Can the Washington State Energy Code Leap Toward the PHIUS+2015 Standard? —

Passive House Northwest

13th Annual North American Passive House Conference
Boston, Massachusetts

September 21, 2018

Book Cover: Encyclopedia of the Anthropocene
By Dominick A. DellaSafa and Michael I. Goldstein

Mike Fowler

@islandermike

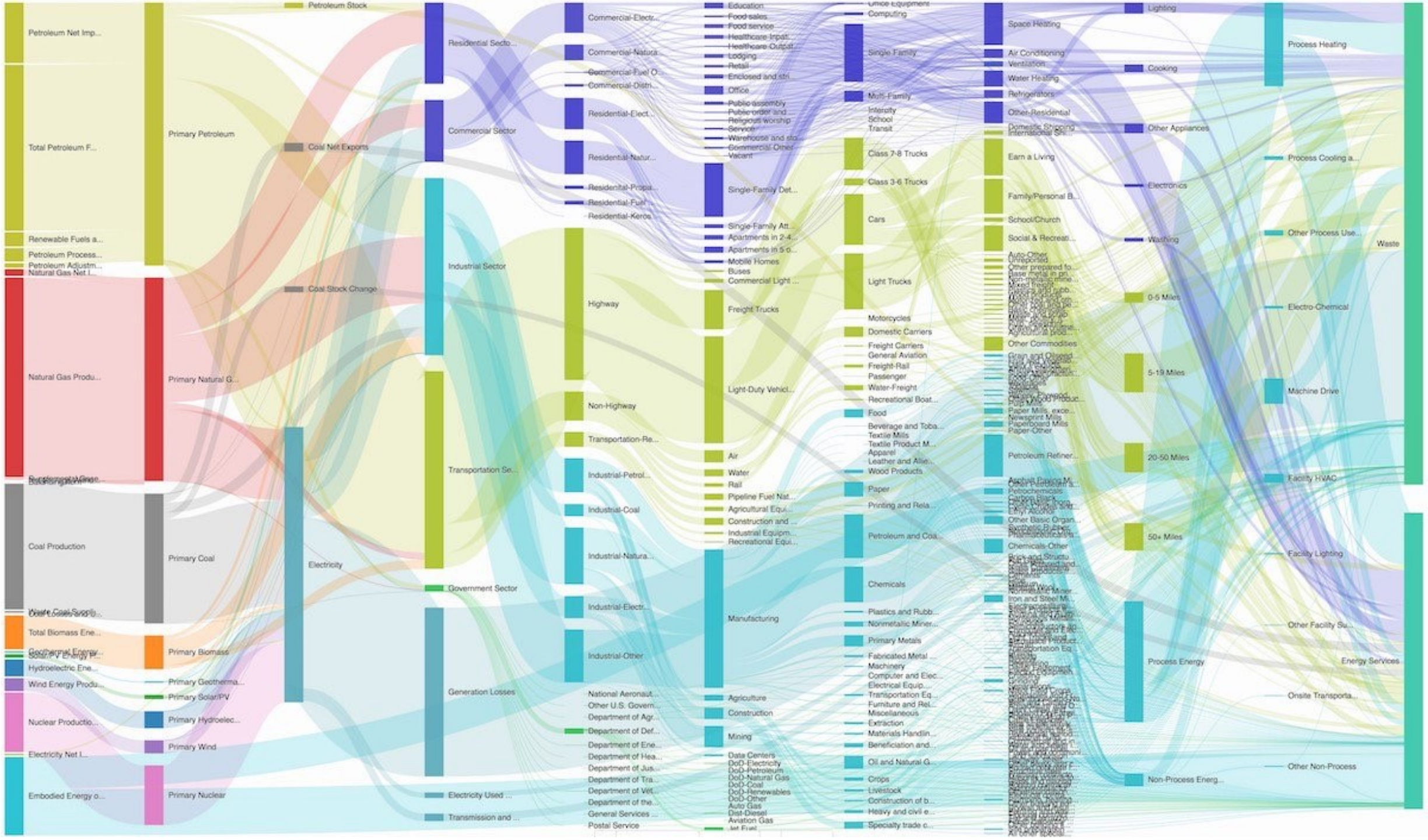
Architect | Passivhaus. The ‘crazy yahoo’ energy code proposer for WA Outcome-based energy budget and passive first measures. Airtightness/CAPE. PHnw President

Bainbridge Island, WA USA

PASSIVE HOUSE
+
POLICY

WHY?—


CLIMATE CHANGE
HEALTH CARE
RUSSIA
PRESIDENT
TAX
AMERICAN
VETERANS
FEDERAL
PROFILE
PHOTO
MARCO
SECURITY
AMERICA
POLICY
FACEBOOK
DONATE
EDUCATION
MUST
GOVERNMENT
VOLUNTEER
STATES
ISSUES
NEED
PLAN
JOIN
AMENDMENT
PEOPLE
BORDER
SYSTEM
MILITARY
ENERGY
CARE
VA
PAID
ENDORSE
IMMIGRATION
REFORM
JOBS
HEALTH
SUPPORT
CONTACT
HOME
ALSO
CRUZ
NEWS
FOREIGN
ELECTION
GOVERNOR
RIGHTS
PRIVACY
RAND
TWITTER
MAKE
SIGN
UNITED
NAME
BEN
U.S
FIRST
WAY
CARSON
MIKE
WASHINGTON
BUSINESSES
STORE
LAW
EVERY
FUNDS
WORLD
FAMILIES
SHARE
MEET
CRIMINAL
BETTER
ECONOMY
TIME
YEARS
PERSONAL
ENSURE
INSTAGRAM
SOCIAL
REFORMS
UPDATES
STRONG
HELP
CORPORATE
ANOTHER
EMAIL
FIGHT
YOUTUBE
GROWTH
TWEET
DEFENSE
ISRAEL
CONTRIBUTIONS
WORKERS
ACT
ONE
TAXES
LIKE
NEEDS
BACK
FOLLOW
PROGRAM
SUBMENU
TAKE
COSTS
USE
SERVICE
BUSINESS
CODE
TERMS
SANTORUM
DEBT
HOURS
INCOME
READ
WORK
SENIORS
VIDEOS
DEC
SPENDING
TRUMP
SMALL
CONTRIBUTE
STATE
TOGGLE
@TEDCRUZ
COUNTRY
TODAY
PROTECT
AGO
PAUL
ECONOMIC
MANY
LEARN
NATIONAL
ILLEGAL
BEST
HUCKABEE
SECOND
AMERICANS
LIFE
NATION
GET
RIGHT
INCREASE
JUST
RETWEETS
MAY
PAY
PRIVACY
ADMINISTRATION
OWN


Petroleum Net Imp...
Total Petroleum F...
Renewable Fuels a...
Petroleum Process...
Petroleum Adjustm...
Natural Gas Net I...
Natural Gas Produ...
Coal Production
Total Biomass Ene...
Hydroelectric Ene...
Wind Energy Produ...
Nuclear Productio...
Electricity Net I...
Embodied Energy o...
Primary Petroleum
Primary Natural G...
Primary Coal
Primary Biomass
Primary Geotherma...
Primary Solar/PV
Primary Hydroelec...
Primary Wind
Primary Nuclear
Petroleum Stock
Coal Net Exports
Coal Stock Change
Electricity
Residential Secto...
Commercial Sector
Industrial Sector
Transportation Se...
Government Sector
Generation Losses
Electricity Used ...
Transmission and ...
Commercial-Electr...
Commercial-Natura...
Commercial-Fuel O...
Commercial-Distri...
Residential-Elect...
Residential-Natur...
Residential-Propa...
Residential-Fuel ...
Residential-Keros...
Highway
Non-Highway
Transportation-Re...
Industrial-Petrol...
Industrial-Coal
Industrial-Natura...
Industrial-Electr...
Industrial-Other
National Aeronaut...
Other U.S. Govern...
Department of Agr...
Department of Def...
Department of Ene...
Department of Hea...
Department of Jus...
Department of Tra...
Department of Vet...
Department of the...
General Services ...
Postal Service
Education
Food sales
Food service
Healthcare Inpati...
Healthcare Outpat...
Lodging
Retail
Enclosed and stri...
Office
Public assembly
Public order and ...
Religious worship
Service
Warehouse and sto...
Commercial Other
Vacant
Single-Family Det...
Single-Family Att...
Apartments in 2-4...
Apartments in 5 o...
Mobile Homes
Buses
Commercial Light ...
Freight Trucks
Light-Duty Vehicl...
Air
Water
Rail
Pipeline Fuel Nat...
Agricultural Equi...
Construction and ...
Industrial Equipm...
Recreational Equi...
Manufacturing
Agriculture
Construction
Mining
Data Centers
DoD-Electricity
DoD-Petroleum
DoD-Natural Gas
DoD-Coal
DoD-Renewables
DoD-Other
Auto Gas
Dist-Diesel
Aviation Gas
Jet Fuel
Office Equipment
Computing
Single Family
Multi-Family
Intercity
School
Transit
Class 7-8 Trucks
Class 3-6 Trucks
Cars
Light Trucks
Motorcycles
Domestic Carriers
Freight Carriers
General Aviation
Freight-Rail
Passenger
Water-Freight
Recreational Boat...
Food
Beverage and Toba...
Textile Mills
Textile Product M...
Apparel
Leather and Allie...
Wood Products
Paper
Printing and Rela...
Petroleum and Coa...
Chemicals
Plastics and Rubb...
Nonmetallic Miner...
Primary Metals
Fabricated Metal ...
Machinery
Computer and Elec...
Electrical Equip....
Transportation Eq...
Furniture and Rel...
Miscellaneous
Extraction
Materials Handlin...
Beneficiation and...
Oil and Natural G...
Crops
Livestock
Construction of b...
Heavy and civil e...
Specialty trade c...
Space Heating
Air Conditioning
Ventilation
Water Heating
Refrigerators
Other-Residential
Domestic Shipping
International Shi...
Earn a Living
Family/Personal B...
School/Church
Social & Recreati...
Auto-Other
Unreported
Other prepared fo...
Base metal in pri...
Non-metallic mine...
Mixed freight
Other Commodities
Grain and Oilseed
Paper Mills, exce...
Newsprint Mills
Paperboard Mills
Paper-Other
Petroleum Refiner...
Petrochemicals
Other Basic Organ...
Chemicals-Other
Iron and Steel Mi...
Process Energy
Non-Process Energ...
Lighting
Cooking
Other Appliances
Electronics
Washing
0-5 Miles
5-19 Miles
20-50 Miles
50+ Miles
Process Heating
Process Cooling a...
Other Process Use...
Electro-Chemical
Machine Drive
Facility HVAC
Facility Lighting
Other Facility Su...
Onsite Transporta...
Other Non-Process
Waste
Energy Services

Will the COP-21 PARIS AGREEMENT goals be achieved?

