EXPANDING PASSIVE HOUSE HORIZONS FOR CARBON NEUTRAL DEVELOPMENT IN HEALTHCARE

Managing Risk, Protecting Assets and Reducing Operating Costs

Responsive buildings.
Responsive people.

INTRODUCTIONS

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GOAL:

Target future proof healthcare facilities while delivering the same quality of care as expected today, while also improving patient outcomes.

STRATEGY:

Build efficient buildings, to lower heating and cooling loads. Meet those heating and cooling loads with fully electrified equipment and renewable energy.

OVERVIEW

1. Context: Changing Regulation
2. Defining Healthcare Environment: Energy Intensive Features
3. Minimizing Risk: Future Proofing Healthcare Assets
4. Case Study 1: PH Strategies Employed
5. Case Study 2: Cost of PH
6. How to Future Proof: Best Practices

CONTEXT: CHANGING REGULATONS

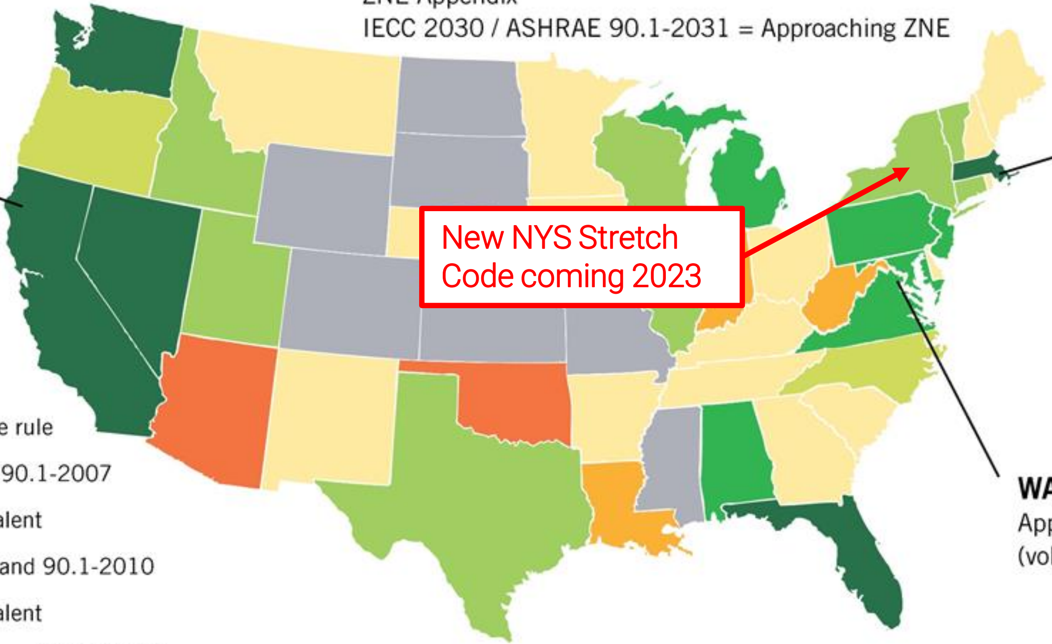
ZNE CODE PRECEDENTS

Portland, Seattle, Vancouver, and other cities

NATIONAL
IECC 2021
ZNE Appendix
IECC 2030 / ASHRAE 90.1-2031 = Approaching ZNE

PROTOTYPES
Zero Code

CALIFORNIA
Title 24-2019
(near residential ZNE)
Zero Code
(commercial proposed)



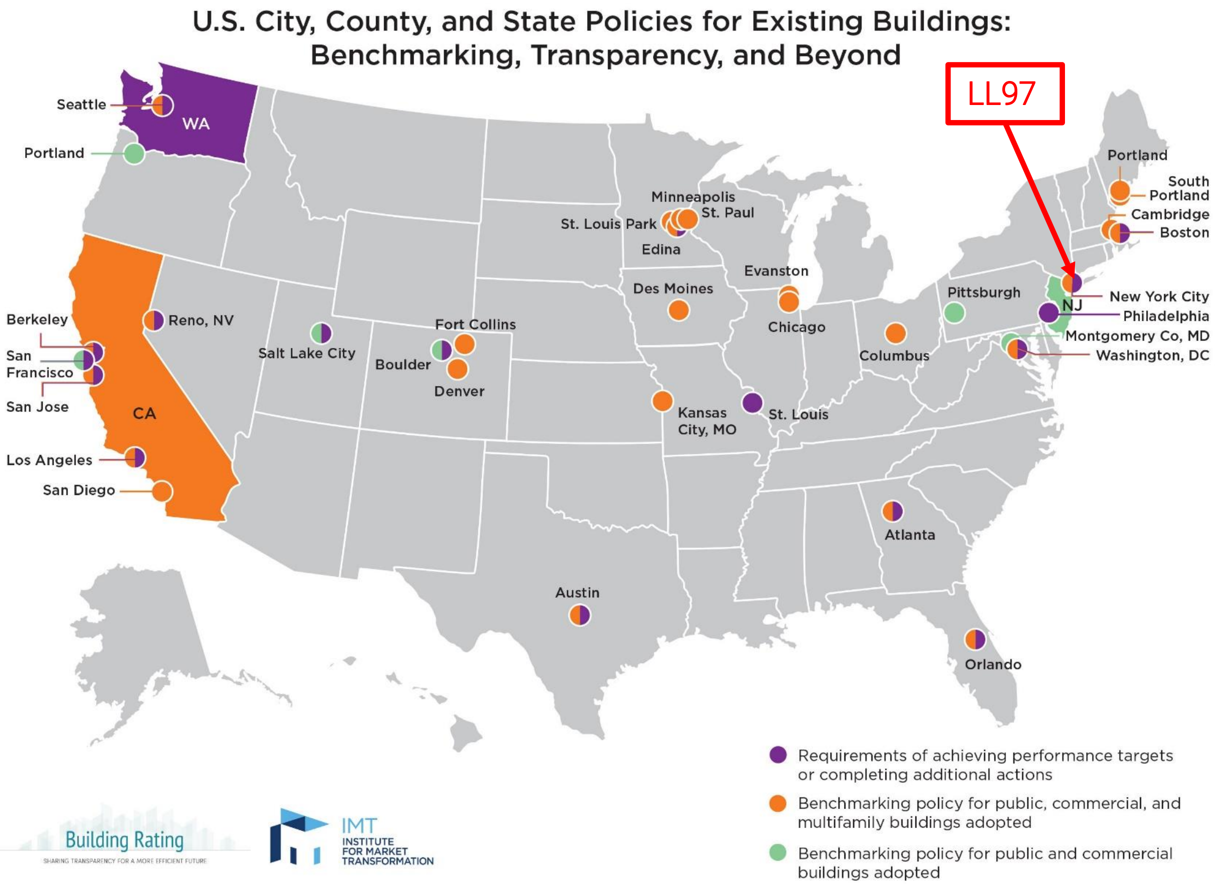
MASSACHUSETTS
Net Zero Carbon Stretch Code

Boston + Cambridge + Somerville
ZNE zoning regulations being developed

WASHINGTON DC
Appendix Z
(voluntary compliance path)

- No statewide code or home rule
- Less energy efficient than 90.1-2007
- IECC 90.1-2007 or equivalent
- Between IECC 90.1-2007and 90.1-2010
- IECC 90.1-2010 or equivalent
- Between IECC 90.1-2010 and 90.1-2013
- IECC 90.1-2013 or equivalent
- IECC 90.1-2013 or better

EXISTING BUILDING CARBON REQUIREMENTS



NEW YORK CITY: LOCAL LAW 97

NYC 80 x 50
80% carbon reduction by 2050

LOCAL LAW 97

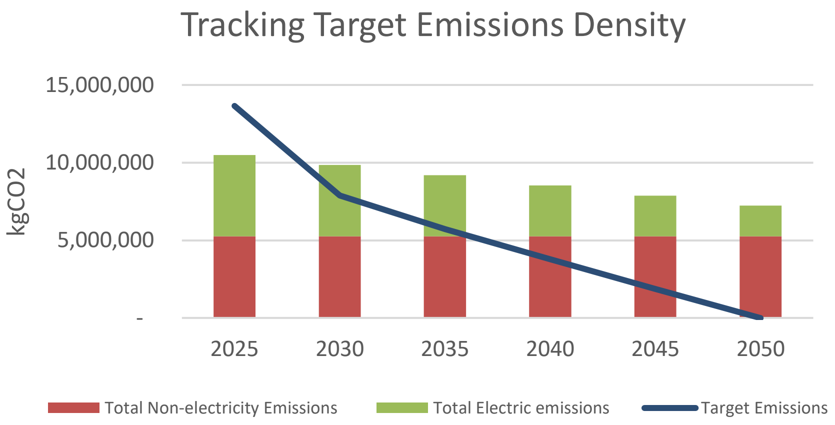
2024-2029 limits will affect the 20% most carbon-intensive buildings

2030-2034 limits will affect the 75% most carbon-intensive buildings

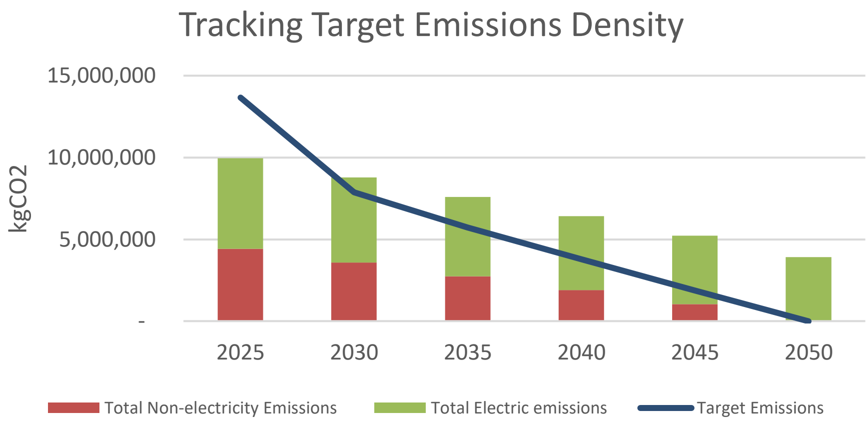
- Expensive penalties to those buildings exceeding the limits.

CARBON LIMIT RISK – EXISTING BUILDINGS

No Energy Upgrades



With Electrification
(linear to zero fossil fuel by 2050)



