RECEPTACLE CONTROL

- NOTE: Requirement in ASHRAE 90.1, but NOT in 2018 IECC
- Not necessarily as applicable to multifamily, but important to keep in mind

Automatically controlled

≥ 50% of all 125 volt 15- and 20-amp receptacles in:

- Private offices
- Conference rooms
- Rooms used primarily for printing and/or copying functions
- Break rooms
- Classrooms
- Individual workstations



≥ 25% of branch circuit feeders installed for modular furniture not shown on construction documents

SECTION 8 – 8.4.2
AUTOMATIC RECEPTACLE CONTROL *(CONT'D)*

Automatic control devices must function on:

- Time-of-day controller provided to control ≤ 5,000 ft^2 and not more than one floor (occupant able to manually override up to 2 hours) OR
- Occupant sensor(s) to turn off receptacles within 20 minutes of occupant leaving the space, OR
- Automated signal from another control or alarm that turns receptacles off within 20 minutes after determining the area is unoccupied

Controlled receptacles must be

- **visually marked to differentiate from uncontrolled receptacles**
- **uniformly distributed throughout the space**

Plug-in type devices may not be used to comply with this requirement

<u>Exceptions</u>

- **Receptacles designated for equipment requiring 24 hr/day 365 days/yr operation**
- **Spaces where automatic control would cause security or safety concerns**

SECTION 8 – 8.4.3
ELECTRICAL ENERGY MONITORING

Measurement devices in new building to monitor electrical energy use for each of these separately:

- Total electrical energy
- HVAC systems
- Interior lighting
- Exterior lighting
- Receptacle circuits

For buildings with multiple tenants, the above must be separately monitored for total building and for each tenant (excluding shared systems)

Exception:

- up to 10% of each separate load (other than total) can be from other electrical loads

SECTION 8 – 8.4.3
ELECTRICAL ENERGY MONITORING – RECORDING AND REPORTING

- Energy use must be automatically recorded a minimum of every 15 minutes
- Use must be reported at least hourly, daily, monthly, and annually
- Data for tenants must be made available to that tenant
- The system must be capable of retaining data for at least 36 months

Exceptions to Sections 8.4.3.1 and 8.4.3.2

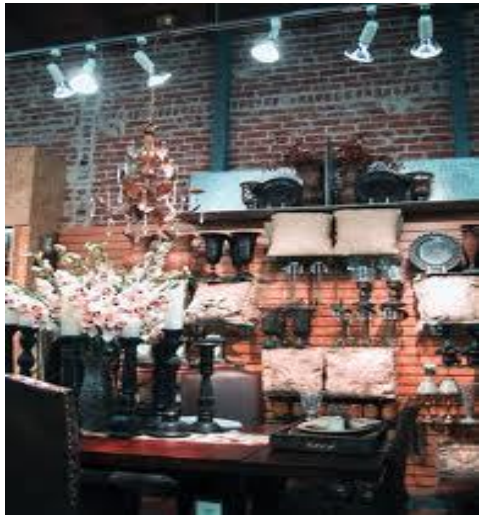
1. *Building* less than 25,000 ft^2.
2. Individual tenant *spaces* less than 10,000 ft^2.
3. *Dwelling units*.
4. *Residential buildings* with less than 10,000 ft^2 of common area.
5. Critical and *Equipment* branches of NEC Article 517.