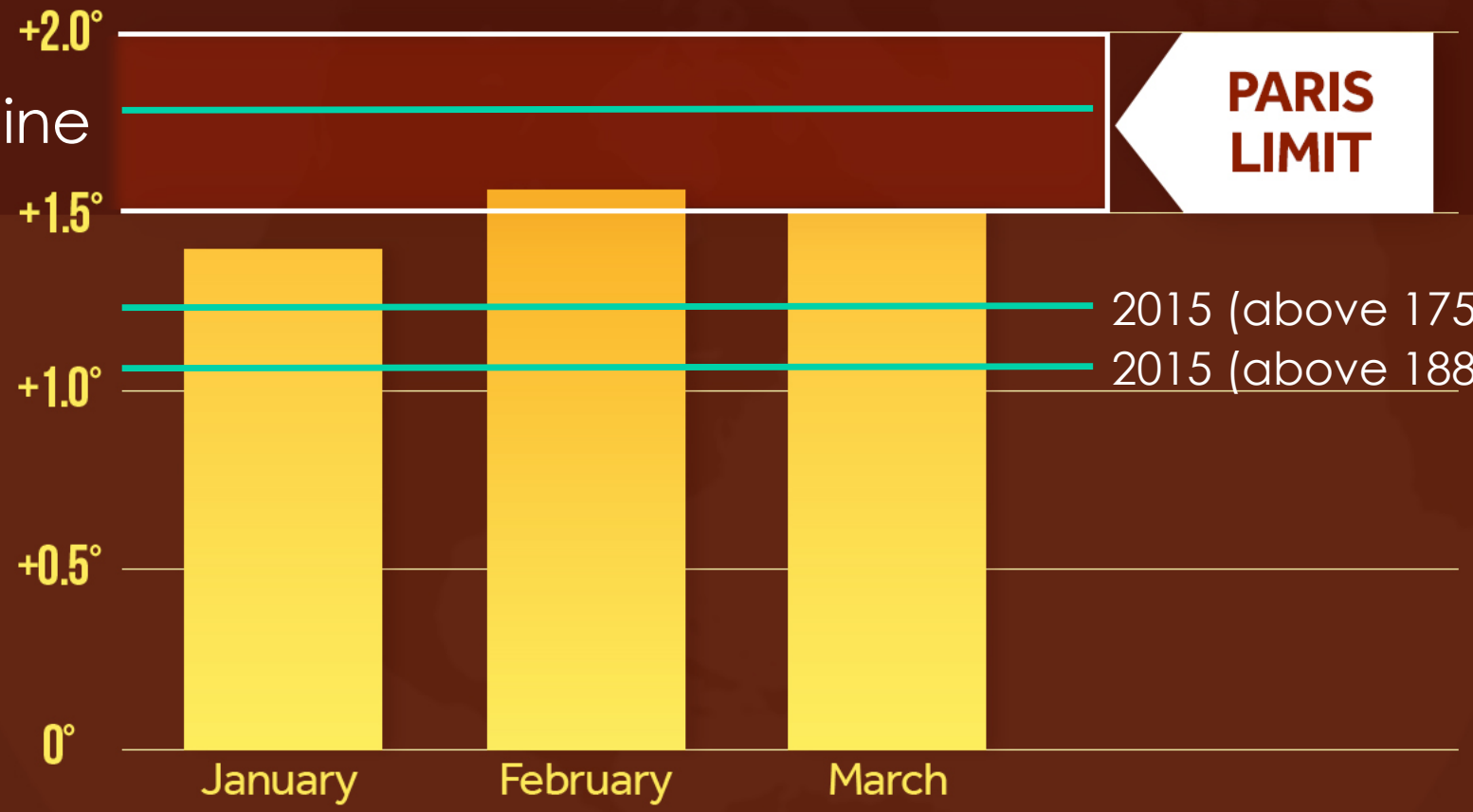
PARIS – COP21

2.7 – 3.5 C (if all commitments met)

In the pipeline

ALREADY PUSHING THE LIMIT

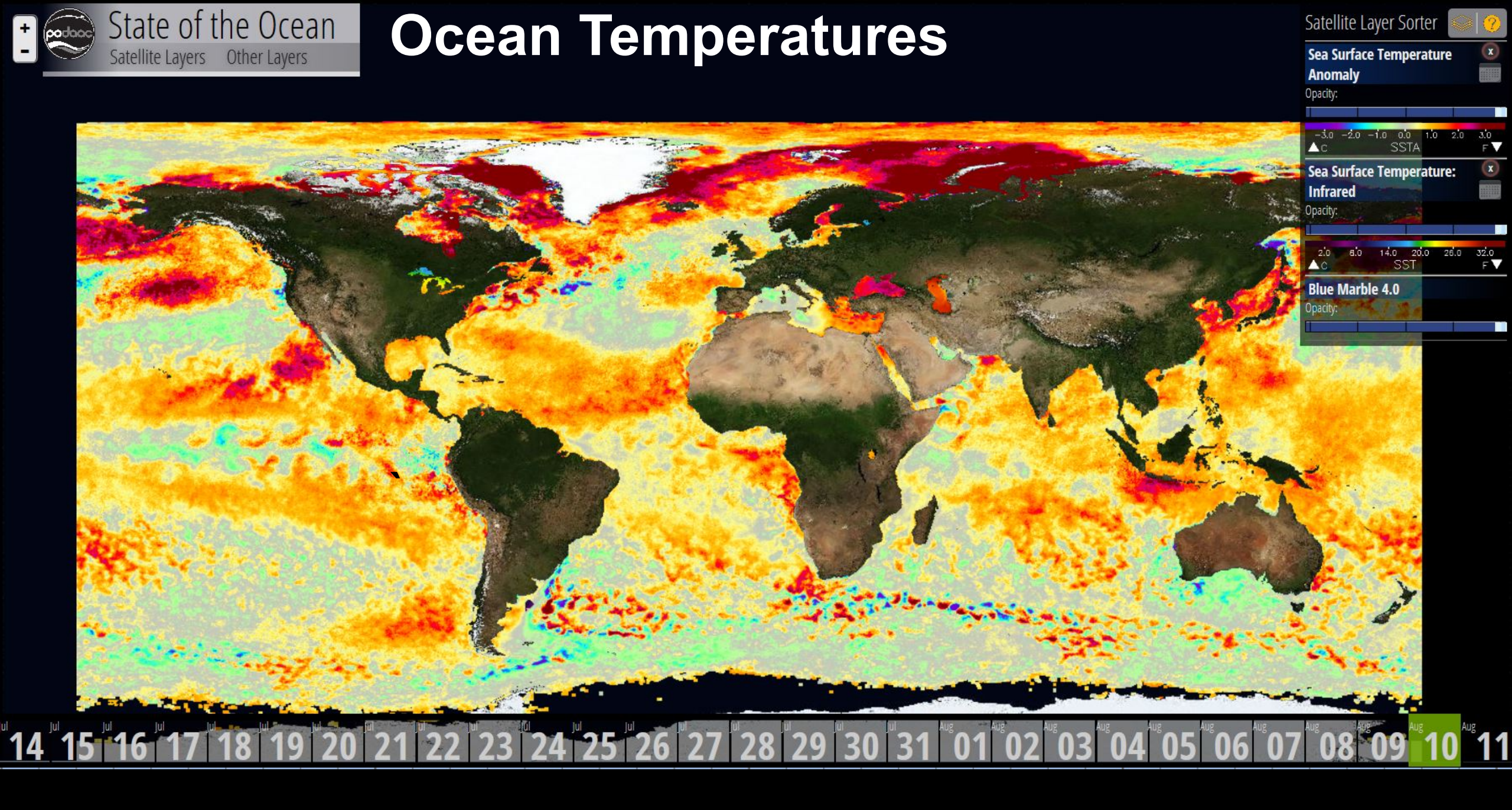
2016 Global Monthly Temperature Anomalies (°C)



Source: NASA GISS and NOAA NCEI global temperature data averaged and adjusted to early industrial baseline (1881-1910). Data as of April 2016.