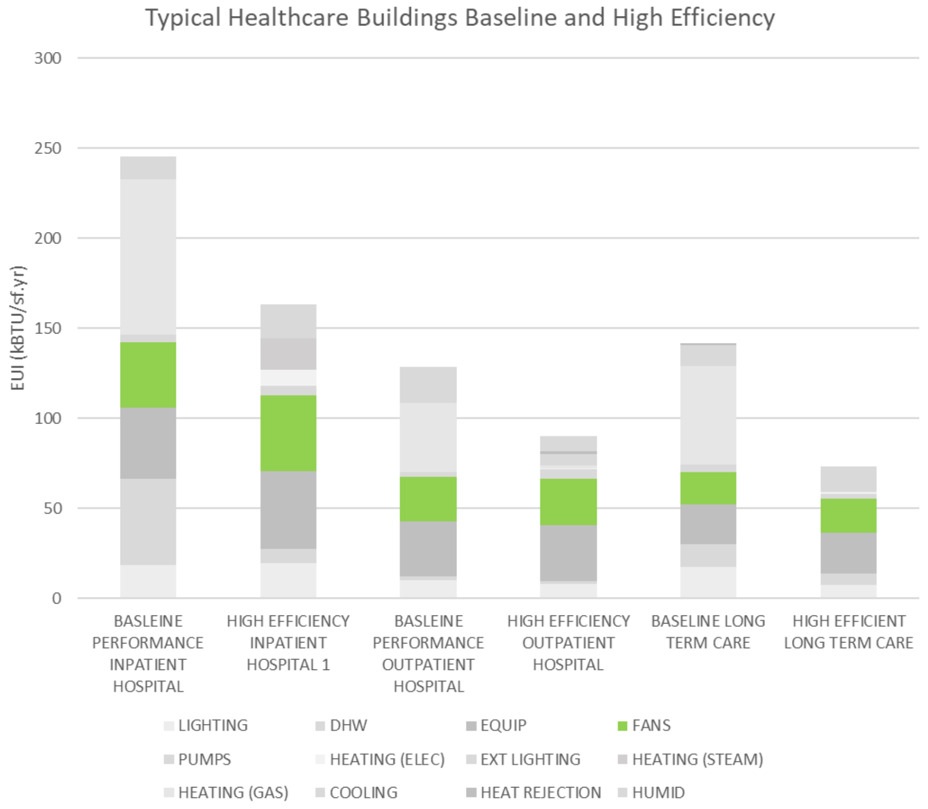
Payments: **$16 Million** over 30 years

$4 Million over 30 years

DEFINING HEALTHCARE ENVIRONMENT: ENERGY INTENSIVE FEATURES

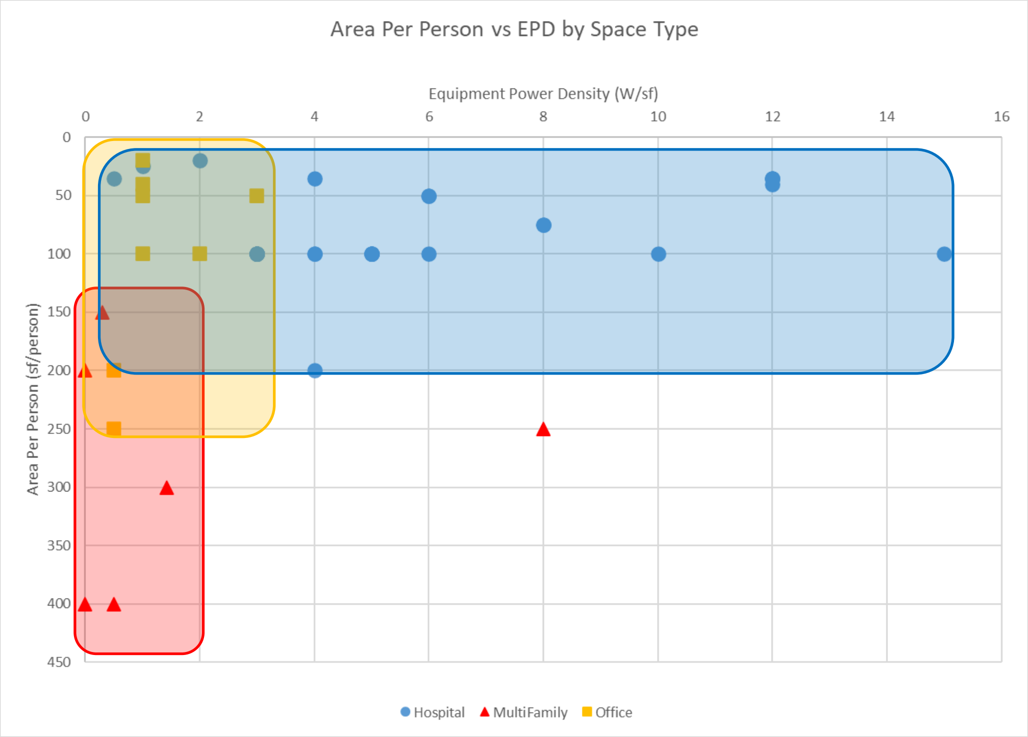
LARGEST CONTRIBUTORS TO HEALTHCARE ENERGY CONSUMPTION

- Equipment
  - MRI / CT/ Imaging equipment, etc.
- Hot Water and Steam
  - Domestic Hot Water
  - Sterilization
- Occupant Density
  - Patients, faculty and staff, families
- Ventilation
  - ASHRAE 170 rates



BENCHMARKING HEALTHCARE SPACE TYPES

Parameter	Healthcare	MF	Office
Ventilation	high	low	med
Occupant Density	med	low	high
Equipment Power Densities	high	low	med



DEFINE HEALTHCARE TYPOLOGY & VENTILATION REQUIREMENTS

– Healthcare Typology: hospitals, in-patient, out-patient, nursing homes, psychiatric facility, etc.

– Purpose of **ASHRAE 170:** “*The purpose of this standard is to define ventilation system design requirements that provide environmental control for comfort, asepsis, and odor in healthcare facilities.*”

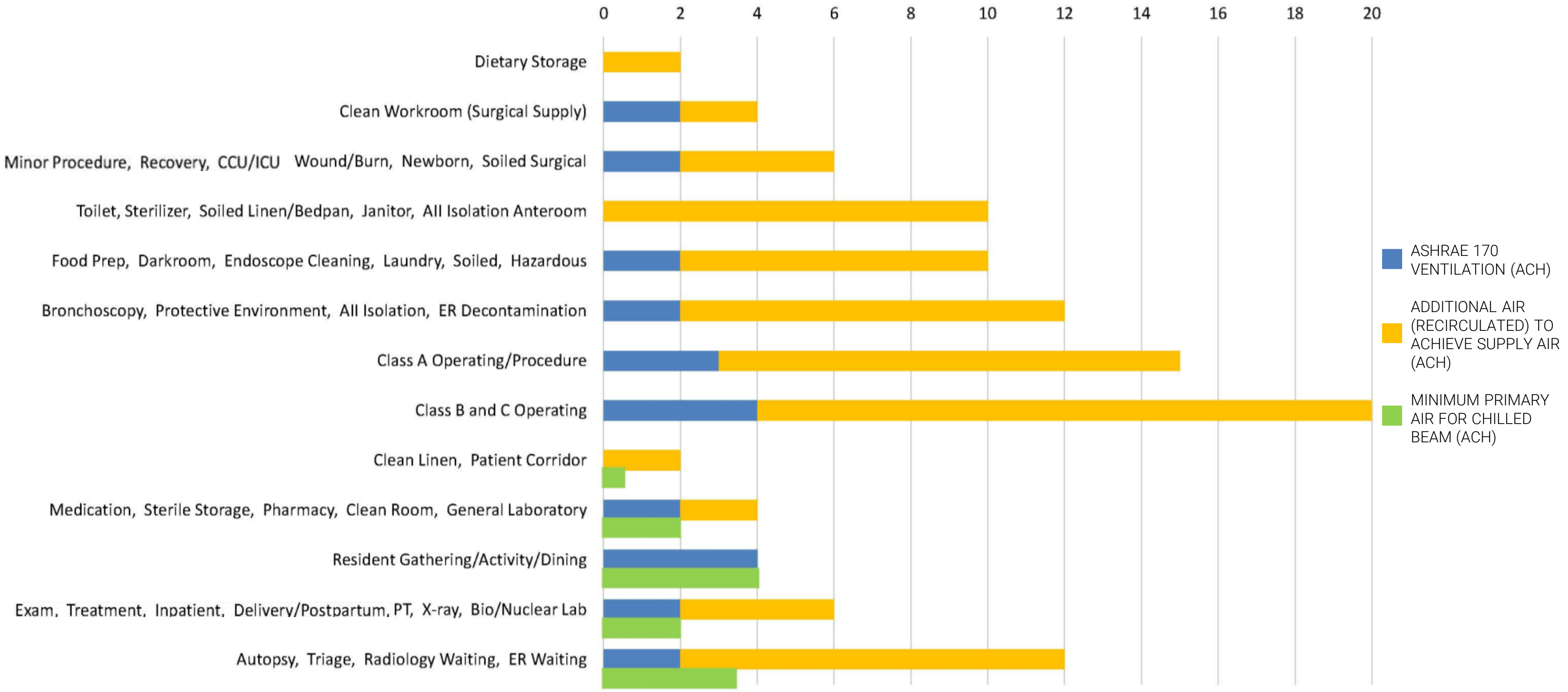
WHO/WHERE: ***“****The requirements in this standard apply to* ***patient care areas*** *and related support areas within healthcare facilities, including hospitals, nursing facilities, and outpatient facilities. This standard applies to new buildings, additions to existing buildings, and those alterations to existing buildings that are identified within this standard.”*

WHAT: This standard sets **requirements for ventilation systems** such as:

Filtration, Outdoor Air Rates, Exhaust, Humidification

WHY: ***“****This standard considers chemical, physical, and biological contaminants that can affect the delivery of medical care to patients; the convalescence of patients; and the* ***safety of patients, healthcare workers, and visitors****.”*

ASHRAE 170 VENTILATION RATES



MINIMIZING RISK: FUTURE PROOFING HEALTHCARE ASSETS

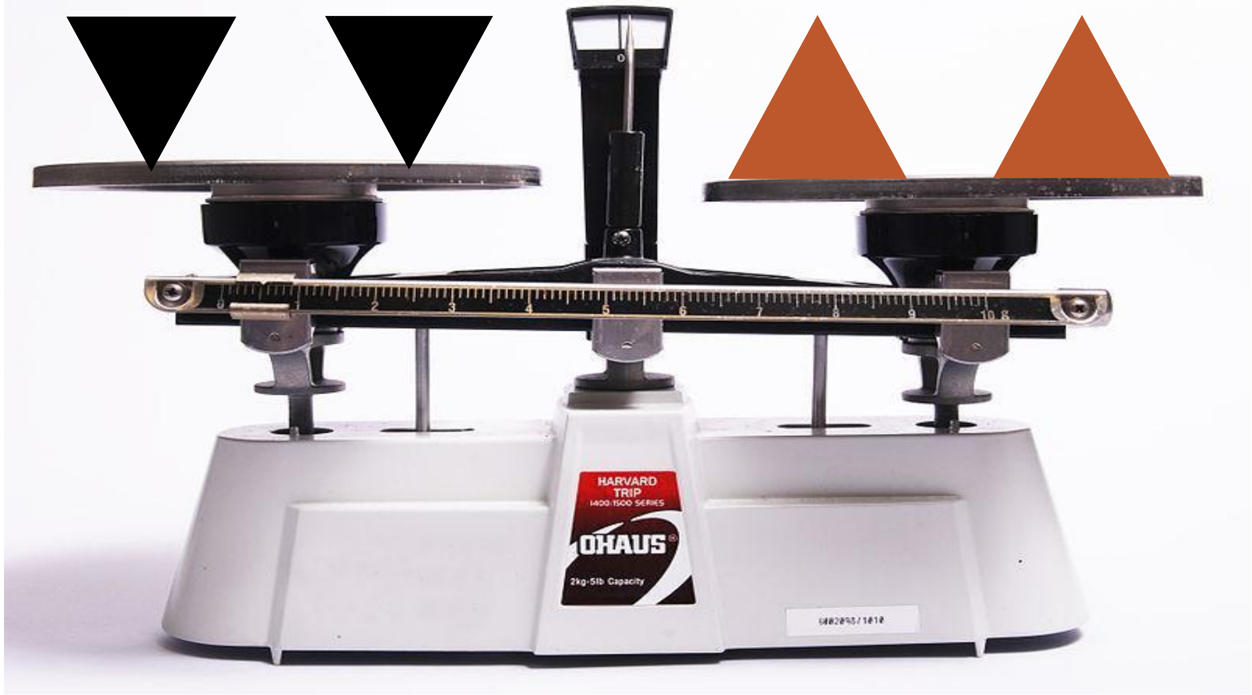
ENERGY BALANCE

2 LOSS PARAMETERS:

- Transmission Loss
- Ventilation Loss

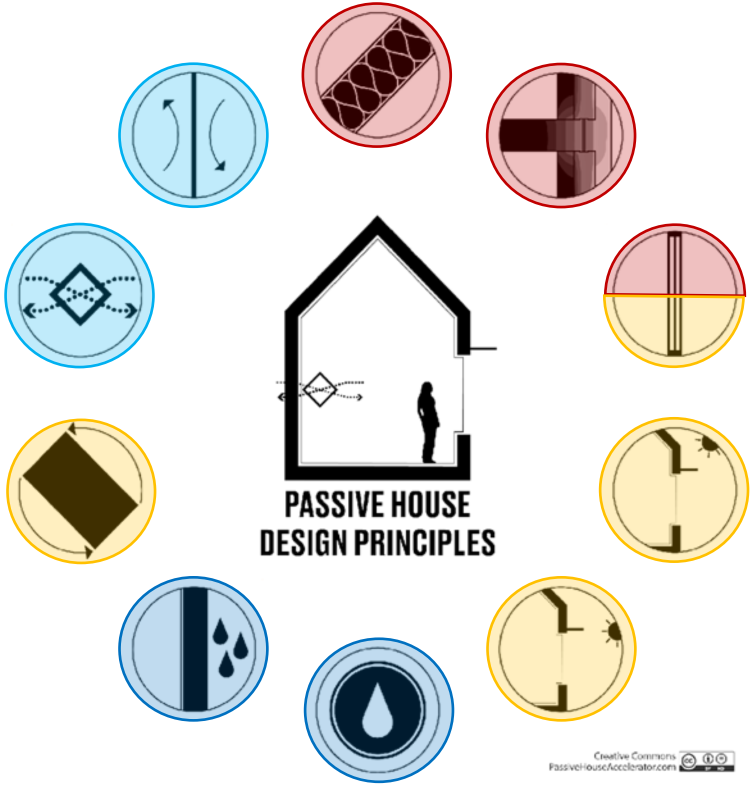
2 GAIN PARAMETERS:

- Solar Gains
- Internal Gains



PASSIVE HOUSE (PH) PRINCIPLES

- Thermal Control
  - High Performance Enclosure
  - Thermal Bridge Elimination
- Air Control
  - Airtightness
  - Balanced ventilation with heat and moisture recovery
- Radiation Control
  - High Performance Glazing
  - Shading and Daylighting
- Moisture Control
  - Material Moisture
  - Air Humidity



PHIUS PASSIVE HOUSE CRITERIA

Phius 2021
Performance Criteria Calculator v3.1

UNITS:	IMPERIAL (IP)
BUILDING FUNCTION:	NON-RESIDENTIAL
PROJECT TYPE:	NEW CONSTRUCTION

STATE/ PROVINCE	NEW YORK
CITY	NEW YORK LAGUARDIA

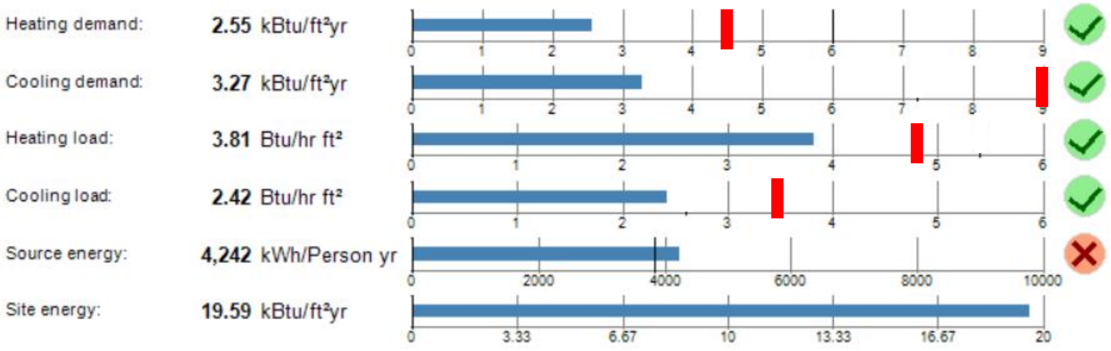
Envelope Area (ft²)	77,560.0
iCFA (ft²)	206,059.0
Average Occupancy	600
Design (Max) Occupancy	1,000

Space Conditioning Criteria

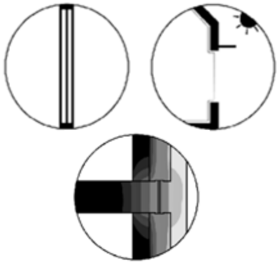
Annual Heating Demand	4.6	kBtu/ft²yr
Annual Cooling Demand	10.7	kBtu/ft²yr
Peak Heating Load	4.8	Btu/ft²hr
Peak Cooling Load	3.3	Btu/ft²hr

Source Energy Criteria

Phius CORE	24.5	kBtu/ft²yr
Phius ZERO	0	kBtu/ft²yr

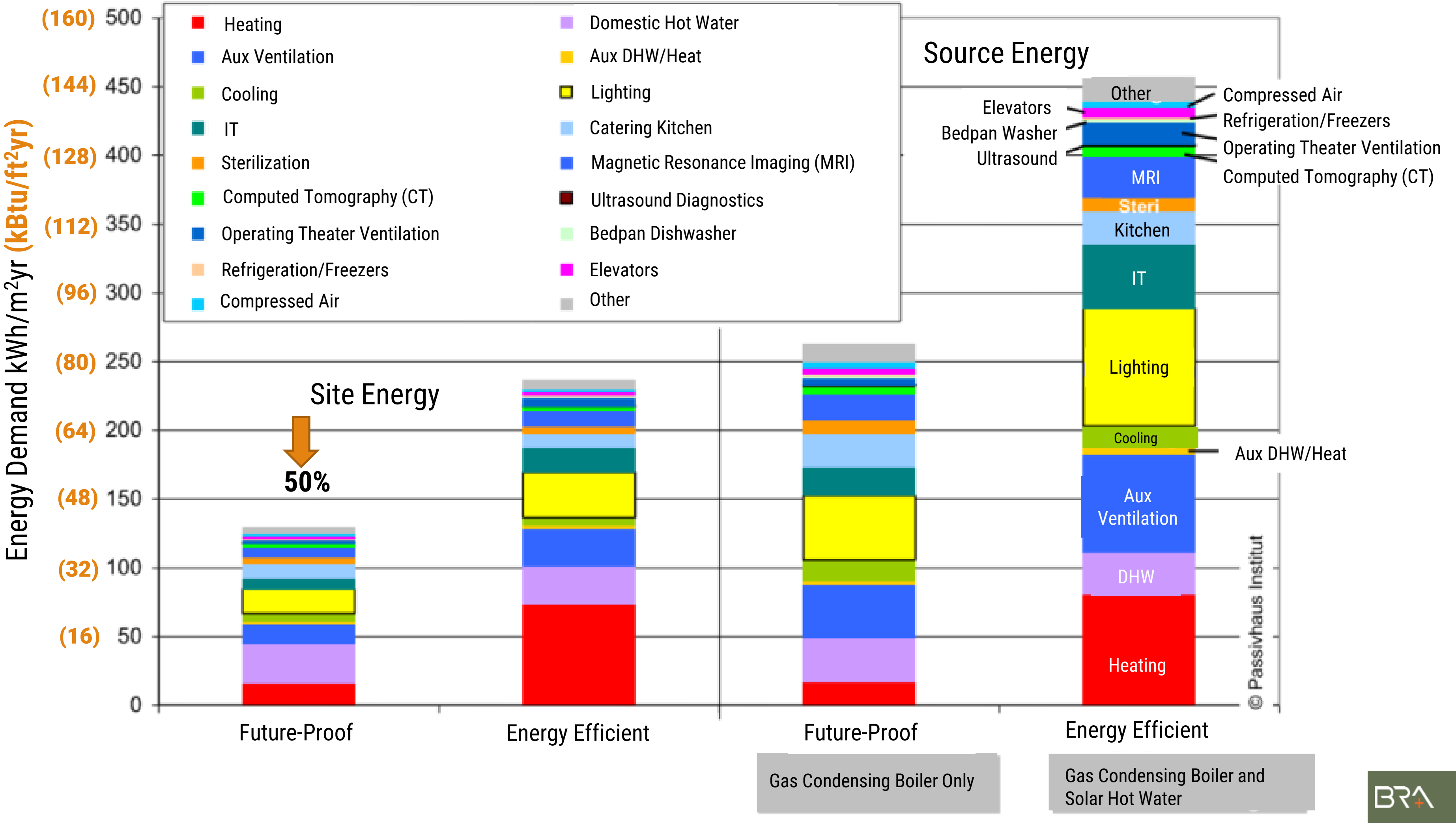


CHALLENGES APPLYING PH PRINCIPLES TO HEALTHCARE



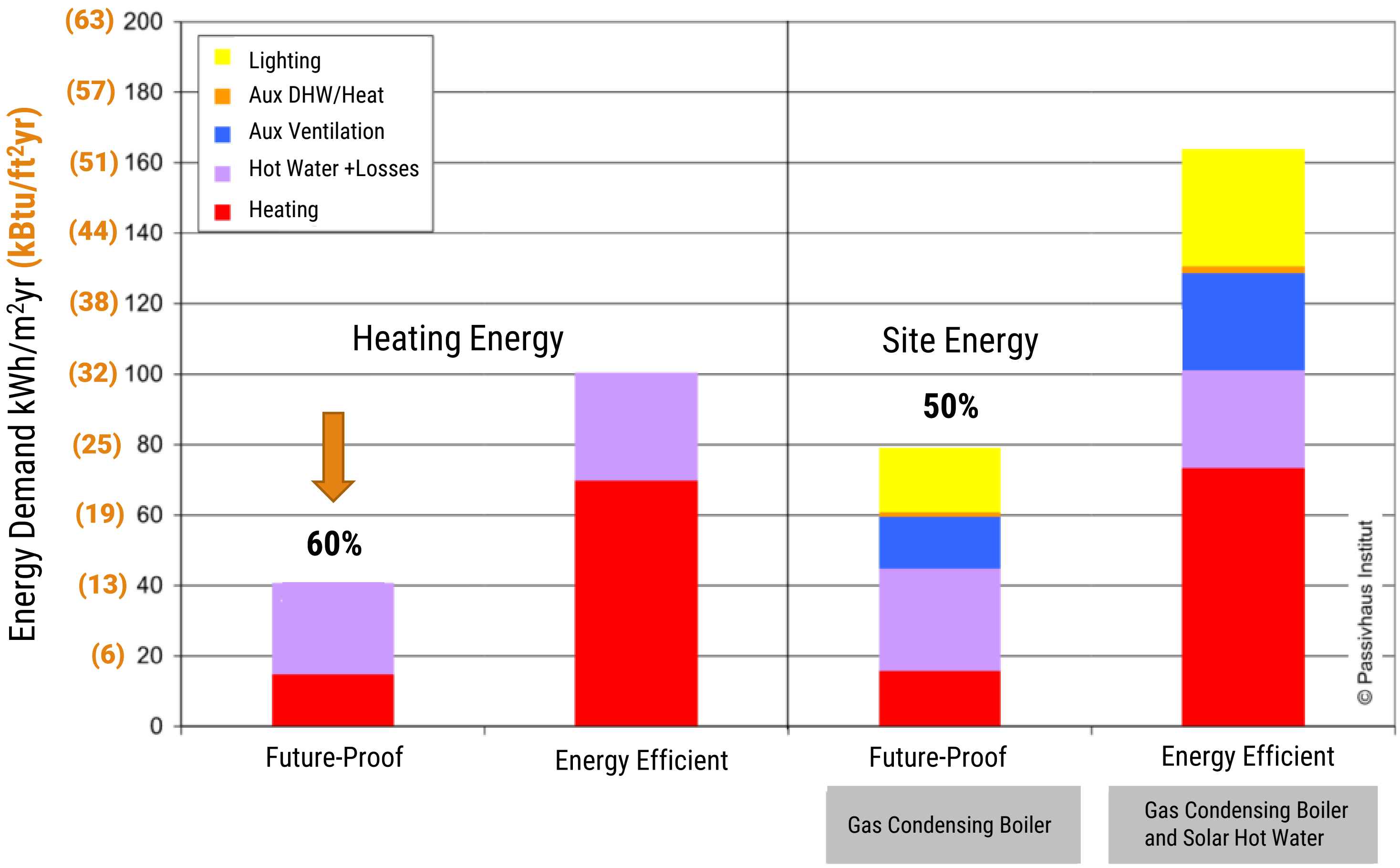
Challenge	Heating Limits	Cooling Limits	Source Energy
ASHRAE 170 Ventilation	X	X	X
Occupant Density		X	
Internal Gains		X	X
High Window-to-Wall Ratio	X	X	
Large Service Hot Water Demand	X		X

CASE STUDY 1: PH STRATEGIES EMPLOYED



Energy Demand kWh/m²yr (kBtu/ft²yr)
(160) 500
(144) 450
(128) 400
(112) 350
(96) 300
(80) 250
(64) 200
(48) 150
(32) 100
(16) 50
0
Heating
Aux Ventilation
Cooling
IT
Sterilization
Computed Tomography (CT)
Operating Theater Ventilation
Refrigeration/Freezers
Compressed Air
Domestic Hot Water
Aux DHW/Heat
Lighting
Catering Kitchen
Magnetic Resonance Imaging (MRI)
Ultrasound Diagnostics
Bedpan Dishwasher
Elevators
Other
Site Energy
50%
Source Energy
Other
Elevators
Bedpan Washer
Ultrasound
Compressed Air
Refrigeration/Freezers
Operating Theater Ventilation
Computed Tomography (CT)
MRI
Steri
Kitchen
IT
Lighting
Cooling
Aux DHW/Heat
Aux Ventilation
DHW
Heating
© Passivhaus Institut
Future-Proof
Energy Efficient
Future-Proof
Energy Efficient
Gas Condensing Boiler Only
Gas Condensing Boiler and Solar Hot Water
BR+A

FUTURE-PROOF HEALTHCARE CASE STUDY – FRANKFURT PH HOSPITAL



CASE STUDY 2: COST OF EMPLOYING PH

BALANCING PERFORMANCE AND COST

PERFORMANCE

- Phius buildings perform up to 85% better than conventional buildings.
- Carbon neutrality +Electrification
- Climate-appropriate energy targets
- Phius ZERO certification pushes further than Phius CORE,
  - Using renewable energy to meet all electricity demands.
  - Operational carbon neutrality
  - Energy independence.