9 - Lighting

REDUCED LIGHTING POWER ALLOWANCES

- Primarily based on improved efficacy of LED lighting
- Exterior lighting power reduced ~ 40%
- LPDs reduced in general, **but not for Multifamily**
- Interior LPD (Building):
- Space-by-space
  generally reduced more

Example LPD	OR 2014	90.1-2016
Office Building	0.91	0.79
Multifamily	0.58	0.68



SECTION 9 LIGHTING

- ✓ **General Application *(Section 9.1)***
  - Scope
  - Lighting Alterations
  - Installed Lighting Power
  - Interior and Exterior Luminaire Wattage
- ✓ **Compliance *(Section 9.2)***
- ✓ **Mandatory Provisions *(Section 9.4)***
  - Lighting control
  - Exterior lighting power
  - Functional testing
  - **Dwelling units**
  - Climate zone exception for daylighting control
- ✓ **Building Area Method Compliance Path *(Section 9.5)***
- ✓ **Alternative Compliance Path: Space-by-Space Method *(Section 9.6)***

DWELLING UNIT LIGHTING

- ## ASHRAE 90.1-2016

9.4.4 Dwelling Units

Not less than 75% of the *permanently installed* lighting *fixtures* shall use *lamps* with an *efficacy* of at least 55 lm/W or have a total *luminaire efficacy* of at least 45 lm/W.

Exception to 9.4.4:

Lighting that is controlled with *dimmers* or *automatic control devices*.

- ## 2018 IECC

R404.1 Lighting equipment (Mandatory). Not less than 90 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps.

HIGH-EFFICACY LAMPS. Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, or other lamps with an efficacy of not less than the following:

1. 60 lumens per watt for lamps over 40 watts.
2. 50 lumens per watt for lamps over 15 watts to 40 watts.
3. 40 lumens per watt for lamps 15 watts or less.

TABLE 9.5.1 BUILDING AREA METHOD

Table 9.5.1 *Lighting Power Density* Allowances Using the *Building* Area Method

Building Area Type[a]	*LPD*, W/ft^2
Automotive facility	~~0.79~~ 0.71
Convention center	~~1.08~~ 0.76
Courthouse	~~1.05~~ 0.90
Dining: Bar lounge/leisure	~~0.99~~ 0.90
Dining: Cafeteria/fast food	~~0.90~~ 0.79
Dining: Family	~~0.89~~ 0.78
Dormitory	~~1.00~~ 0.61
Exercise center	~~0.88~~ 0.65
Fire station	~~0.74~~ 0.53
Gymnasium	~~1.00~~ 0.68
Health-care clinic	~~0.89~~ 0.82
Hospital	~~1.08~~ 1.05
Hotel/motel	~~1.00~~ 0.75
Library	~~1.17~~ 0.78
Manufacturing facility ~~(Data Center)~~	~~1.24~~ 0.90
Motion picture theater	0.83
Multifamily	~~0.58~~ 0.68
Museum	~~1.04~~ 1.06
Office	~~0.91~~ 0.79
Parking garage	~~0.25~~ 0.15
Penitentiary	~~1.00~~ 0.75
Performing arts theater	~~1.39~~ 1.18
Police station	~~0.89~~ 0.80
Post office	~~0.98~~ 0.67
Religious facility	~~1.05~~ 0.94
Retail	~~1.32~~ 1.06
School/university	~~1.01~~ 0.81
Sports arena	~~0.78~~ 0.87
Town hall	~~0.94~~ 0.80
Transportation	~~0.77~~ 0.61
Warehouse	~~0.66~~ 0.48
Workshop	~~1.20~~ 0.90

a. In cases where both a general *building* area type and a specific *building* area type are listed, the specific *building* area type shall apply.