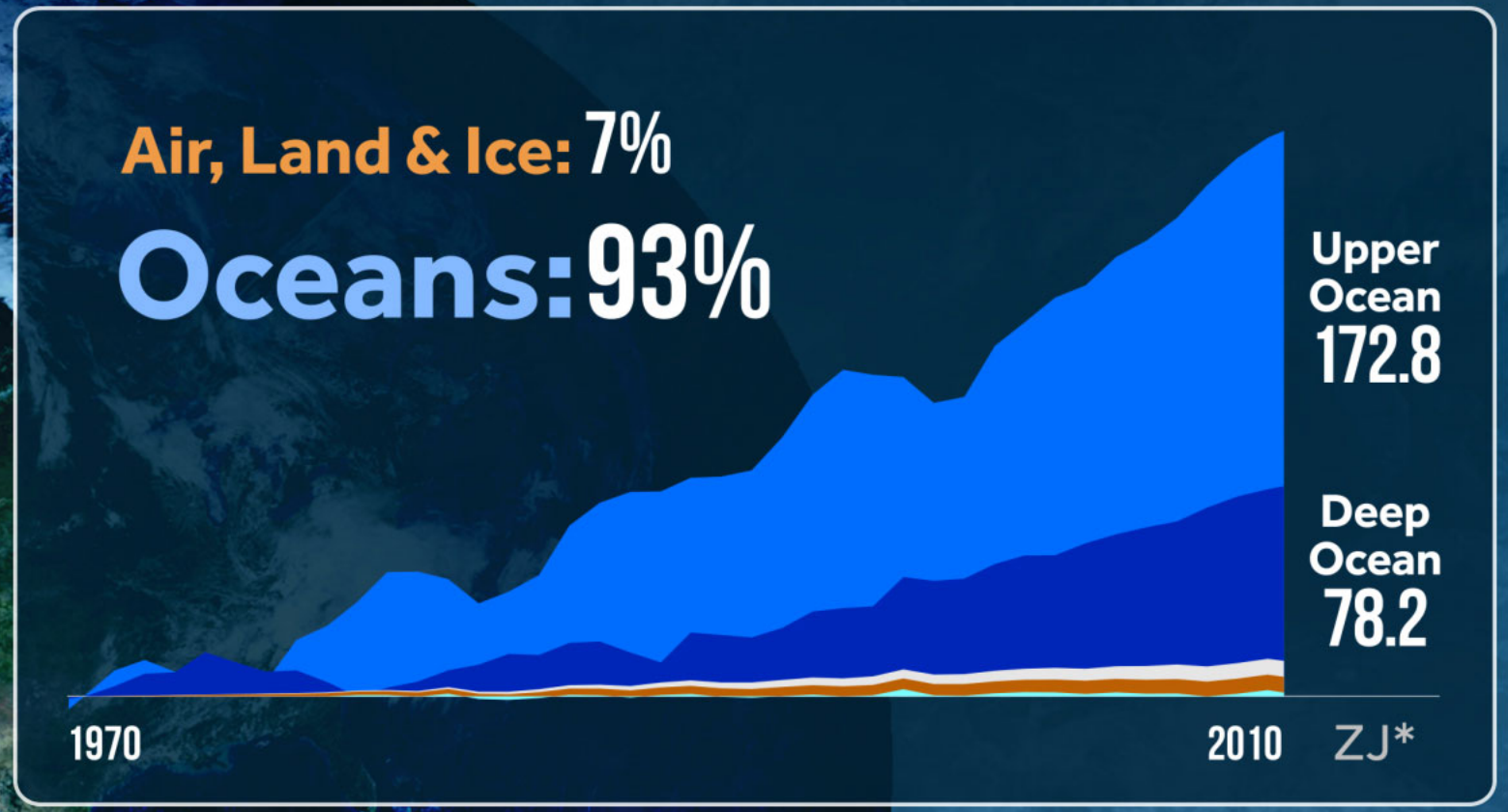
CLIMATE CENTRAL

Ocean Temperatures



Where's the Heat?

Earth's Accumulated Energy



*Accumulated Heat Energy Measured in Zettajoules
Source: Climate Change 2013: The Physical Science Basis (IPCC) Chapter 3

CLIMATE CENTRAL

FORECASTED HIGH TODAY IN BOSTON

74 degrees F

FORECASTED HIGH TODAY IN BOSTON, WITHOUT THE OCEANS

FORECASTED HIGH TODAY IN BOSTON

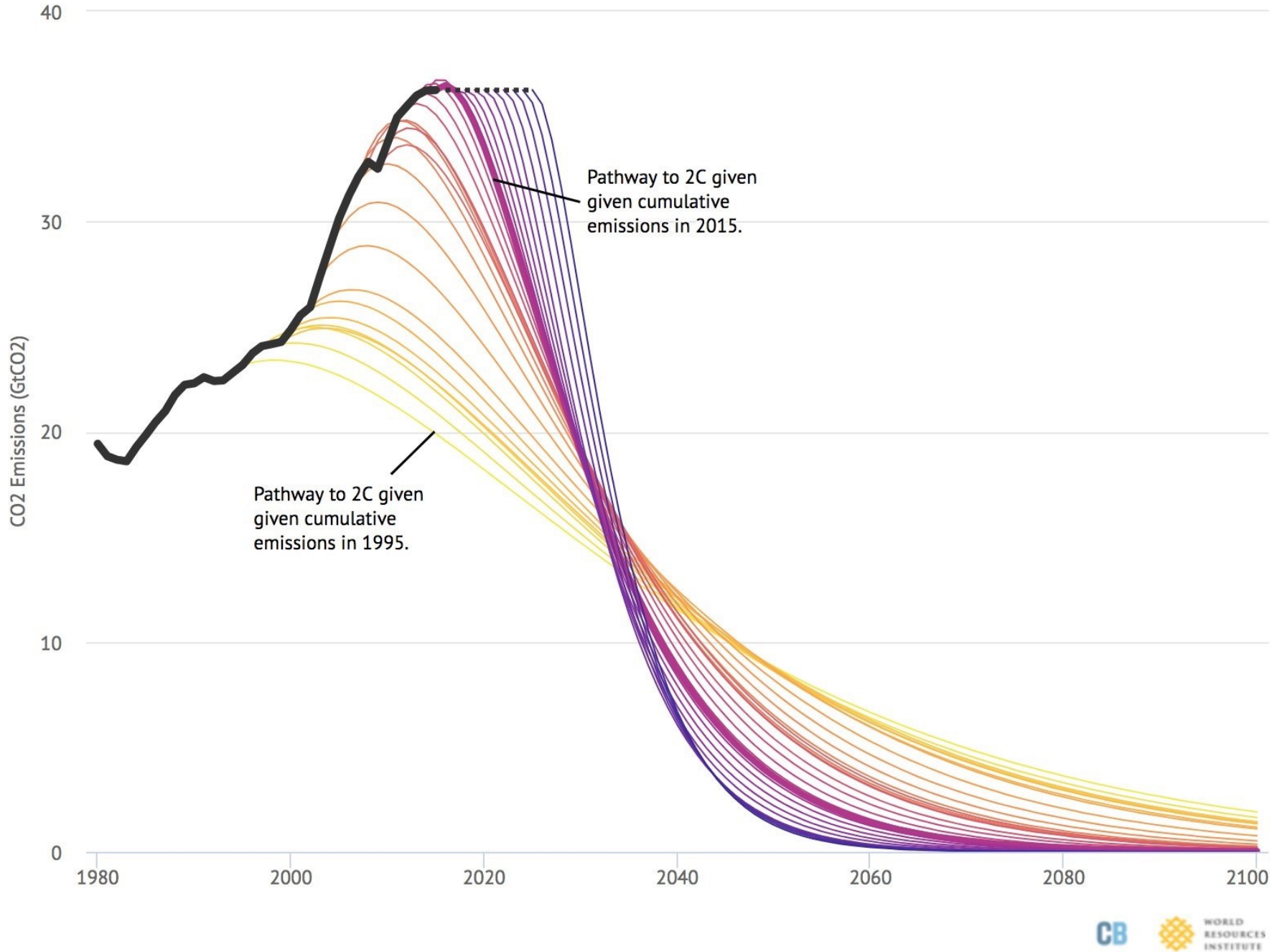
74 degrees F

FORECASTED HIGH TODAY IN BOSTON, WITHOUT THE OCEANS

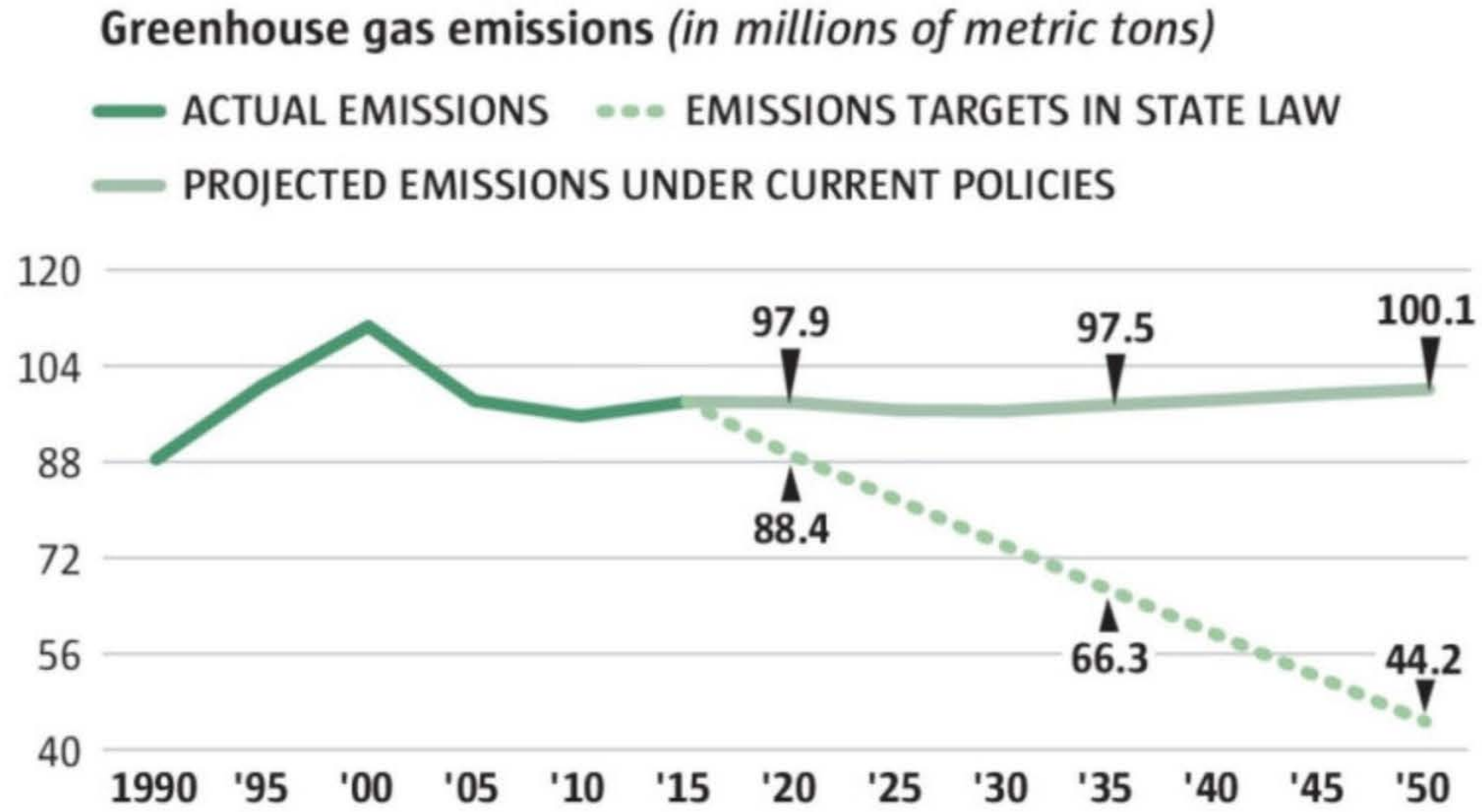
139 degrees F

Source: IUCN (International Union for Conservation of Nature)

To limit warming to 2C, global emissions must fall more quickly if they peak later