PHIUS.org

COST

- Building to the Phius standard costs only 3-5% more than conventional building methods for a conventional home
- Larger projects benefit from the economy of scale:
  - multifamily passive building typically only costs 0-3% more than a building built to an energy star baseline.
- In general, the larger the building the smaller the cost difference.
- As more large-scale window and door manufacturers bring high-performance products to market, economies of scale are expected to drive down costs even further.

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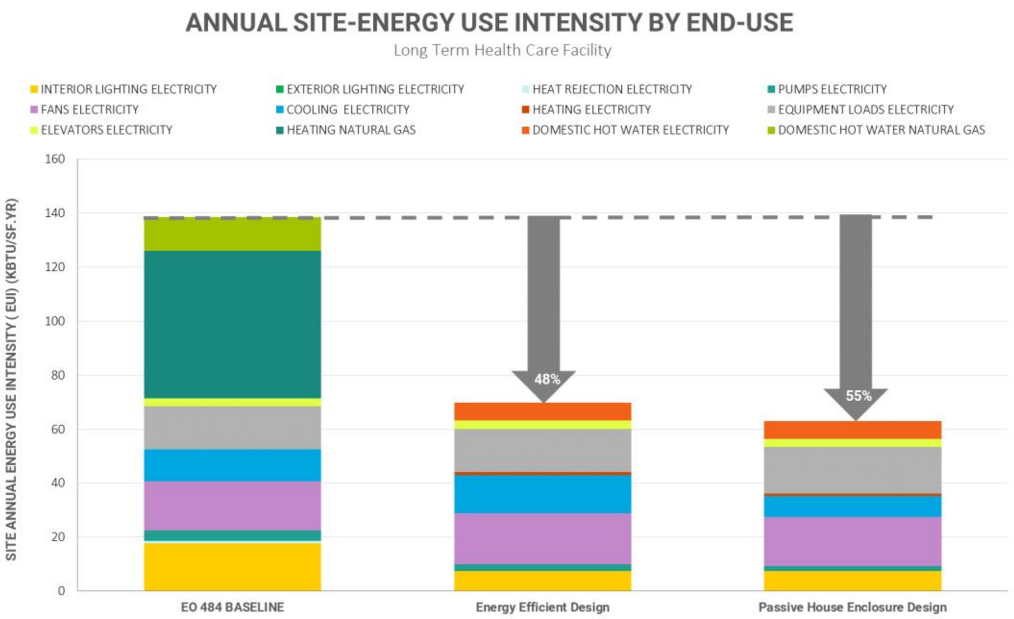
MODEL INPUTS

ENCLOSURE

MODEL INPUT PARAMETER	HIGH EFFICIENCY CASE	PASSIVE HOUSE CASE
Wall Assembly - Above Grade	*Face brick: U-0.043*	*Face brick: U-0.030*
Vertical Glazing - U-Value	0.19 Curtainwall	0.172 Curtainwall
Air Infiltration	0.083 INF-ACH	0.035 INF-ACH

VENTILATION ENERGY RECOVERY

MODEL INPUT PARAMETER	HIGH EFFICIENCY CASE	PASSIVE HOUSE CASE
Exhaust Air Energy Recovery	Enthalpy wheel + Desiccant wheel	Dual core



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LOW CARBON PRINCIPLES IN ACTION

CONFIDENTIAL LONG-TERM CARE FACILITY

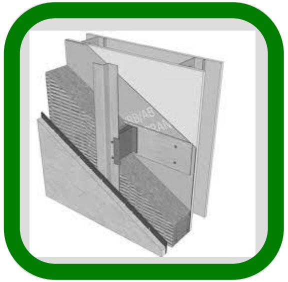
Life Cycle Cost Analysis (LCCA)

All Values in $ Millions	Baseline Current Design with Solar PV	Baseline no PV Current Design without Solar PV	Alternate Improved Envelope with Solar PV	Alternate no PV Improved Envelope without Solar PV
TOTAL CONSTRUCTION COSTS	$287.7	$286.2	$288.0	$286
ENVELOPE UPGRADES	-	-	$1.6	[illegible]
MEP SAVINGS	-	-	-$1.4	[illegible]
SOLAR PV (G40 - SITE ELEC UTILITIES)	-$1.5	-$3.0	-$1.5	[illegible]
40-YR TOTAL OPERATING COSTS	$31.1	$31.8	$26.0	[illegible]
40-YR MAINTENANCE + REPLACEMENT	$16.3	$16.2	$16.3	[illegible]
40-YR ENERGY	$14.8	$15.5	$9.7	$10.5
40-YR DEMAND CHARGE (*TBD)	2nd Highest	Highest	Lowest	2nd Lowest
40-YR NET PRESENT COST	**$317.3**	**$315.0**	**$312.7**	**$310.4**
40-YR NET PRESENT COST DIFFERENCE	**$0.0**	**$2.3**	**$4.6**	**$6.9**
PERCENT DIFFERENCE FROM BASE	-	0.7%	1.4%	2.2%
LBS CO2e PER SF (ISO NE 2019)	11.8	12.4	7.8	8.4
KG CO2e PER SF (ISO NE 2019)	5.4	5.6	3.5	3.8
40-YR CO2e EMISSIONS (KILOTONNES)	70,765	74,423	46,636	50,294
40-YR CO2e EMISSIONS DIFFERENCE	-	3,658	(24,129)	(20,471)

ADDITIONAL SAVINGS WHEN ACCOUNTING FOR REDUCTION IN CARBON EMISSION FINES FROM LOCAL REGULATIONS LIKE LL97

HOW TO FUTURE-PROOF:
BEST PRACTICES

GET THE BALANCE RIGHT



Energy Efficiency

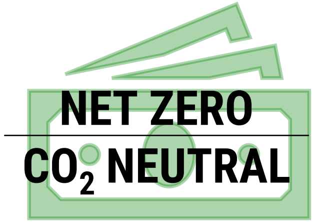
+

Electrification
(Heat + Hot Water)

+

Renewable
Energy

=



SPC 227P, Proposed Standard authorized January 16, 2019.
Passive Building Design Standard

PURPOSE: This standard provides requirements for the design of buildings that have exceptionally low energy usage and that are durable, resilient, comfortable, and healthy.

SCOPE:
2.1 This standard is applicable to all new and existing buildings intended for human occupancy.

2.2 This standard provides requirements for the design and construction of the:

1. building envelope,
2. heating and cooling equipment and systems,
3. ventilation systems,
4. service hot water systems,
5. interior and exterior lighting systems, and
6. plug and appliance loads.

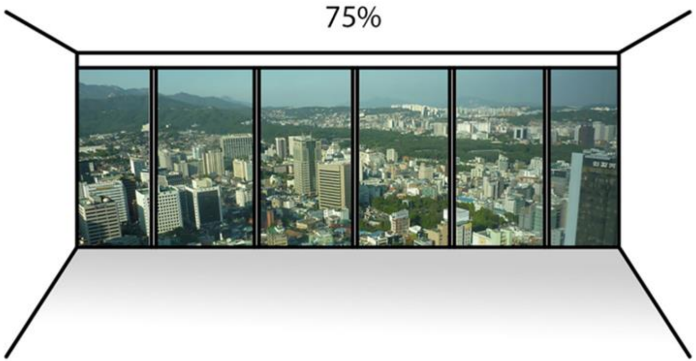
2.3 This standard does not provide requirements for the operation, maintenance, or use of buildings.

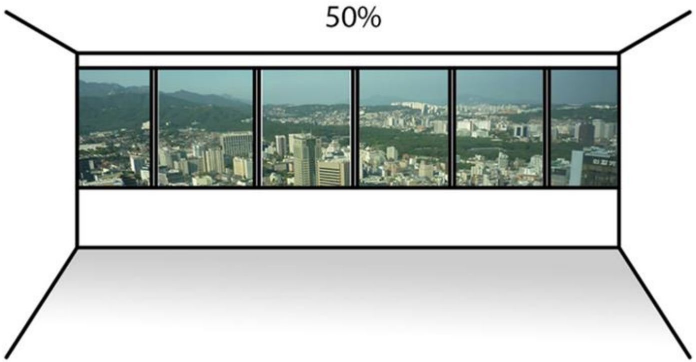
2.4 This standard does not apply to process related systems or equipment.

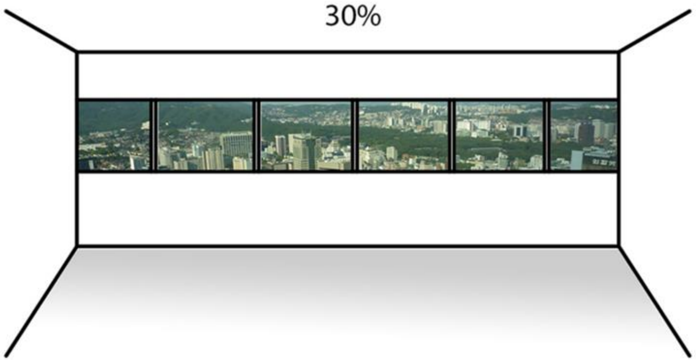
2.5 This standard shall not be used to circumvent any safety, health, or environmental requirements.