Multifamily	0.68

Building Area Method LPDs are the same between 90.1-2016 and 2018 IECC

9.6 INTERIOR LIGHTING CONTROLS

- New table format that includes Space-By-Space LPDs and control requirements

Small part of Table 9.6.1 shown below

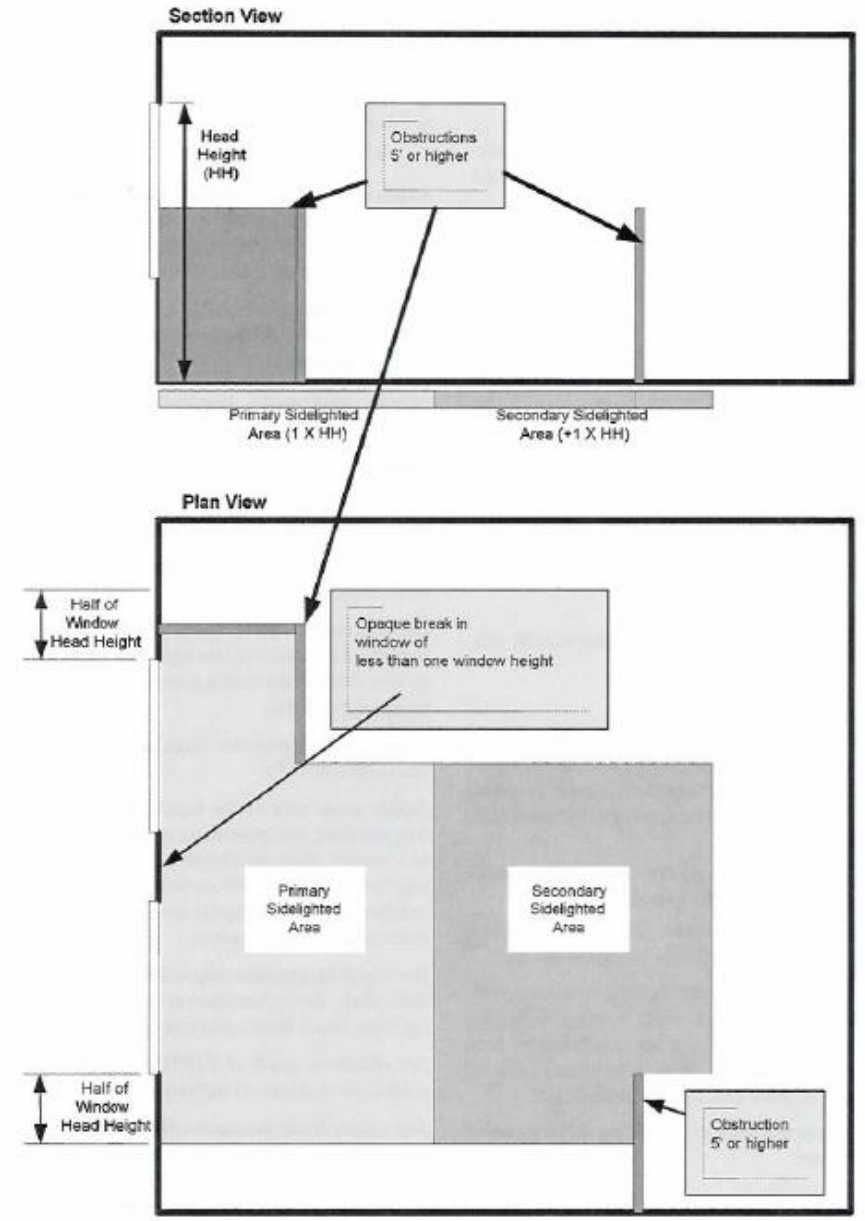
Informative Note: This table is divided into two sections; this first section covers space types that can be commonly found in multiple building types. The second part of this table covers space types that are typically found in a single building type.			The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each space type: (1) All REQs shall be implemented. (2) At least one ADD1 (when present) shall be implemented. (3) At least one ADD2 (when present) shall be implemented.								
Common Space Types[1]	LPD	RCR	Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c]	Bilevel Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section	Automatic Daylight Responsive Controls for Toplighting (See Section	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complie	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
			a	b	c	d	e	f	g	h	i
Atrium											
<20 ft in height	0.03/ft total	NA	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
≥20 ft and ≤40 ft in height	0.03/ft total	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
>40 ft in height	0.40 + 0.02/ft total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Audience Seating Area											
Auditorium	0.63	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Convention center	0.82	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Gymnasium	0.65	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Motion picture theater	1.14	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Penitentiary	0.28	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Performing arts theater	2.03	8	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Religious building	1.53	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Sports arena	0.43	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
All other audience seating areas	0.43	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Banking Activity Area	0.86	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Breakroom (See Lounge/Breakroom)											
Classroom/Lecture Hall/Training Room											