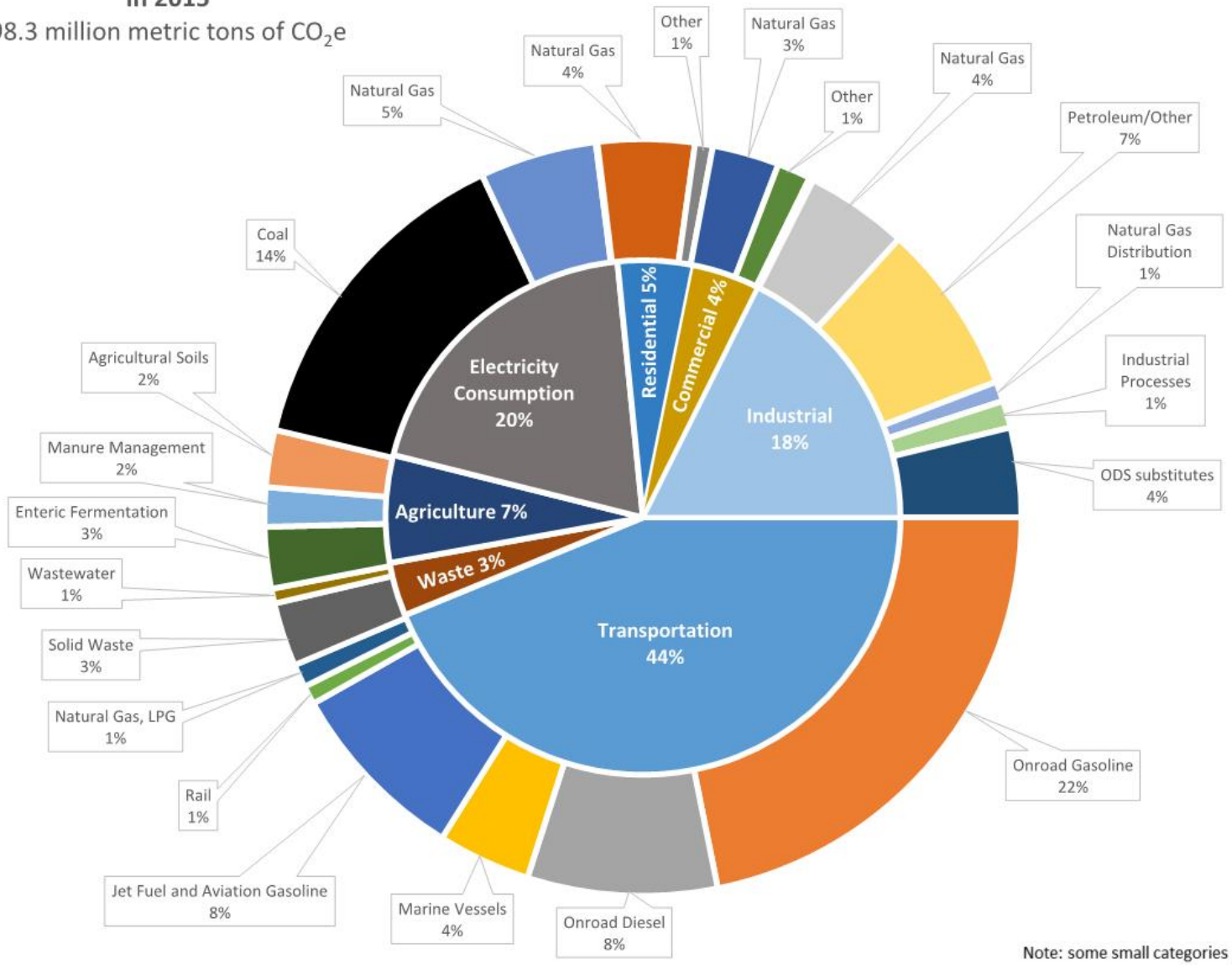
Washington not on track to meet climate targets



Absent a carbon tax of other new policies, Washington is projected to fail to meet greenhouse-gas reduction targets in state law. Source: Washington State Department of Ecology (Stephanie Redding / The Seattle... (Stephanie Redding / The Seattle Times) ***More***

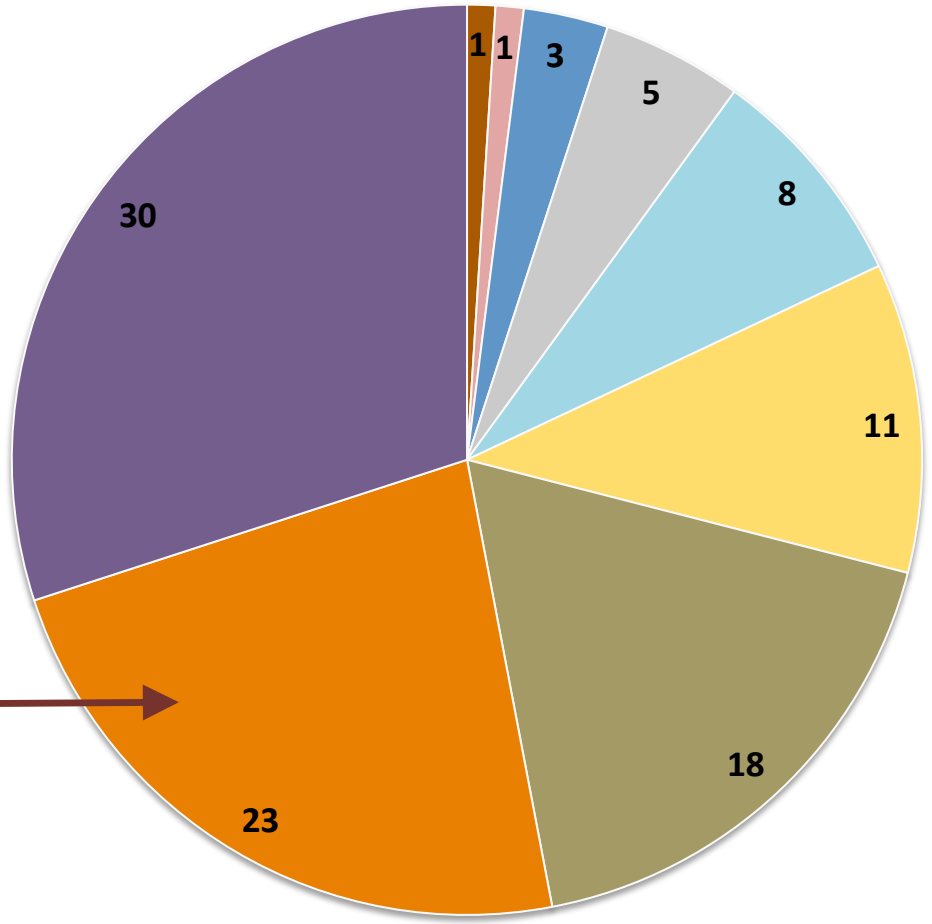
Washington Greenhouse Gas Emissions in 2015

98.3 million metric tons of CO_2e



Note: some small categories (<1%) excluded

Weighted End Use Energy (across building types)



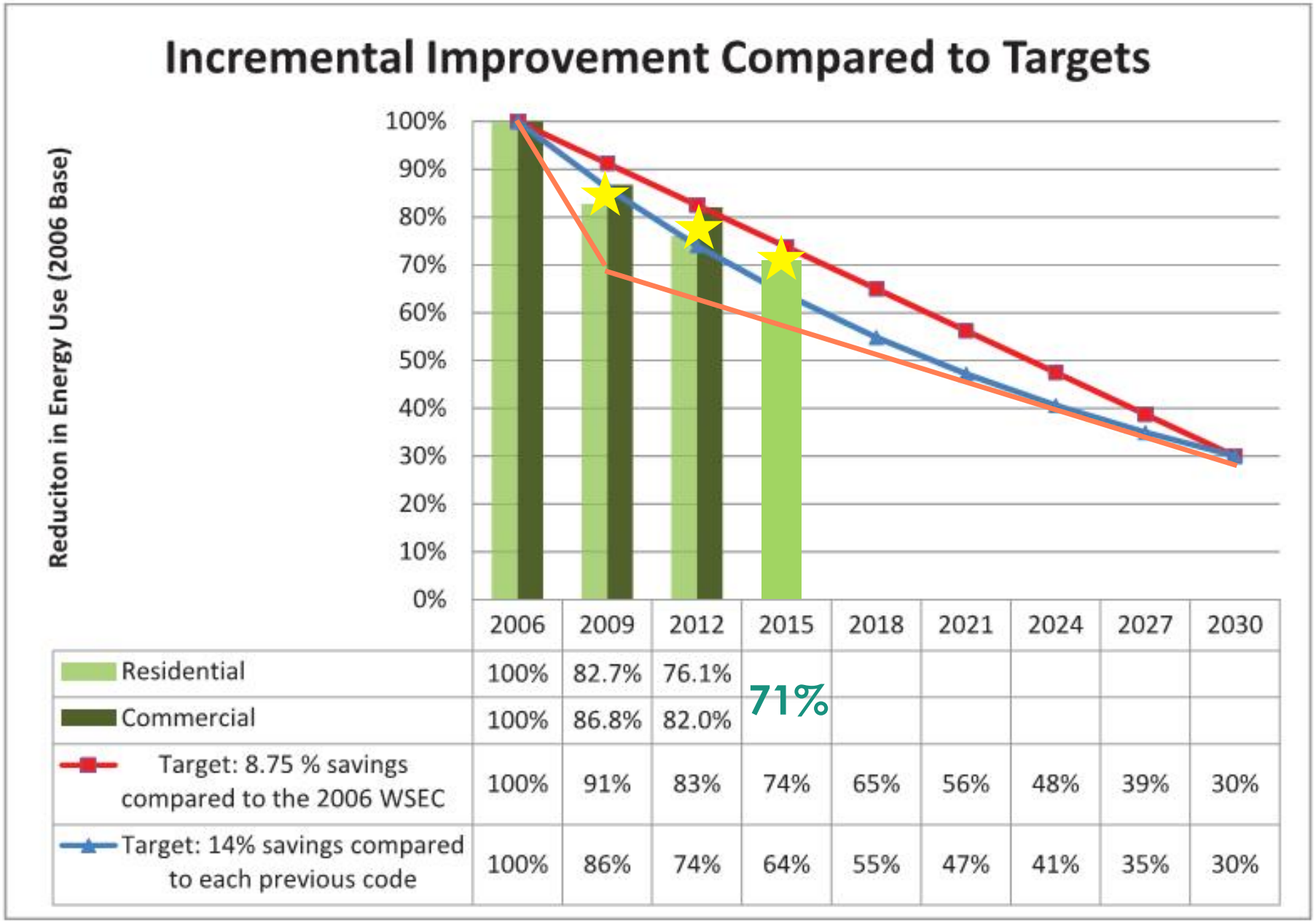
Passive House (TEDI)