ENCLOSURE

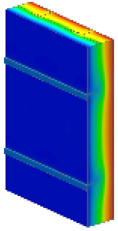
RETHINKING FENESTRATION TO WALL RATIOS

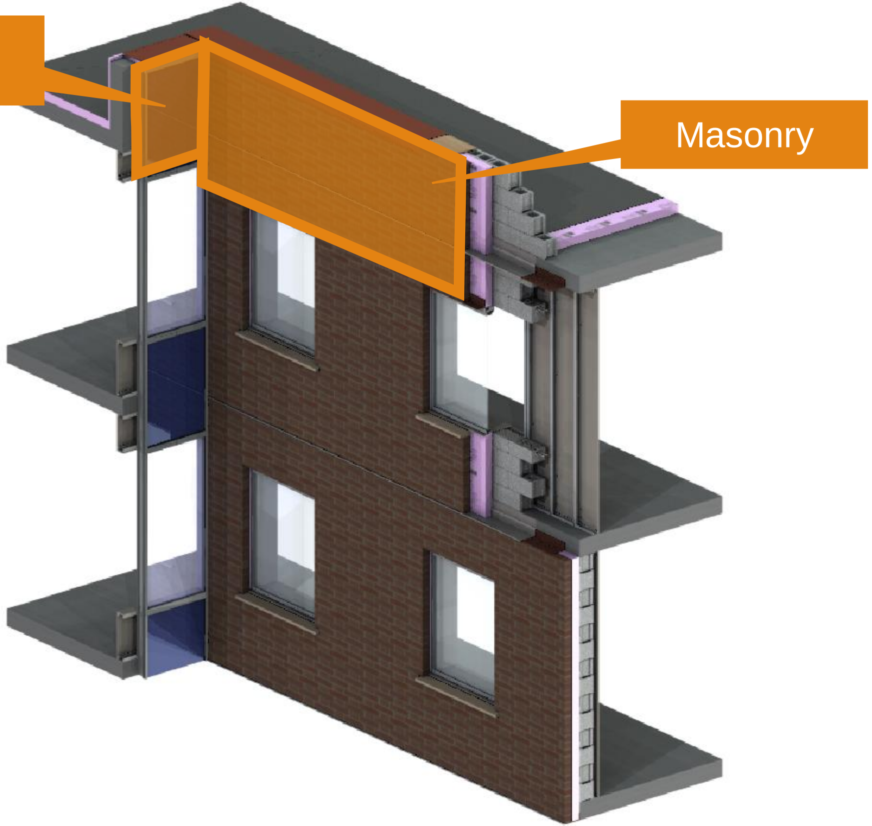






THERMAL BRIDGING





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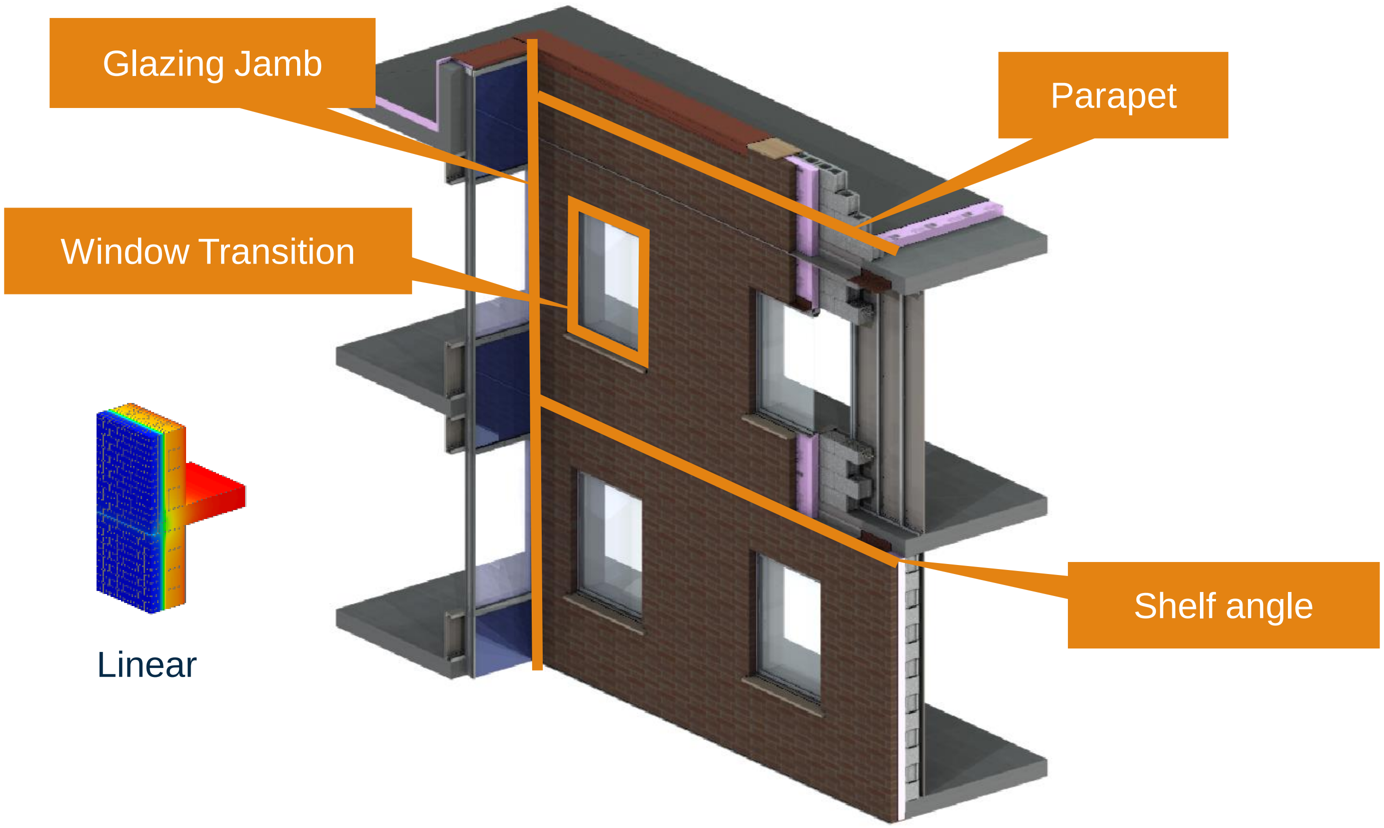
THERMAL BRIDGING



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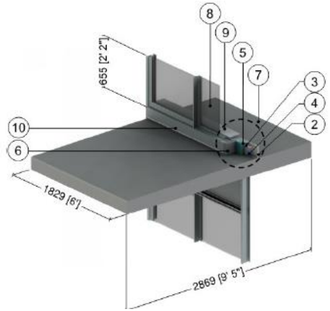
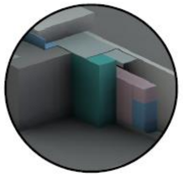
EFFECTIVE R-VALUE?

Detail 8.1.3 | Interior Insulated Concrete Curb – Window-Wall and Intermediate Floor Intersection

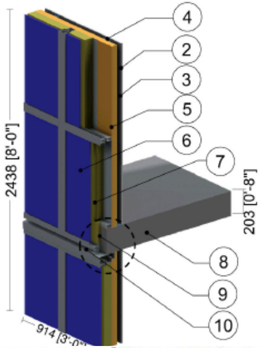


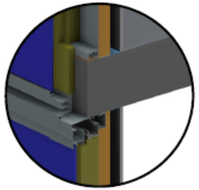


Curb Detail

Ψ = 0.974 Btu/ft.F
Ψ = 1.686 W/mK

Detail 1.2.6 | Window Wall System – Full Height Spandrel at Slab Intersection with Spandrel Bypass & Interior Spray Foam Insulation

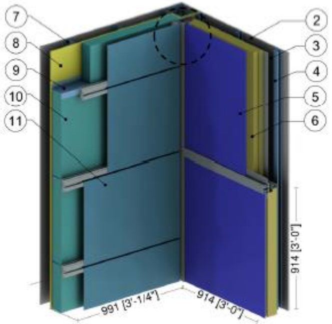


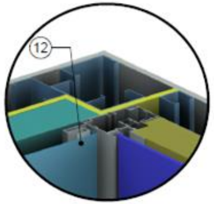


Bypass Detail with Deflection Header and 1/2" (12mm) Air Gap Behind Horizontal Mullion

Ψ = 0.447 Btu/ft.F
Ψ = 0.774 W/mK

Detail 5.6.6 | Window Wall System – Transition to Exterior Insulated Steel Stud Wall Assembly with Horizontal Z-girts (24" o.c.) Supporting Metal Cladding & No Interior Stud Cavity Insulation

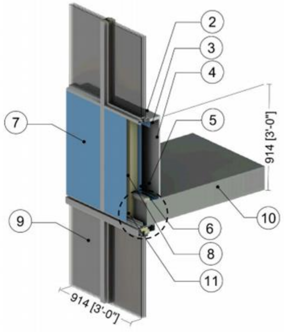


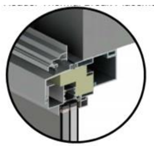


Corner Post Detail

Ψ = 0.444 Btu/ft.F
Ψ = 0.768 W/mK

Detail 1.2.4 | Window Wall System – Triple Glazed Insulated Frame at Slab Intersection with Improved Spandrel Bypass & No Interior Stud Cavity Insulation

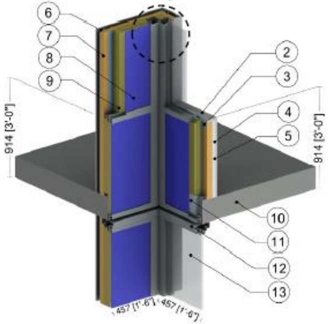


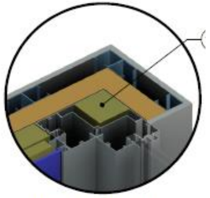


B. Improved Bypass with 1" (25mm) insulation behind horizontal mullion, and Deflection Header Thermal Break in line with Bypass Insulation

Ψ = 0.104 Btu/ft.F
Ψ = 0.181 W/mK

Detail 1.4.2 | Window Wall System – Inside Corner with Spandrel to Vision Transition & Interior Spray Foam Insulation

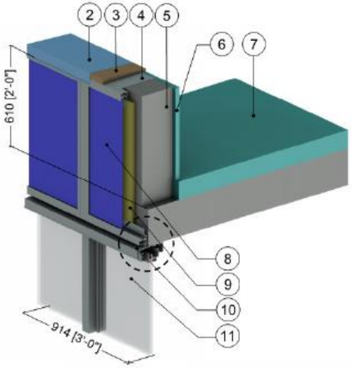


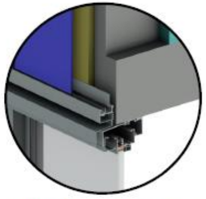


Corner Post Detail

Ψ = 0.119 Btu/ft.F
Ψ = 0.206 W/mK

Detail 1.3.2 | Window Wall System – Partially Insulated Concrete Parapet & Roof Intersection





Parapet Intersection Detail

Ψ = 0.563 Btu/ft.F
Ψ = 0.975 W/mK

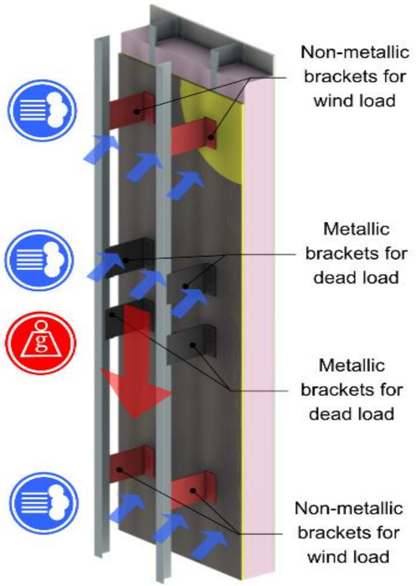
Images courtesy of Morrison Hershfield

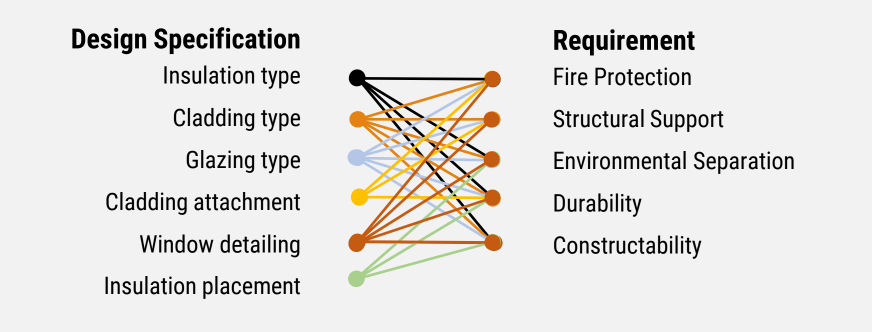
BRA

MORE THAN THICKER WALLS AND EXTRA INSULATION

All Stakeholders to Recognize:

- The impact of thermal bridging at every junction between building components
- Deviation from conventional practice is required, but it is in everyone's best interest to minimize disruption and build on local practice
- Success will come from a holistic viewpoint to design specifications and project requirements
- More effort will be required, by everyone, until new norms are established





Slide courtesy of Morrison Hershfield

GENERAL BEST PRACTICES

HEATING, AND HOT WATER BEST PRACTICES

Heating

- Utilize waste heat via **energy recovery ventilation**
- Utilize low temp waste heat by means of **heat pumps**
- Avoid steam generation

DHW

- **Water saving fixtures** and fitting
- Reduce distribution losses with **efficient layouts** and running hot water pipes in conditioned space (up to 50% of losses from distribution)
- Utilize low temp waste heat by means of **heat pumps**
- **Solar thermal**