SPACE-BY-SPACE METHOD LPD

Figure 2: ASHRAE 90.1-2016 & 2018 IECC LPD Allowances Using Space-by-Space Method and Minimum Control Requirements for Common Multifamily Space Types

Space Type	ASHRAE 90.1-2016			2018 IECC	
	LPD (W/ft^2)	Lighting Controls Required	If Lighting Controls not Required, Recommended Reduction for Savings Credit	LPD (W/ft^2)	Lighting Controls Required[19]
Conference / Meeting / Multipurpose Room	1.07	YES	-	1.07	YES
Corridor	0.66	YES	-	0.66	-
Corridor, Facility for the Visually Impaired	0.92	YES	-	0.92	-
Electrical/Mechanical	0.43	-	10%	0.43	-
Exercise Area	0.50	YES	-	0.50	-
Laundry/Washing Area	0.43	YES	-	0.43	-
Lobby	1.00	YES	-	1.0	-
Lobby, Facility for the Visually Impaired	2.03	YES		2.03	-
Lounge/Recreation	0.62	YES	-	0.62	YES
Office	0.93	YES	-	0.93	YES
Restroom	0.85	YES	-	0.85	YES
Stairwell	0.58	YES	-	0.58	-
Storage, ≤50 ft2	0.97	YES	-	N/A	N/A
Storage, all other	0.46	YES	-	0.46	YES
Workshop	1.14	YES	-	1.14	-

SECTION 9 – 9.4.1.4
DAYLIGHT ZONE DEFINITION – SECONDARY SIDELIGHTED AREA



SECTION 9 – 9.4.1.1 (E)
AUTOMATIC DAYLIGHT RESPONSIVE CONTROLS FOR SIDELIGHTING

- **Apply photocontrols if the combined input power of all general lighting completely or partially within:**
  - Primary sidelighted areas is ≥ 150 W
  - Primary and secondary sidelighted areas is ≥ 300 W
  - General lighting in secondary sidelighted area controlled independently of general lighting in primary sidelighted area
- **Control system must have following characteristics**
  - Calibration adjustment located ≤ 11ft above finished floor
  - Photocontrol to reduce electric lighting in response to available daylight using
    - Continuous dimming or
    - At least one control point between 50% and 70% of design light power
    - Second control point between 20% and 40% of design light power or
    - Lowest dimming level technology allows
    - Third control point that turns off all controlled lighting
    - Calibration doesn't require physical presence of a person at sensor while calibration is processing

EXTERIOR/PARKING CONTROLS

- General exterior lighting requirements to reduce power by 50% during unoccupied periods or after business hours (no requirement in 2014 OEESC)
- Exterior parking lighting required to reduce by 50% during period of inactivity (2014 OEESC states 33%)
- New parking garage lighting controls (30% reduction during periods of inactivity and daylight controls)