- Pumping
- Hot Water
- Cooling
- Bad Operation
- Ventilation
- Lights
- Other
- Heating
- Equipment

nbi new buildings institute

Data from the Pacific Northwest

Washington State Energy Code—



Q1 –

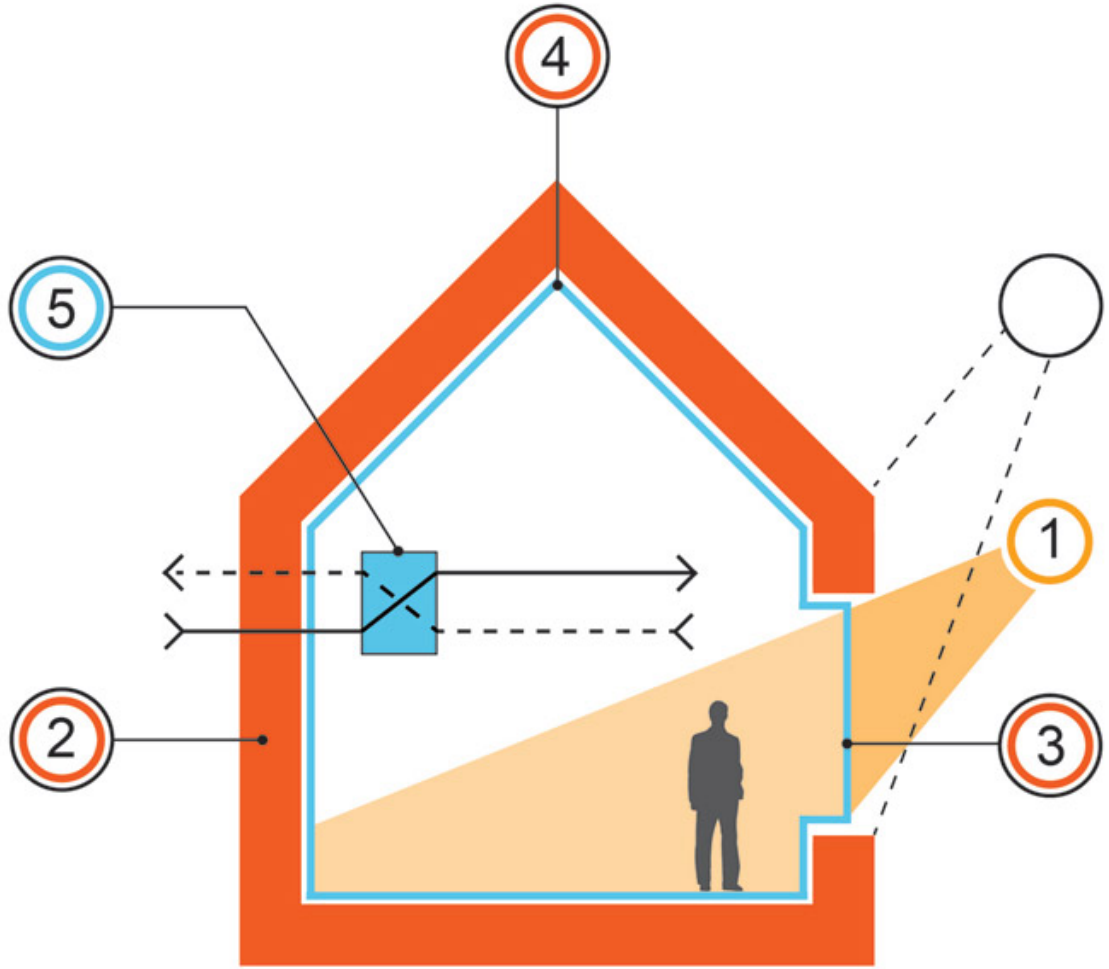
In today's political context, can we create and implement policies that :

PROVIDE ACTION QUICKLY,

AT A LARGE SCALE,

AND WITH EQUITY TO EVERYONE?

PASSIVE HOUSE IS A SOLUTION—



PASSIVE HOUSE PRINCIPLES

1. SOLAR ORIENTATION
2. HIGH INSULATION
3. HIGH PERFORMANCE WINDOWS
4. AIR TIGHT ENCLOSURE
5. BALANCED VENTILATION WITH HEAT RECOVERY

RPA
Richard Pedranti Architect
richard@richardpedranti.com
570.296.0466

Location – PHIUS +2015	kBTU/sf/yr heating	BTU/hr heating	kBTU/sf/yr cooling	BTU/hr cooling
Bellingham	5.9	4.0	1.0	4.4
Pasco	4.9	4.7	2.1	6.7
Pullman	6.2	4.6	1.0	5.6
Seattle-Tacoma	5.4	3.7	1.0	4.8
Seattle (Boeing)	5.1	3.7	1.0	5.6
Spokane	6.4	3.9	1.0	5.6
Walla Walla	5.0	4.5	2.1	6.6
Wenatchee	5.7	4.6	1.6	6.0
Yakima	5.8	4.6	1.2	6.0
Passivhaus Institut	4.75	3.17	4.75	3.17
EnerPHit	6.33* – 7.92**	-	4.75	-
PHI low-energy	9.50	-	4.75	-

* Seattle ** Spokane

Modeling—

TABLE 2: Four-Story Multifamily Building Prototype Energy Modeling

Measure	**EUI (kBTU/sf/yr)**	**kWh saved**	**% save**	**Heat Demand kBTU/sf/yr**	**Heat Load BTU/hr/yr**	**First Install Cost**	**kWh saved/$**
Baseline	41.6			20.94	15.29		
Airtightness (CFM75) – NOTE: bold equals measures the achieved desired target range for code proposal							
0.25	36.7	48,897	11.8 %	14.81	10.76	$7,491	6.5
0.17	34.3	72,846	17.5 %	11.75	8.41	$10,214	7.1
0.15	33.7	78,833	19.0 %	10.95	7.79	$11,576	6.8
0.08	31.6	99,789	24.0 %	**8.44**	5.74	$13,279	7.5

TABLE 2: Four-Story Multifamily Building Prototype Energy Modeling

Measure	**EUI (kBTU/sf/yr)**	**kWh saved**	**% save**	**Heat Demand kBTU/sf/yr**	**Heat Load BTU/hr/yr**	**First Install Cost**	**kWh saved/$**
Baseline	41.6			20.94	15.29		
Windows – U-value 0.25 baseline							
.16 glass	40.7	8,981	2.2 %	19.81	14.96	$33,367	0.3
.12 glass	40.3	12,973	3.1 %	19.31	14.81	$67,075	0.2

TABLE 2: Four-Story Multifamily Building Prototype Energy Modeling

Measure	**EUI (kBTU/sf/yr)**	**kWh saved**	**% save**	**Heat Demand kBTU/sf/yr**	**Heat Load BTU/hr/yr**	**First Install Cost**	**kWh saved/$**
Baseline	41.6			20.94	15.29		
Heat Recovery Ventilation – baseline 0%							
60%	38.4	31,932	7.7 %	16.91	14.11	$30,643	1.0
70%	37.9	36,922	8.9 %	16.25	13.91	$78,991	0.5
80%	37.4	41,911	10.1 %	15.59	13.71	$129,042	0.3
90%	36.8	47,899	11.5 %	14.94	13.52	$177,731	0.3

TABLE 2: Four-Story Multifamily Building Prototype Energy Modeling

Measure	**EUI (kBTU/sf/yr)**	**kWh saved**	**% save**	**Heat Demand kBTU/sf/yr**	**Heat Load BTU/hr/yr**	**First Install Cost**	**kWh saved/$**
Baseline	41.6			20.94	15.29		
Wall Insulation (Effective) baseline R-17							
R-22	40.9	6,985	1.7 %	20.09	15.03	$2,724	2.6
R-25	40.7	8,981	2.2 %	19.75	14.93	$3,405	2.6
R-38	40.0	15,966	3.8%	18.88	14.67	$7,491	2.1

TABLE 2: Four-Story Multifamily Building Prototype Energy Modeling

Measure	**EUI (kBTU/sf/yr)**	**kWh saved**	**% save**	**Heat Demand kBTU/sf/yr**	**Heat Load BTU/hr/yr**	**First Install Cost**	**kWh saved/$**
Baseline	41.6			20.94	15.29		
Roof Insulation – baseline R-38							
R-60	41.3	2,994	0.7 %	20.54	15.17	$12,938	0.2