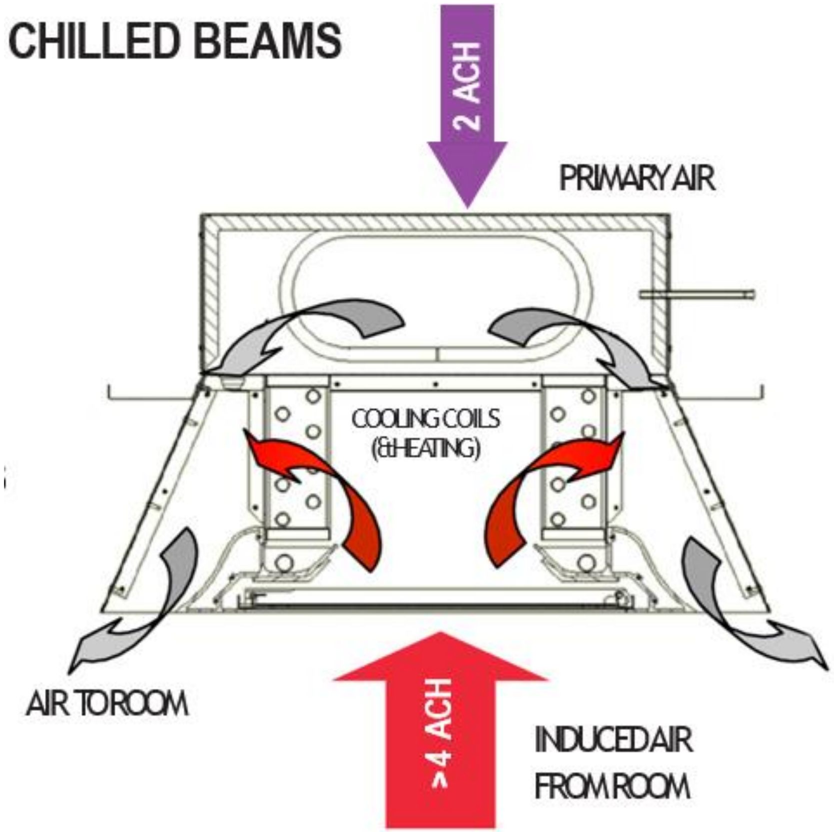
COOLING BEST PRACTICES

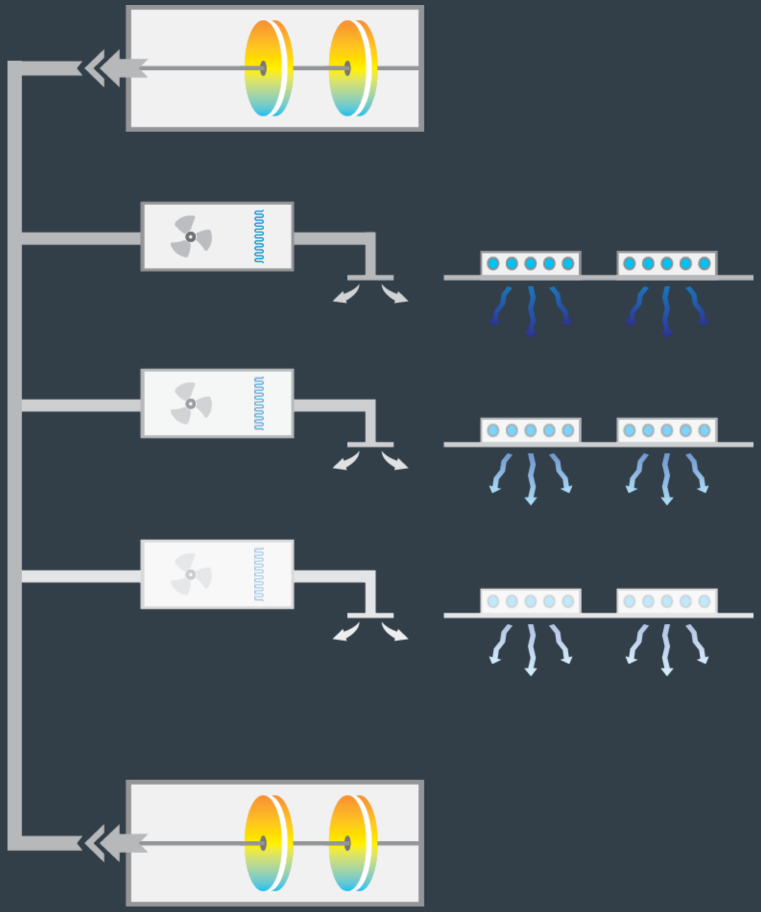
– Regulate Cooling Load

- Reduce internal heat gains
- Reduced solar loads and *shading*
- *Thermal mass* (exposed concrete ceilings)

– Use Efficient Equipment

- *Localized/chilled beam cooling* should be favored over cooling large volumes of air
- Night ventilation when/if humidity is not too high
- Low pressure losses in ventilation system
- *Efficient fans*
- Evaporative cooling within ventilation unit
- Place exhaust or chilled water-cooling circuit at the source of internal heat gains





VENTILATION BEST PRACTICES

- Provide efficient **energy recovery** (≥ 80 % sensible and >%75 latent)
- **Simplify** and shorten ventilation duct network
- Avoid unnecessarily high-pressure losses
- Demand control ventilation

LIGHTING BEST PRACTICES

Maximize Daylight Utilization.

- Common rooms have room depths that can usually be sufficiently supplied with daylight with one-sided windowing.
  - bedrooms, examination rooms or office-like service rooms,
- In occupied spaces the building design should strive for good daylighting conditions
  - examination, treatment and therapy rooms and, in some cases, duty rooms

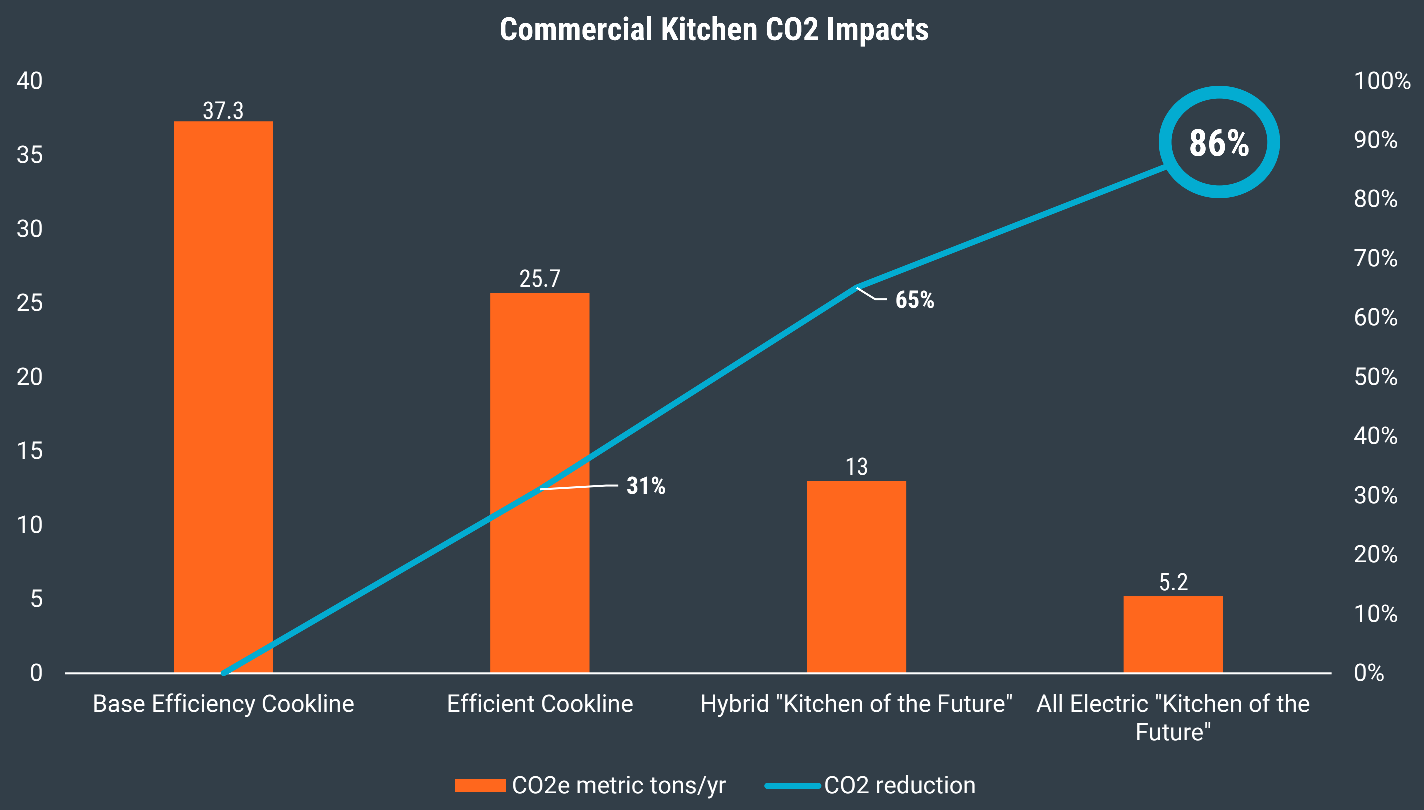
Lighting Design

- Exceed standard reflectance values of walls (50 %) and ceilings (70 %).
- Specify illuminance levels within rooms based on visual task(s) when possible.
- Use luminaries best fit for different lighting tasks
- Agree at an early stage on target and limit values for installed electrical power of lighting

IT BEST PRACTICES

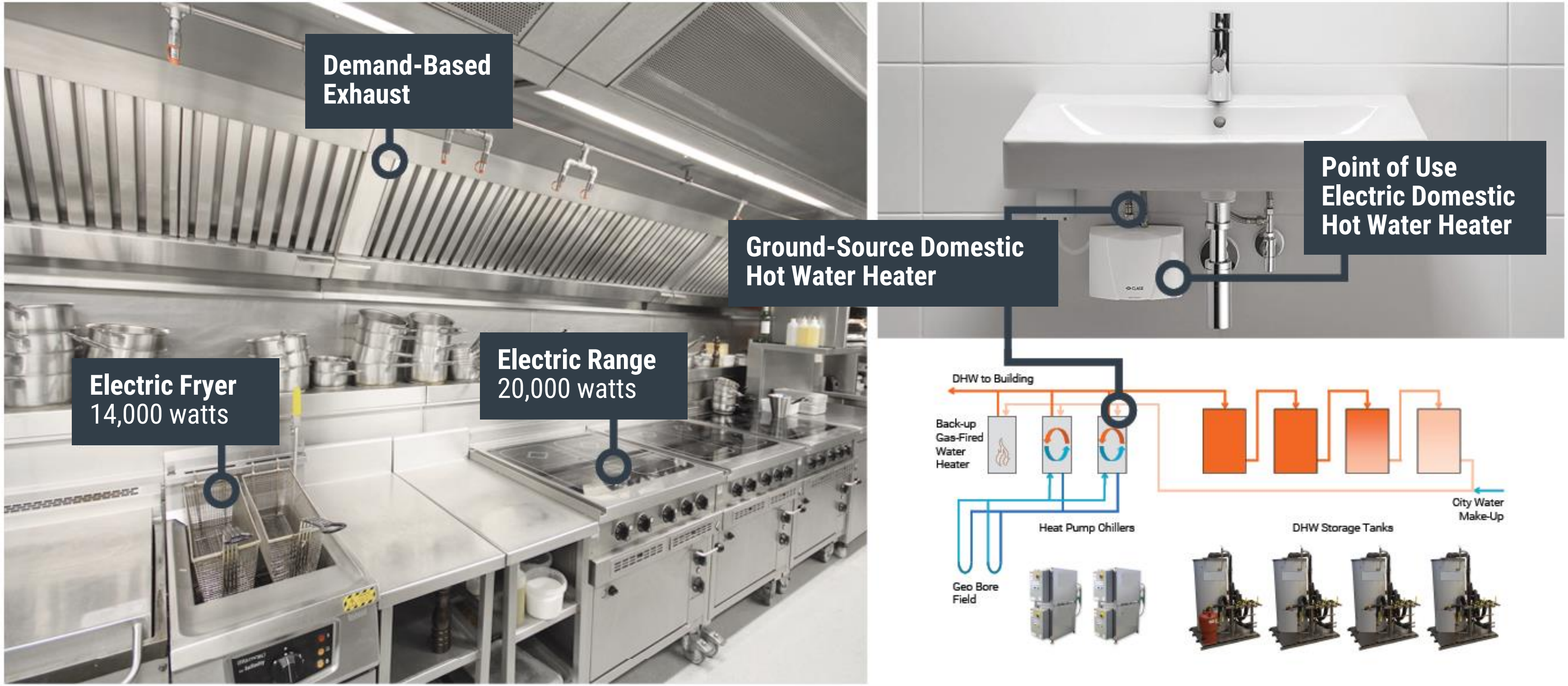
- The final energy demand of the entire IT system with efficient equipment should be <750 $W/ft^2.yr$. This value is based on the planned IT equipment.
- Other systems and lower efficiency quickly increase the energy demand to 1400 to 1850 $W/ft^2.yr$ **(100%-150% increase)**
- In order to keep the cooling requirement low in addition to the energy requirement of the server structure, **servers with higher temperature tolerance should be used.**
- Recover server waste heat

COMMERCIAL KITCHEN EMISSIONS



** Source: Food Service Technology Center 2019*

ALL ELECTRIC KITCHEN



HEALTHCARE BEST PRACTICES

MEDICAL APPLIANCES AND DEVICES BEST PRACTICES

*Although energy efficiency in medical and professional equipment does not yet seem to have been recognized as an issue, **available equipment** and improved processes offer **savings potentials of more than 30%** in total when executed in an energy-efficient manner.*

STERILIZATION AND GLASS WASH BEST PRACTICES

- Washer-disinfectors largest energy end use is **heating water and steam**.
- Solution: **economical use of water**.
  - Minimize standing times - reduce distance between sanitation/wash-rooms and OR and patient care spaces
    - *Up to 20% savings possible*

STERILIZATION AND GLASS WASH BEST PRACTICES CONT'D

- Tank systems allow reuse of the hot deionized water from the disinfection phase.
  - Valve circuit collects water in a separate tank and can be used a second time in large-scale cleaning machines, which exclusively clean transport trolleys and containers.
- Heat contained in the wastewater recovered in heat recovery system + heat pump system.
  - heavily contaminated water from the pre-rinse is bypassed

MRI

- Carefully review spec sheets to ensure that energy efficient equipment is being selected
- Can significantly reduce cooling load
- New technology using superconductors shows promise for energy reductions.