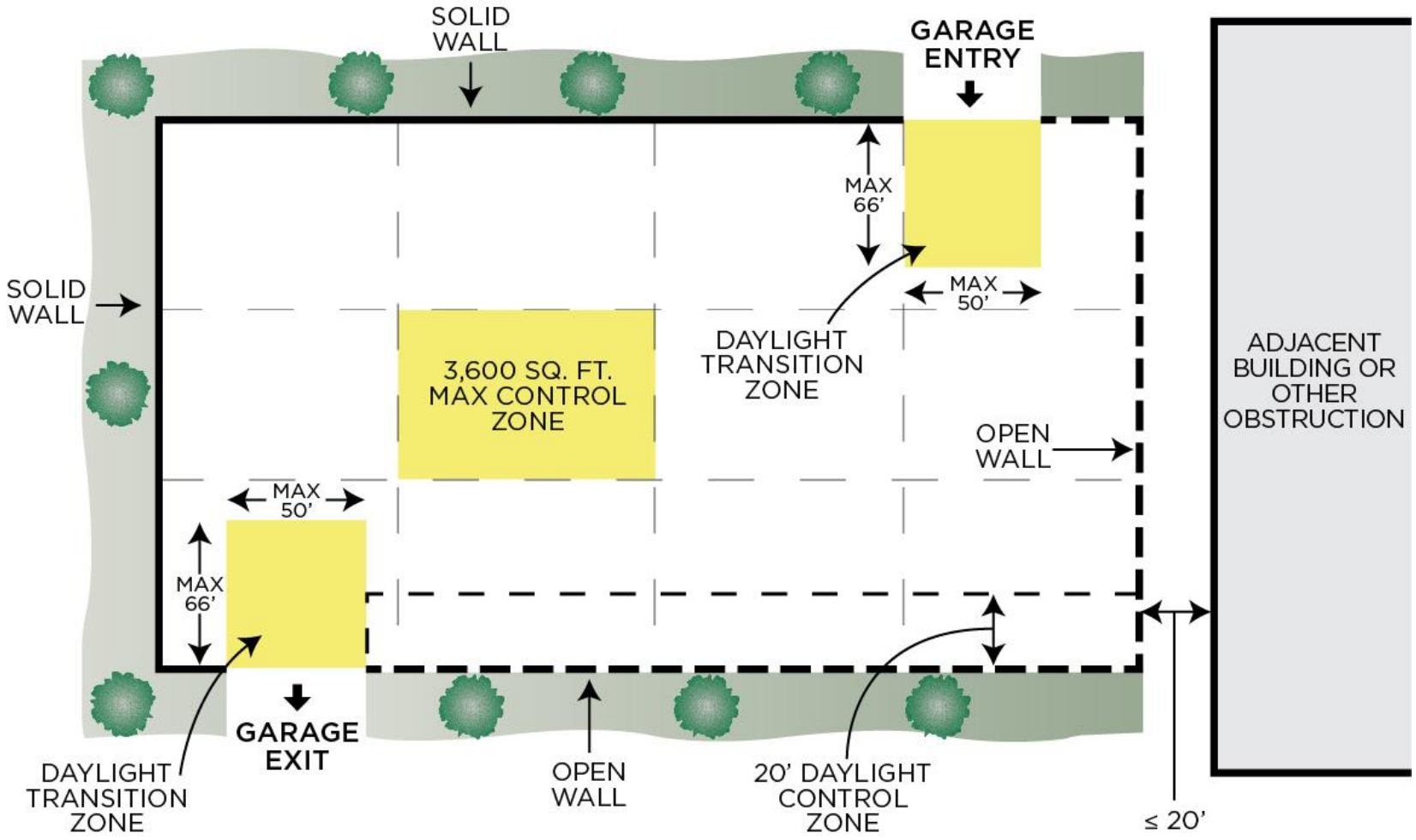
SECTION 9 – 9.4.1.2
PARKING GARAGE LIGHTING CONTROL

- **Automatic lighting shutoff per 9.4.1.1(i)**
- **Must reduce lighting power by minimum of 30% when no activity is detected for 20 minutes within a lighting zone ≤ 3,600 ft^2**
- **Automatically reduce power at least 50% in response to daylight for luminaires within 20 ft of any perimeter wall that has**
  - a net opening to wall ratio of ≥ 40% and
  - no exterior obstructions within 20 ft

Exception

- **Daylight transition zones and ramps without parking are exempt from 30% reduction and daylight control**

SECTION 9 – 9.4.1.2
PARKING GARAGE LIGHTING CONTROL



IECC Additional Efficiency Package Options

IECC C406

- In addition to the prescriptive requirements, IECC also requires an "additional efficiency package option" to be selected for compliance
- ASHRAE 90.1-2016 does not have this same additional "pick one" requirement