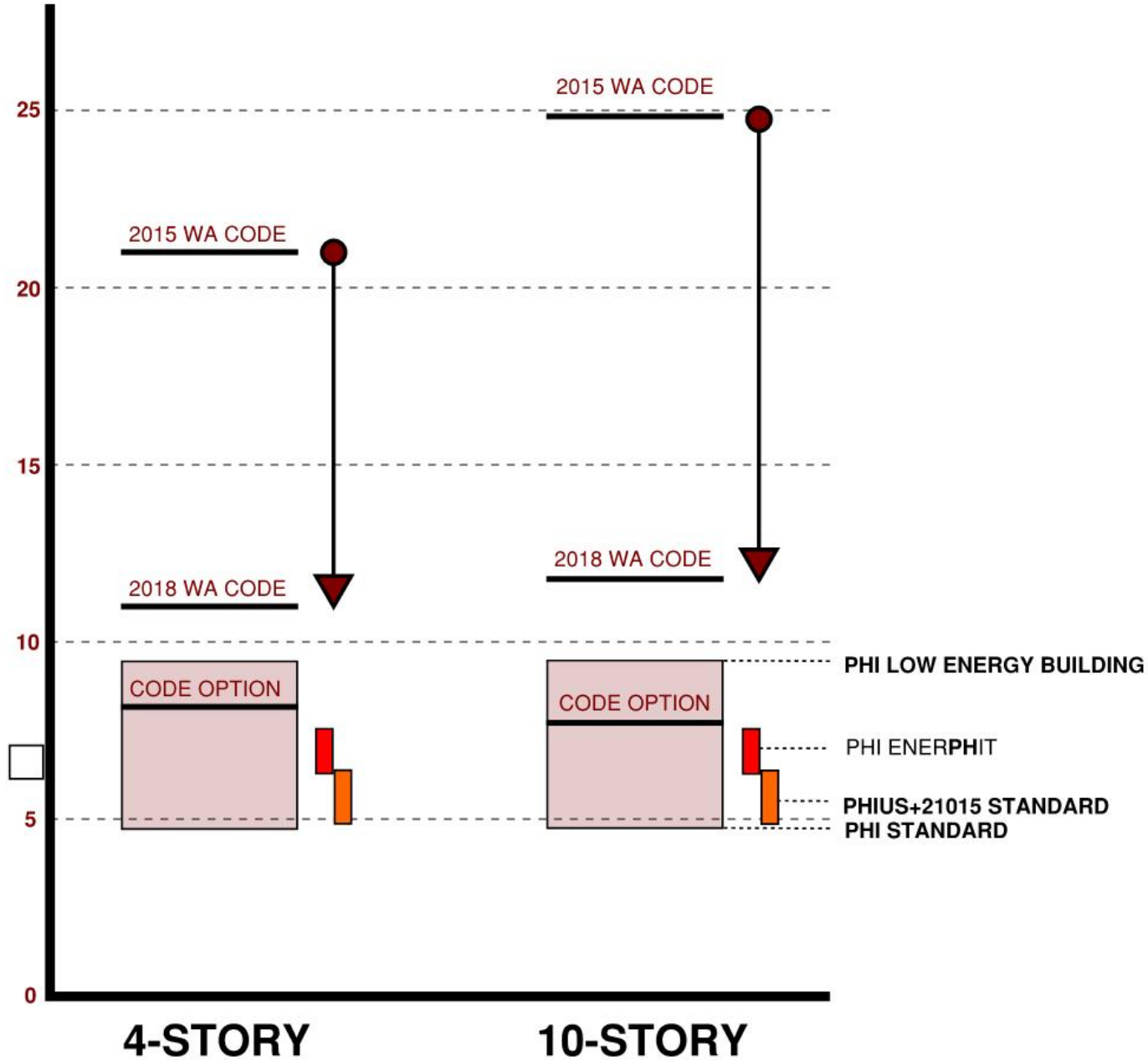
TABLE 2: Four-Story Multifamily Building Prototype Energy Modeling

Measure	**EUI (kBTU/sf/yr)**	**kWh saved**	**% save**	**Heat Demand kBTU/sf/yr**	**Heat Load BTU/hr/yr**	**First Install Cost**	**kWh saved/$**
Baseline	41.6			20.94	15.29		
Heat Pump – baseline electric baseboard							
Ductless	31.6	99,789	24.0 %	20.54	15.17	$203,267	0.5

TABLE 2: Four-Story Multifamily Building Prototype Energy Modeling

Measure	**EUI (kBTU/sf/yr)**	**kWh saved**	**% save**	**Heat Demand kBTU/sf/yr**	**Heat Load BTU/hr/yr**	**First Install Cost**	**kWh saved/$**
Baseline	41.6			20.94	15.29		
Combinations							
.25 and 60%	33.7	78,833	19.0 %	10.98	9.58	$38,134	2.1
.17 and 60%	31.5	101,785	24.5 %	**8.09**	7.23	$40,858	2.5
.08 and 60%	29.0	125,734	30.3 %	**5.05**	4.56	$43,922	2.9
.25 and R-22	36.1	54,884	13.2 %	14.0	10.51	$10,214	5.4
.25 and R-25	35.8	57,878	13.9 %	13.66	10.41	$10,895	5.3
.25 and R-38	35.1	64,863	15.6 %	12.83	10.15	$14,981	4.3
.25 / 60% / R-22	33.0	85,819	20.7 %	10.2	9.33	$40,858	2.1
.17 / 60% / R-22	30.8	107,772	26.0 %	**7.35**	6.97	$43,581	2.5

ANNUAL HEATING DEMAND



PARTNERS AND STAKEHOLDERS—

4-story MF	41.6	EUI	34,048	GSF	31	units		
Code Baseline	278,411	kWh	27.9	EUI	8,981	kWh / unit		
	4,664.58	Therms	13.7	EUI	150.5	Therms / unit		
C402.5.1.2	Cost/SF	Savings/SF	*Cost/Unit	*Savings/Unit	Cost/building	Savings/building		
Air Sealing 0.25	$ 0.31	1.4	$ 338.28	1,577	$ 10,486.78	48,897		
HRV 60%	$ 1.26	0.9	$ 1,383.89	1,030	$ 42,900.48	31,932		
Combined	$ 1.57	2.3	$ 1,722.17	2,543	$ 53,387.26	78,833		
			* includes common area					
C406.9	Cost/SF	Savings/SF	*Cost/Unit	*Savings/Unit	Cost/building	Savings/building		
Air Sealing 0.17	$ 0.42	2.1	$ 461.30	2,350	$ 14,300.16	72,846		
HRV 60%	$ 1.26	0.9	$ 1,383.89	1,030	$ 42,900.48	31,932		
Combined	$ 1.68	3.0	$ 1,845.18	3,283	$ 57,200.64	101,785		
Notes:	combined energy savings is lower than adding individual stand alone measures							
	savings = kWh savings							

10-story MF	45.2	EUI	85,120	GSF	79	units		
Code Baseline	780,849	kWh	31.3	EUI	9,884	kWh / unit		
	11,831.68	Therms	13.9	EUI	149.8	Therms / unit		
C402.5.1.2	Cost/SF	Savings/SF	*Cost/Unit	*Savings/Unit	Cost/building	Savings/building		
Air Sealing 0.25	$ 0.31	2.3	$ 331.86	2,432	$ 26,216.96	192,094		
HRV 60%	$ 1.26	0.9	$ 1,357.61	979	$ 107,251.20	77,336		
Combined	$ 1.57	3.1	$ 1,689.47	3,347	$ 133,468.16	264,441		
			* includes common area					
C406.9	Cost/SF	Savings/SF	*Cost/Unit	*Savings/Unit	Cost/building	Savings/building		
Air Sealing 0.17	$ 0.42	3.4	$ 452.54	3,632	$ 35,750.40	286,893		
HRV 60%	$ 1.26	0.9	$ 1,357.61	979	$ 107,251.20	77,336		
Combined	$ 1.68	4.1	$ 1,810.15	4,453	$ 143,001.60	351,756		

ENV 046—

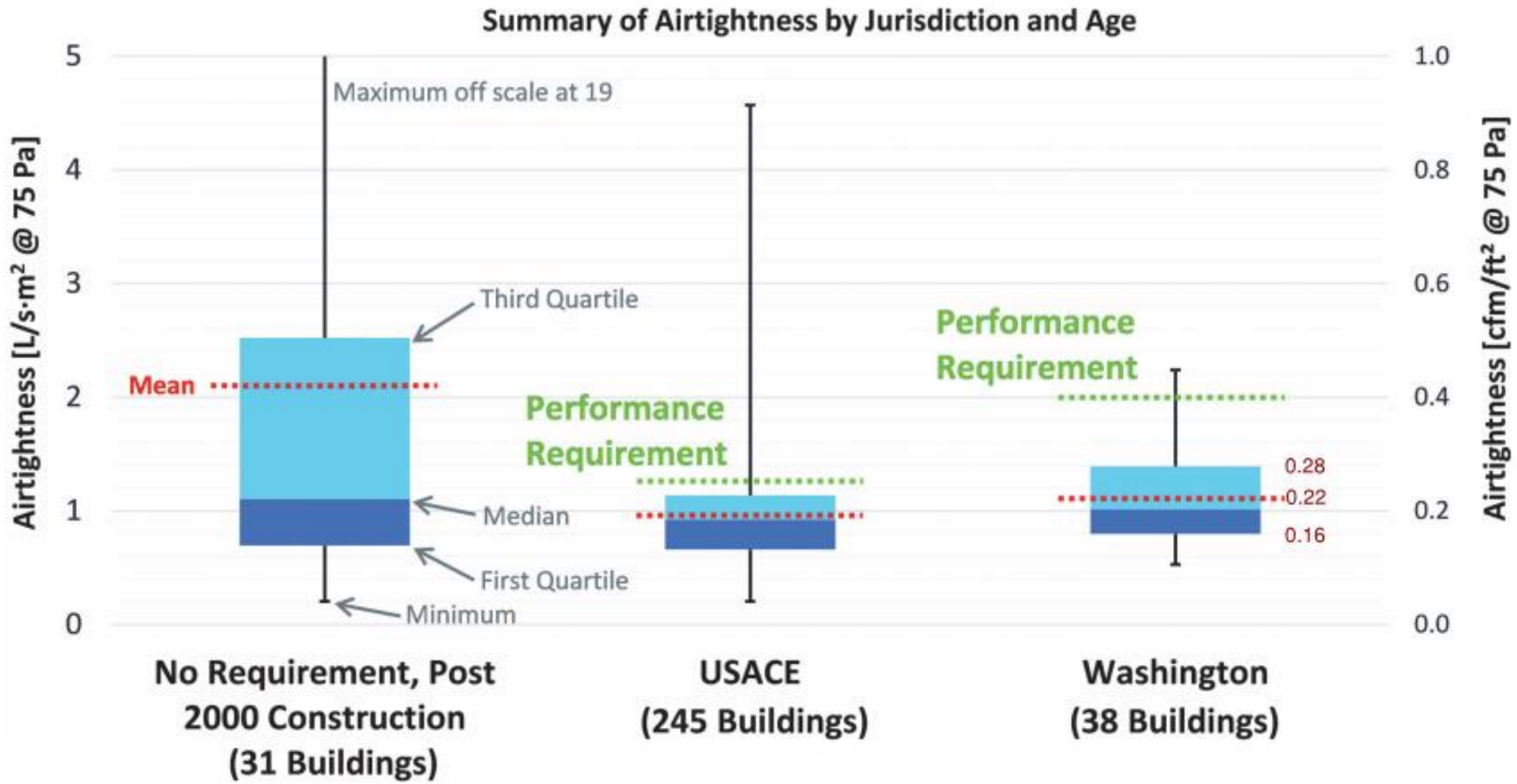
C402.5.1.2 Building Test
C403.2.2.1 Ventilation – Group R-2
C406.9 Reduced Air Infiltration