CT

- Compared to previous generation, consumption of current devices is **30% lower.**
- Engage standby mode automatic switch-off and rapid switch-on modes.
- The energy demand per study of current devices when switched off when not in active use (nights and weekends) is about 1.4 kWh

OTHER EQUIPMENT

- Medical coolers: Adjust set points on -80C freezers to -70C
- Fume Hoods: Lower VAV Fume Hood sashes when not in use to reduce energy use by 40%
  - Automatic sash closers
- Solid state lasers> gas lasers.
  - Reduce energy consumption, last longer, lower cooling loads.
- Biosafety cabinets (BSC)
  - Turn off when not in use.
- Compressed air: The supply of compressed air -> high energy losses.
  - Minimize devices operated with compressed air

CONCLUSIONS

CONCLUSIONS

GOAL: target future proof healthcare facilities while delivering the same quality of care and improving patient outcomes.

- Prioritizing envelope efficiency leads to load reduction and operational cost savings

- 150 kBtu/sf/yr EUI is the new baseline for efficient healthcare facilities.
- < 50 kBtu/sf/yr EUI's are best in-class future-proof healthcare facilities.

- Mitigating carbon risk and future liability associated with inefficient facilities can have significant lifecycle cost savings, depending on utility rates.

- With early planning and integrated design, best-in class future-proof healthcare facilities can be built at less than 1% construction cost premium.

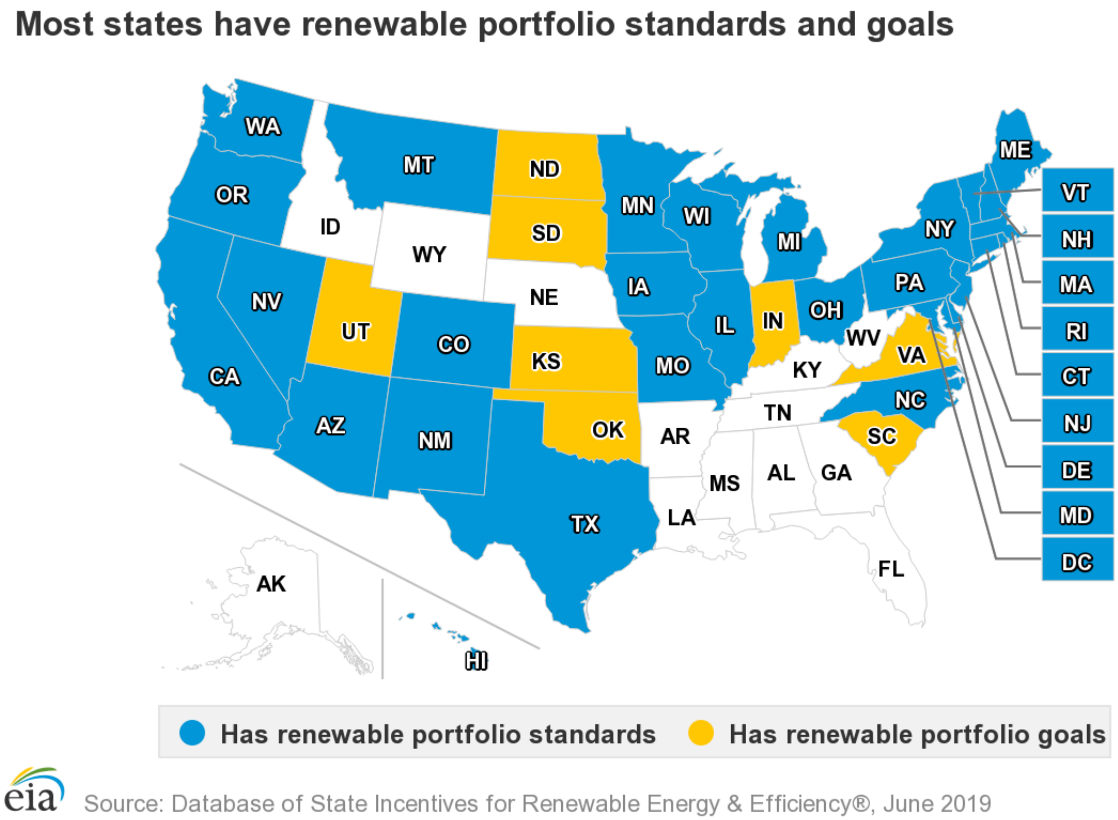
THANK YOU

Questions?

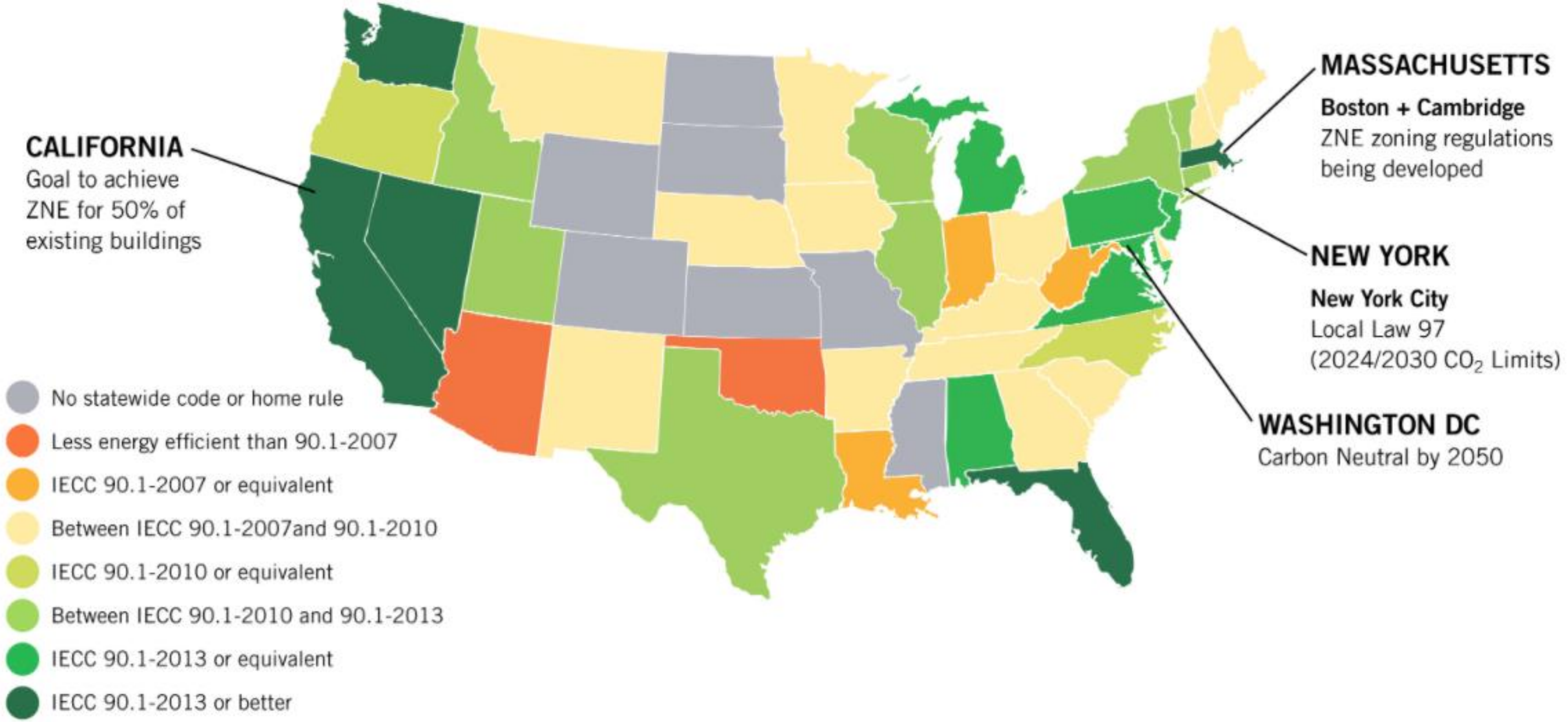
Responsive buildings.
Responsive people.

BACKUP/APPENDIX

GRID DECARBONIZATION STANDARDS



EXISTING BUILDING ZNE REQUIREMENTS



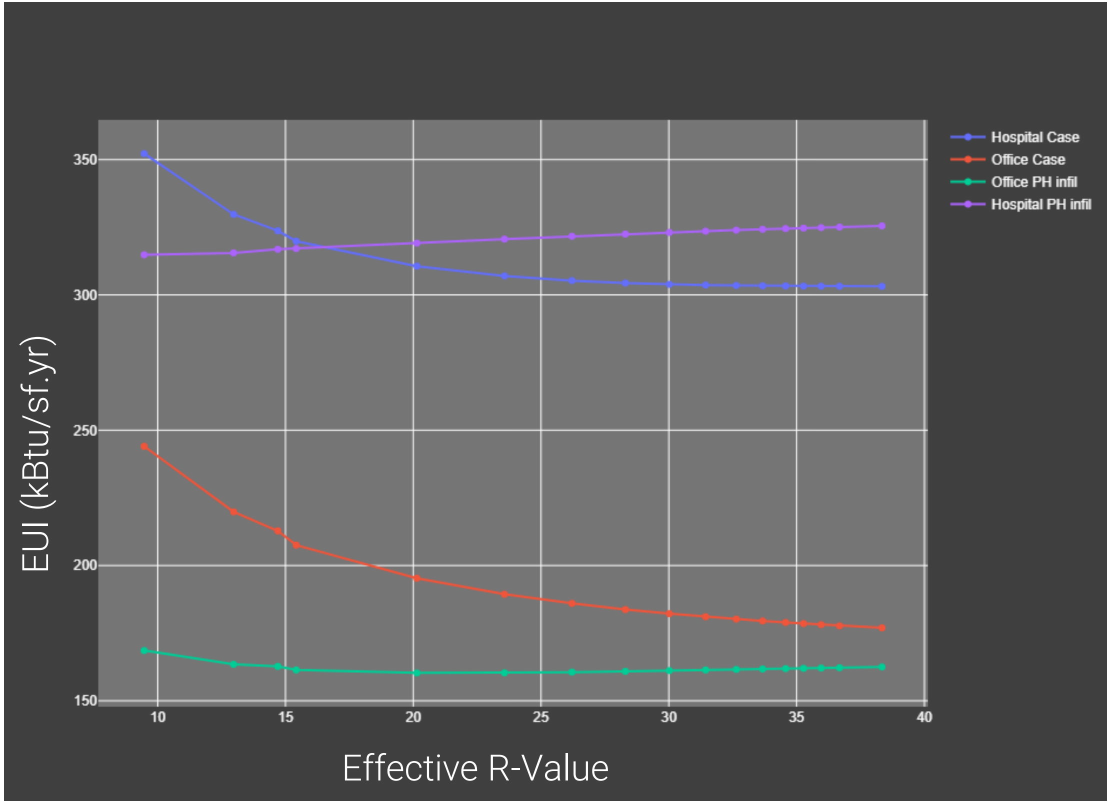
LL97 EXCEPTION FOR NOT-FOR-PROFIT HOSPITALS/HEALTHCARE

28-320.9 Adjustment to applicable annual building emissions limit for not-for-profit hospitals and healthcare facilities. The department shall **grant an adjustment of the annual building emissions limits** for calendar years 2024-2029 and 2030-34 where:

1. The building is classified as a not-for-profit hospital, not-for-profit health center, or not-for-profit HIP center, in existence on the effective date of this article; and
2. By no later than July 21, 2021, the owner of the covered building submits an application to the department for such adjustment in a form and manner prescribed by the department.

For calendar years 2024 through 2029, the adjustment shall result in the covered building being subject to an emissions limit that **is 85 percent of the calendar 2018 building emissions** for such covered building. For calendar years 2030 through 2034, the adjustment shall result in the covered building being subject to an emissions limit that is **70 percent of the calendar 2018** building emissions for such covered building.