SECTION C406
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

C406.1 Requirements. Buildings shall comply with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9

Compliance Documentation

COMMERCIAL ENERGY CODE

Code Compliance Form

State of Oregon
Building Codes Division
Better Buildings for Oregon

Part I COMcheck information

Compliance path:

- ❑ Performance path
- ❑ Prescriptive path

COMcheck (Standard 90.1) results:

- ❑ Pass
- ❑ Fail *If using the performance path, submit the energy model report with this form

Prepared by or under the supervisions of: _____ **Date:** _____

Part II Projected energy use

Enter the ZERO Code Calculator results for projected energy use.

Estimated building energy consumption: _____ MBtu/yr

Part III Estimated available renewables for the building

Enter the ZERO Code Calculator results for offsets.

Total renewable energy necessary to achieve Net Zero: _____ MBtu/yr

On-site potential PV rated capacity _____ kW

CHECKLIST AND APPLICANT SIGNATURE

COMcheck report and ZERO Code Calculator report must be submitted with this form.

- ❑ **COMcheck report is attached**
- ❑ **Energy model report is attached** (if COMcheck failed)
- ❑ **ZERO Code Calculator report is attached**

https://zero-code.org/energy-calculator/

Performance Pathways

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
Ch. 11, Appendix G	506

- Previous Oregon code contained Section 506 Whole Building Approach, based on 90.1 Ch. 11 Energy Cost Budget
- 90.1 includes two performance paths for code compliance, Ch.11 and Appendix G
  - Both based on energy simulation
  - Both compare a proposed building design to a baseline building meeting the prescriptive requirements of the code
  - Both compare the annual energy cost ($) of the proposed building to the baseline building

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Performance Pathways

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
Ch. 11, Appendix G	506

- Ch. 11 Energy Cost Budget has been used for code compliance in the past to demonstrate whole-building compliance when some prescriptive compliance elements are not met
  - ECB proposed design impacts the baseline more. Baseline matches the proposed design in many parameters, backed down to code prescriptive values
  - Baseline changes with each code iteration
- Appendix G is widely used already for beyond-code and performance programs like LEED
  - Provides some credit that wouldn't be available for good design choices that are more energy efficient than what is standard practice
  - Fixed baseline to 90.1-2004, but performance index targets change with each code

$$Performance\ Cost\ Index\ (PCI) = \frac{Proposed\ Building\ Performance}{Baseline\ Building\ Performance}$$

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Performance Pathways

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
Appendix G	506

- Appendix G compliance is achieved when:
  Performance Cost Index PCI < Performance Cost Index Target PCI_t
- Performance Cost Targets are specific for each climate zone and building type and consider regulated vs. unregulated (plug) load impact

$$PCI_t = \frac{(BBUEC + (BPF \cdot BBREC))}{BBP} \qquad Performance\ Cost\ Index\ (PCI) = \frac{Proposed\ Building\ Performance}{Baseline\ Building\ Performance}$$

- New "Building Performance Factors" with each code iteration will ratchet down the PCI_t for compliance
- Appendix G for code compliance and beyond-code programs could lead to efficiencies in model development – one model for multiple purposes – and could encourage market development to automate simulation process for baseline

OREGON DEPARTMENT OF ENERGY

Performance Pathways

2019 Oregon / ASHRAE 90.1-2016	2014 OEESC
Appendix G	506

Table 4.2.1.1 *Building* Performance Factor (BPF)