Proposal to Washington State Building Code Council
2018 Code Cycle

Passive House Northwest

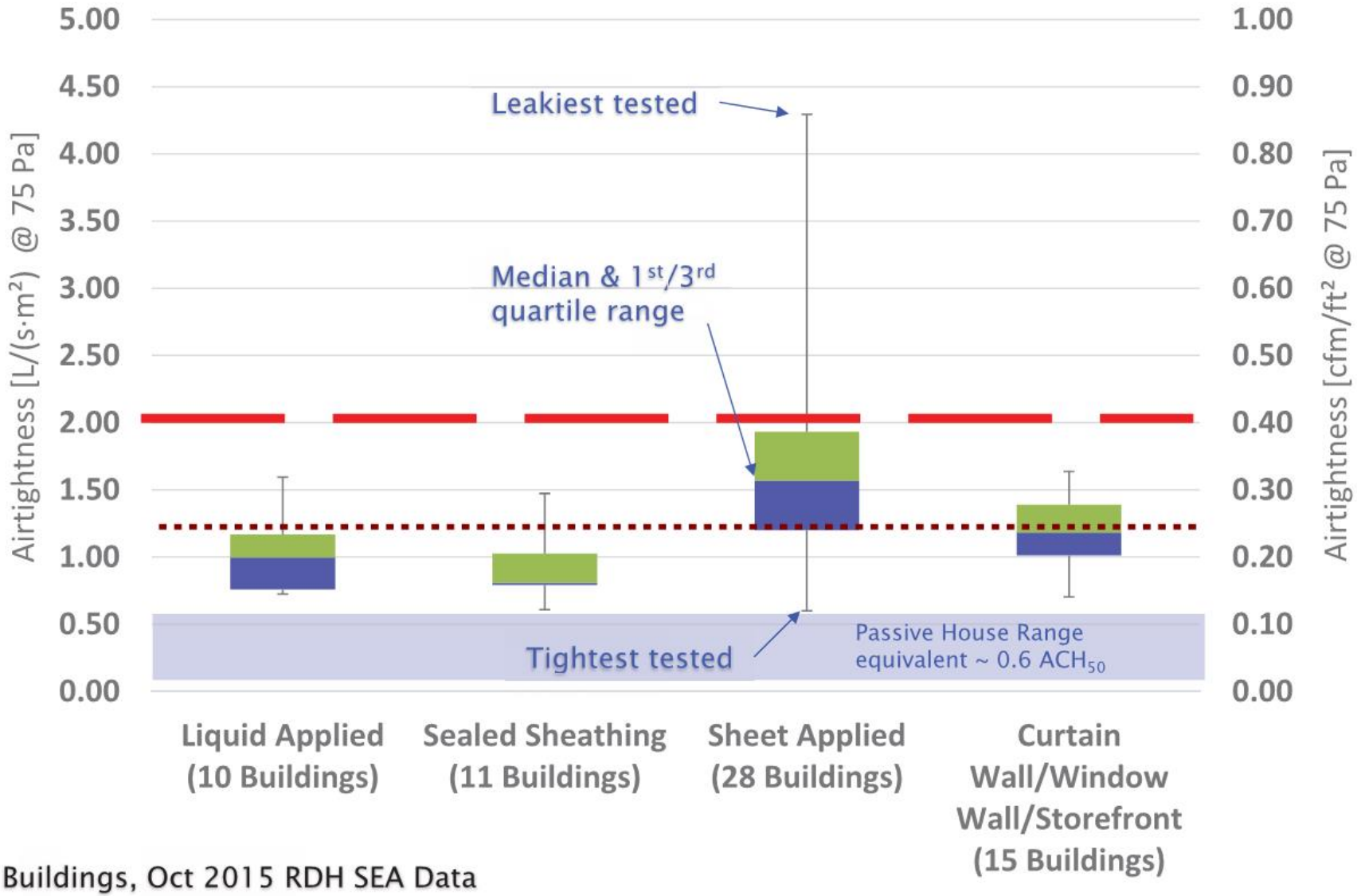
Air tightness—

Air Tightness in Large Commercial Buildings



RDH – Large Building Airtightness, 2016

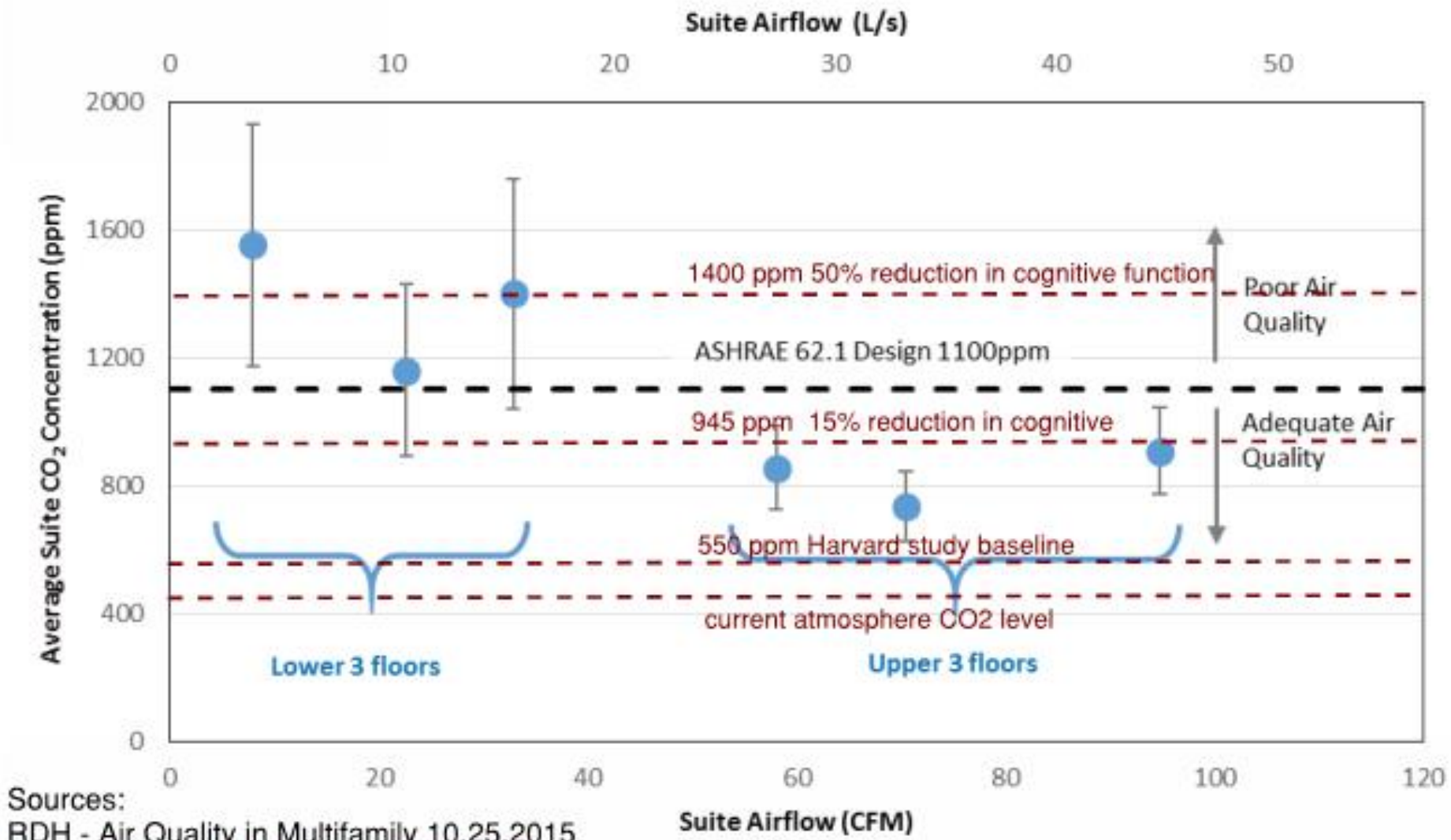
Air Tightness in Commercial Buildings



54 Buildings, Oct 2015 RDH SEA Data

ventilation—

Air Quality in Multifamily Buildings



Sources:
RDH - Air Quality in Multifamily 10.25.2015
Harvard School of Public Health, 2015

Figure 4: Air quality differences between floors due to uneven airflow distribution

Cost effectiveness—

Office of Financial Management
Olympia, Washington - Version: 2016-A
Life Cycle Cost Analysis Tool

Executive Report

C402.5.1.2 - 4 STORY

Project Information	
Project:	4 Story, 31 Unit Multifamily
Address:	
Company:	
Contact:	Mike Fowler
Contact Phone:	
Contact Email:	

Key Analysis Variables		Building Characteristics	
Study Period (years)	51	Gross (Sq.Ft)	34,048
Nominal Discount Rate	3.46%	Useable (Sq.Ft)	0
Maintenance Escalation	1.00%	Space Efficiency	0.0%
Zero Year (Current Year)	2018	Project Phase	0
Construction Years	1	Building Type	0

Life Cycle Cost Analysis		BEST	
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	41.6	33.7	36.1
1st Construction Costs	$ -	$ 52,375	$ 52,375
PV of Capital Costs	$ -	$ 92,513	$ 92,513
PV of Maintenance Costs	$ -	$ 10,548	$ 10,548
PV of Utility Costs	$ 1,006,525	$ 770,812	$ 841,507
Total Life Cycle Cost (LCC)	**$ 1,006,525**	**$ 873,873**	**$ 944,568**
Net Present Savings (NPS)	**N/A**	**$ 132,652**	**$ 61,956**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost		BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	7,111	5,456	5,952
% CO2e Reduction vs. Baseline	N/A	23%	21%
Present Social Cost of Carbon (SCC)	$ 438,520	$ 336,428	$ 367,047
Total LCC with SCC	**$ 1,445,045**	**$ 1,210,301**	**$ 1,311,616**
NPS with SCC	**N/A**	**$ 234,744**	**$ 133,429**

4-STORY

$132,652 net present savings

$128,966 net present savings (0.17 CFM75)

10-STORY

$548,952 net present savings

$800,746 net present savings (0.17 CFM75)

Essential step to 70% goal—

ENERGY SAVINGS

4-story multifamily prototype	**w/ C406**
19% reduction in building energy use	24%
47% reduction in annual heating demand	61%
37% reduction in peak heating load	52%

10-story multifamily prototype	**w/ C406**
23% reduction in building energy use	31%
53% reduction in annual heating demand	70%
39% reduction in peak heating load	57%

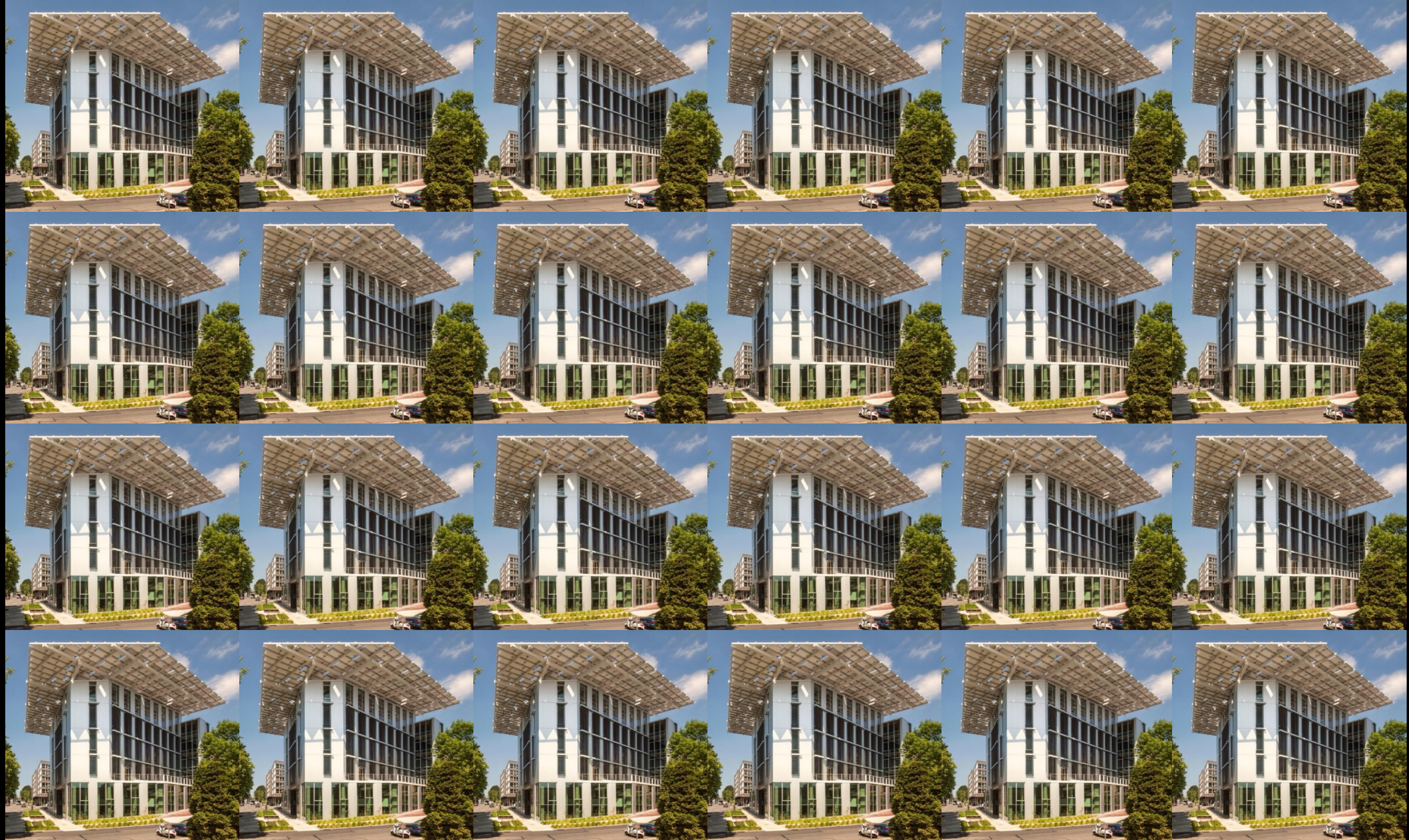
examples—

< 0.08 CFM75 and heat recovery ventilation


2060 FOLSOM
167,500 sf
8 stories, 127 units
19.9 EUI kBTU/sf/yr
15.4 NET EUI
* < 0.20 CFM75
MITHŪN
Affordable Housing – San Francisco


UC SANTA CRUZ
1.19 million sf
4-12 stories
777 units
12.7 EUI kBTU/sf/yr
2.9 NET EUI
Schematic Design
Competition Proposal
Balfour Beatty
Campus Solutions
SWINERTON
BUILDERS
MITHŪN

BUILD THE BULLITT CENTER 24 TIME



HILLSBORO, OR

PHASE 1
57 UNITS
57,759 SF

22.5 EUI
MODELED
20.9 EUI ACTUAL

PHASE 2
58 UNITS
49,900 SF

22.2 EUI
MODELED

Ankrom Moisan

20 by 2020

BUILDING CHALLENGE

4 STORIES
35 UNITS
20,100 GSF
18.5 EUI kBTU/sf/yr
NET ZERO READY

FIRST PLEDGED PROJECT

PAX FUTURA
by NK Architects and Cascade Built
COLUMBIA CITY, SEATTLE

nk ARCHITECTS

nk ARCHITECTS

THE GOAL:

20 PASSIVE HOUSE PROJECTS
OF 20,000 SQUARE FEET OR LARGER
UNDER CONSTRUCTION IN KING COUNTY BY YEAR 2020

ENCOURAGE LOCAL JURISDICTIONS TO:

1. PURSUE PASSIVE HOUSE FOR THEIR OWN PROJECTS, AND
2. CREATE INCENTIVES FOR PASSIVE HOUSE DEVELOPMENT

PLEDGE PROJECTS ON WWW.PHNW.ORG

320 QUEEN ANNE

6 STORIES
59 UNITS
42,000 GSF

17 EUI (estimate)

SEATTLE, WA

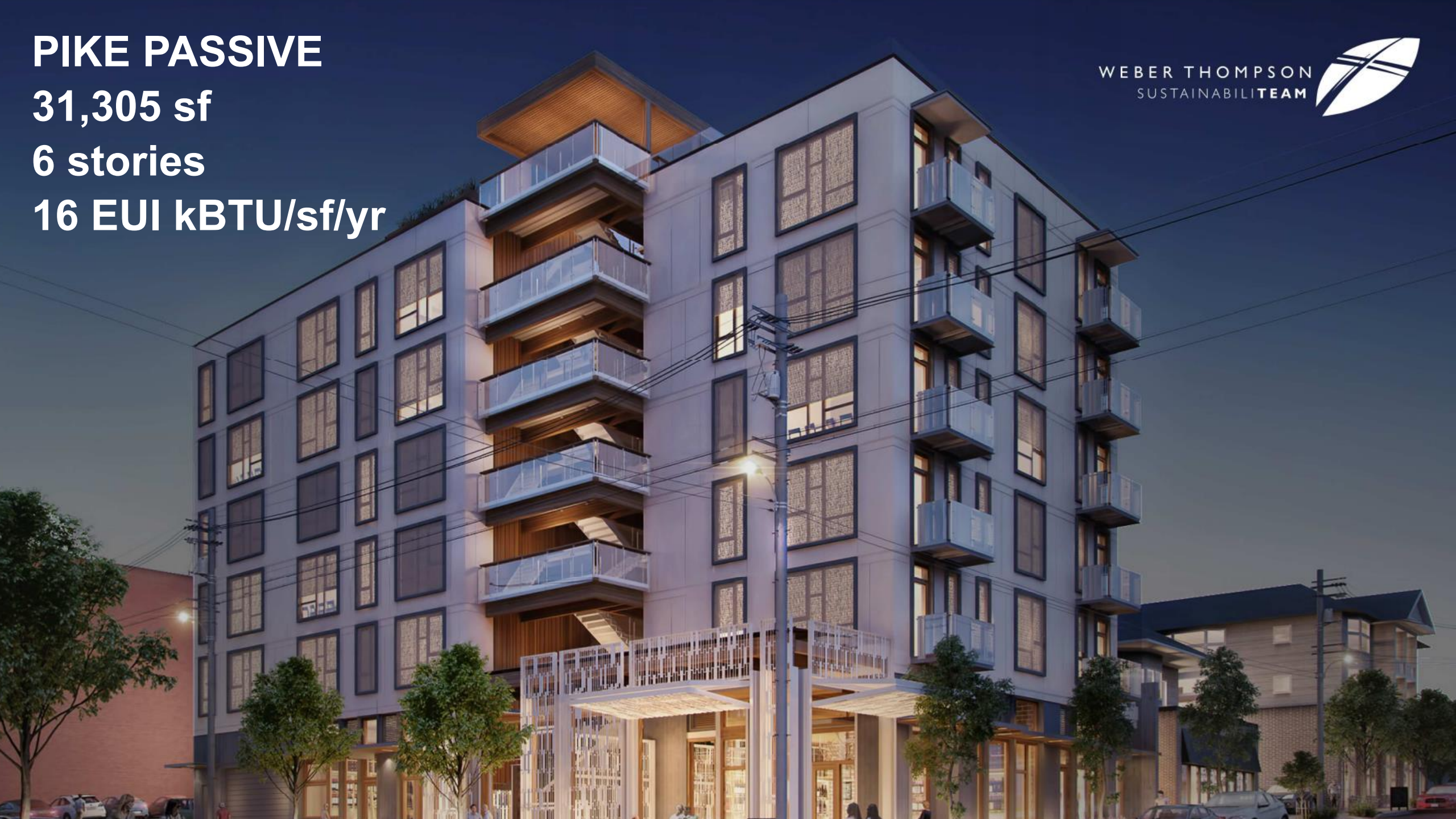
nk ARCHITECTS

PIKE PASSIVE

31,305 sf

6 stories

16 EUI kBTU/sf/yr



WEBER THOMPSON
SUSTAINABILITEAM

11TH AND
REPUBLICAN

4 STORIES
NEW and
RENOVATION

20 UNITS
18,700 GSF

NET ZERO
ENERGY

SEATTLE, WA

nk
ARCHITECTS

Achievable —

Comfort and health —

Cost effective —

Energy savings —

WASHINGTON CODE PROCESS – TIMELINE:

Technical Advisory Group (TAG)	July 13, 2018
Mechanical Ventilation Energy Committee (MVE)	September 13, 2018
State Building Code Council (SBCC) Public Hearing	November 2018
State Legislature	Spring 2020

Thank You

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