Building Area Type[a]	Climate Zone																
	0A and 1A	0B and 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily	0.73	0.73	0.71	0.69	0.74	0.73	0.68	0.78	0.81	0.81	0.76	0.80	0.81	0.76	0.79	0.74	0.80
Healthcare/ hospital	0.64	0.56	0.60	0.56	0.60	0.56	0.54	0.57	0.53	0.55	0.59	0.52	0.55	0.57	0.52	0.56	0.56
Hotel/motel	0.64	0.65	0.62	0.60	0.63	0.65	0.64	0.62	0.64	0.62	0.60	0.61	0.60	0.59	0.61	0.57	0.58
Office	0.58	0.62	0.57	0.62	0.60	0.64	0.54	0.58	0.60	0.58	0.60	0.61	0.58	0.61	0.61	0.57	0.61
Restaurant	0.62	0.62	0.58	0.61	0.60	0.60	0.61	0.58	0.55	0.60	0.62	0.58	0.60	0.63	0.60	0.65	0.68
Retail	0.52	0.58	0.53	0.58	0.54	0.62	0.60	0.55	0.60	0.60	0.55	0.59	0.61	0.55	0.58	0.53	0.53
School	0.46	0.53	0.47	0.53	0.49	0.52	0.50	0.49	0.50	0.49	0.50	0.50	0.50	0.49	0.50	0.47	0.51
Warehouse	0.51	0.52	0.56	0.58	0.57	0.59	0.63	0.58	0.60	0.63	0.60	0.61	0.65	0.66	0.66	0.67	0.67
All others	0.62	0.61	0.55	0.57	0.56	0.61	0.59	0.58	0.57	0.61	0.57	0.57	0.61	0.56	0.56	0.53	0.52

a. In cases where both a general *building* area type and a specific *building* area type are listed, the specific *building* area type shall apply

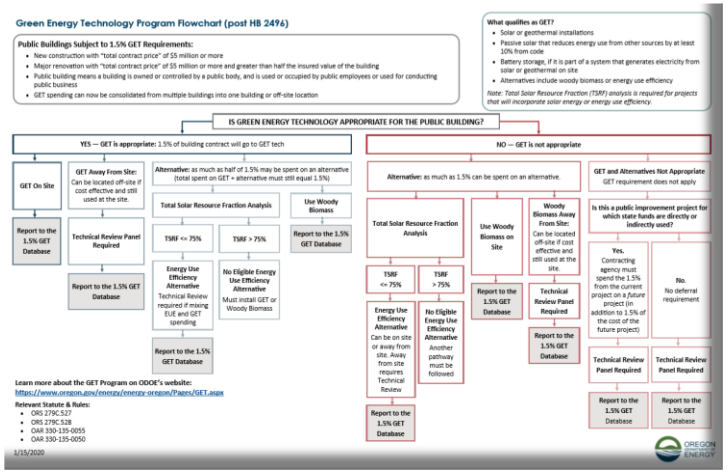
OREGON DEPARTMENT OF ENERGY

1.5% FOR GREEN ENERGY TECHNOLOGY

Not energy code, but related…

The 1.5% for Green Energy Technology (GET) requirement applies to public entities in Oregon. 1.5 percent of the total contract price of a public improvement contract ($5 million or greater) for new construction or a major renovation of a public building must be spent on green energy technology or an alternative, regardless of the funding source.

Program flow chart on ODOE website:



Green energy technology includes

- **Solar technologies** such as photovoltaic and solar thermal systems.
- **Passive solar** and day lighting systems that reduce whole building energy use by 10 percent or more.
- **Geothermal systems** that use geothermal source temperatures of 140 degrees or more to provide heating or make electricity. Geothermal systems in K-12 schools may use a source temperature of 128 degrees or higher. Ground source heat pumps do not meet the green energy technology requirement.
- **Battery storage** equipment and technology paired with solar or geothermal systems that generate electricity.

https://www.oregon.gov/energy/energy-oregon/Pages/GET.aspx

QUESTION BREAK

THANK YOU FOR ATTENDING

Oregon Housing and Community Services Multifamily Energy Program

www.oregonmultifamilyenergy.com

Mekha Abraham

MAbraham@trccompanies.com

Blake Shelide

Blake.Shelide@oregon.gov