STUDY OF HOSPITAL AND OFFICE TYPOLOGIES WITH PH ENCLOSURE



MODEL INPUTS – MAYBE MOVE TO BACKUP

ENCLOSURE

MODEL INPUT PARAMETER	HIGH EFFICIENCY CASE	PASSIVE HOUSE CASE
Roof Assembly	U-0.025 (R-40)	
Wall Assembly - Above Grade	*Face brick: U-0.043*	*Face brick: U-0.030*
	Aluminum rainscreen: U-0.043	
	Spandrel: U-0.05	
Vertical fenestration Area (% of wall)	26%	
Vertical Glazing U-factor	0.16 Punched	
	0.19 Curtainwall	0.172 Curtainwall
Vertical Glazing SHGC	0.3 Punched, 0.25 Curtainwall	
Shading Devices	Punched windows have integral shade frame	
Building Self-Shading Description	Building is self-shaded by its own exterior surfaces.	
Air infiltration	0.083 INF-ACH	0.035 INF-ACH

AIRSIDE

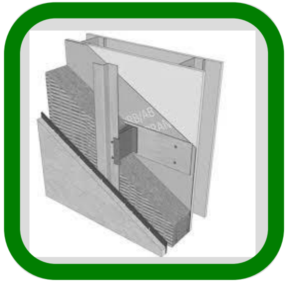
MODEL INPUT PARAMETER	HIGH EFFICIENCY CASE	PASSIVE HOUSE CASE
Primary HVAC Type	Ventilation: 100% OA and hybrid GSHP/DX cooling Zone heating/cooling: Geothermal water-source VRF	
Fan System Operation	24/7	
Exhaust Air Energy Recovery	Enthalpy wheel + Desiccant wheel	Dual core
Demand Control Ventilation	In all spaces	

WATERSIDE

MODEL INPUT PARAMETER	HIGH EFFICIENCY CASE	PASSIVE HOUSE CASE
Primary Cooling Source	Ground-source heat pump (WSHP AHUs and VRF)	
Secondary Cooling Source	Air-cooled DX changeover	
Number of Chillers	n/a	
Heat Rejection Source	Geothermal	
Condenser Water/Geo Pump Speed Control	Variable speed	

MODEL INPUT PARAMETER	HIGH EFFICIENCY CASE	PASSIVE HOUSE CASE
Primary Heating Source	Hot water condensing boiler – backup only to keep geo loop above 50°F	
Boiler Capacity and Efficiency	1 x 5,000 MBH – 90% Efficient	
Hot Water Loop Configuration	Sidecar to geo loop	
Hot Water Pump Speed Control	Variable Speed	

GET THE BALANCE RIGHT



Energy Efficiency

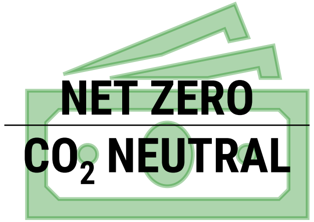
+

Electrification
(Heat + Hot Water)

+

Renewable
Energy

=



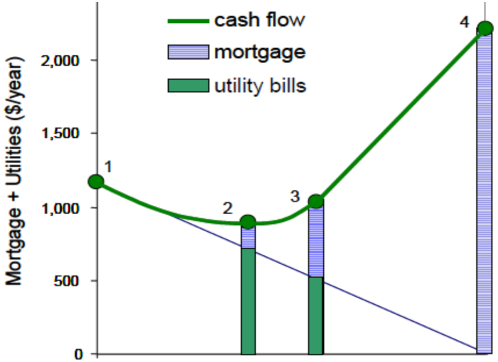


Image: PHIUS

COST OPTIMUM BETWEEN CONSERVATION + GENERATION

ON THE PATH TO NET ZERO/CO2 NEUTRAL

OPTIMIZED FOR:

- CLIMATE
- VARIATIONS IN BUIDING SIZE + MASSING
- OCCUPANT DENSITY

WHICH DETAILS MATTER? THERMAL PERFORMANCE

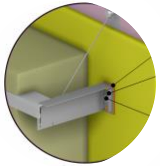
Select Area Calculation (Choose One)	Area	Units
○ Sum of Active Clear Field Areas (Default)	4883.41	m^2
○ User Defined Area	Enter User Defined Opaque Area	m^2

Overall Opaque Wall Thermal Performance Values	
Opaque U-Value (W/m^2K)	1.943
Effective R-value (m^2K/W)	0.51

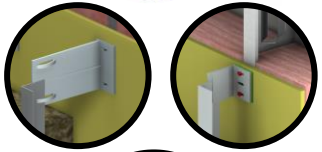
R- 2.9

Add/Remove Detail	Transmittance Type	Include	Transmittance Description	Area, Length or Amount Takeoff	Units	Transmittance Value	Units	Source Reference	Heat Flow W/K	%Total Heat Flow
								Totals	9487.35122	100%
Add Clear Field	Clear Field	☑	Brick Veneer	750.17	m^2	0.421	W/m²K	MH Effective R Value Memo (March 8, 2013)	315.82157	3%
Remove Clear Field	Clear Field	☑	Mechanical Penthouse Walls	273.03	m^2	1.8	W/m²K	Assumed 8" concrete mass wall, non insulated	491.454	5%
Remove Clear Field	Clear Field	☑	Window Wall	3860.21	m^2	0.946	W/m²K	MH Effective R Value Memo (March 8, 2013)	3651.75866	38%
Add Linear Interface Detail	Linear Interface Detail	☑	Parapets @ window wall	223.62	m	0.975	W/mK	BETB 1.3.2	218.0295	2%
Remove Linear Interface Detail	Linear Interface Detail	☑	Window wall to window wall corner	341.82	m	0.197	W/mK	BETB 1.4.2	67.33854	1%
Remove Linear Interface Detail	Linear Interface Detail	☑	Window wall to brick wall transition	220.17	m	0.207	W/mK	BETB 5.6.6	45.57519	0%
Remove Linear Interface Detail	Linear Interface Detail	☑	Window wall bypass	666.22	m	0.651	W/mK	BETB 1.2.2	433.70922	5%
Remove Linear Interface Detail	Linear Interface Detail	☑	Spandrel bypass	270.92	m	0.776	W/mK	BETB 1.2.6	210.23392	2%
Remove Linear Interface Detail	Linear Interface Detail	☑	Window wall @ balcony/eyebrow	2404.17	m	1.686	W/mK	BETB 8.1.3	4053.43062	43%

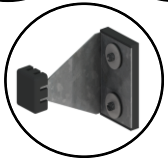
EARLY ENVELOPE OPTIMIZATON
THERMAL CLIPS W/ 6” X 1 5/8” STEEL STUD (16” O.C.)



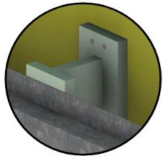
EJOT Crossfix [5.1.100] 16 x 24 Horizontal Rails
200 – 8.5” ext: R-28.3
240 - 10” ext: R-33.1 eff
320 – 13” ext: R-39.5 eff



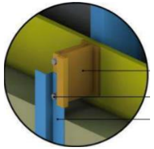
NVELOPE – Eko Clip + NV1 Clip [5.1.52] 16 x 24 Vertical Rails
10” ext: R-40.7 eff *



Knight – MFI System [5.1.22] 16 x 24 Horizontal Rails
8” ext: R-28.9 **
9” ext: R-31.8 eff **
10” ext: R-34.9 eff **
11” ext: R-37.8 eff **
12” ext: R-40.8 eff **
13” ext: R-43.8 eff **

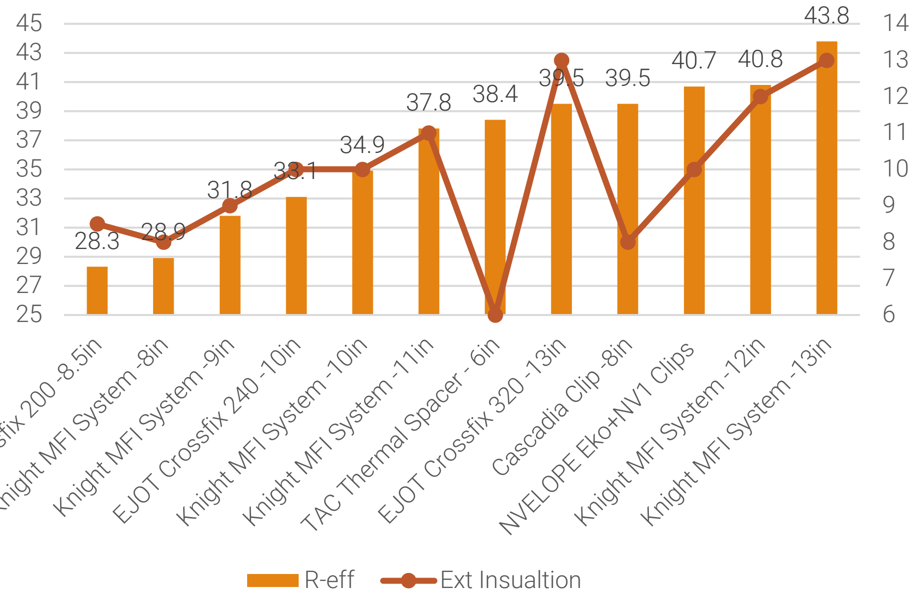


TAC - Fiber Reinforced Plastic Girts [5.1.25] 16 x 24 Limited to 6”
6” ext: R-38.4*



Cascadia Fiberglass Clip [5.1.53] 16 x 26
8” ext: R-39.5 eff *

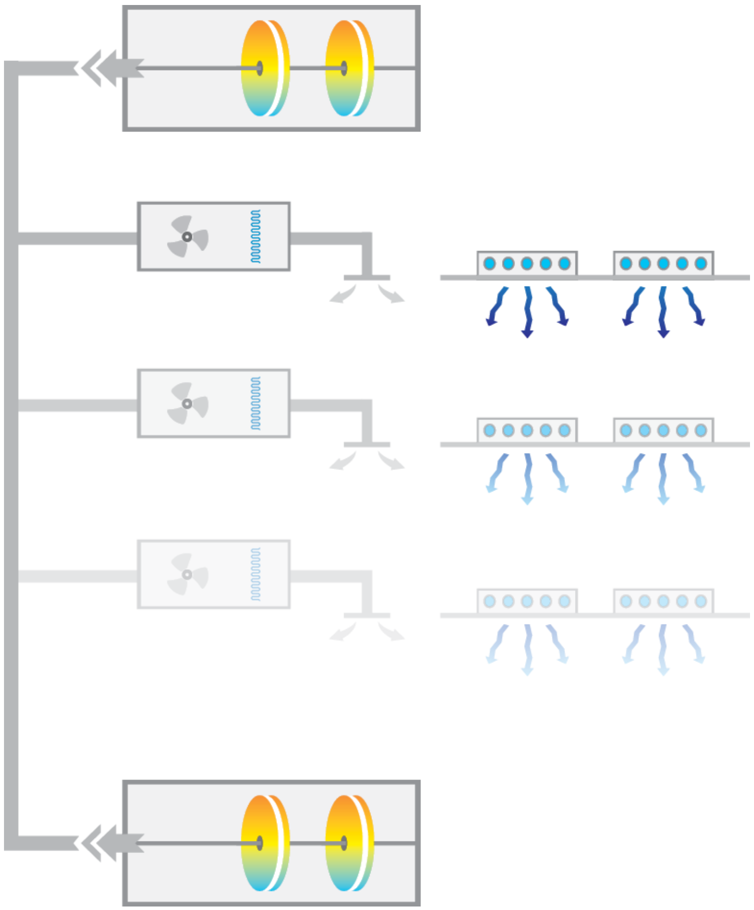
EFFECTIVE R-VALUES (IP) W/6” X 1 5/8” STEEL STUD (16” O.C.) AND 24" VERTICAL SPACING



* Effective R-value adjusted for 6” x 1 5/8” Steel Stud
** Effective R-value extrapolated from modelled data for up to 6” exterior mineral wool

GENERAL BEST PRACTICES

- Orient high internal gain rooms to the North: kitchens, server rooms, rooms with a lot of equipment
- Expected internal gains for hospital:
  - 0.6 W/ft^2 (1.75 $Btu/hr.ft^2$) is recommended for preliminary energy balancing
- Thermal mass – exposed concrete ceilings
- Shading – reduce solar heat gains



VENTILATION BEST PRACTICES

- Provide efficient energy recovery (≥ 80 % sensible and >%75 latent)
- Simplify and shorten ventilation duct network
  - Lowers: pressure loss and power consumption
  - Save: Construction cost, energy
- Adapt dimensioning and control of the air volumes to the actual demand
  - Demand control, fan efficiency <0.76 W/CFM
  - Demand-controlled ventilation with shutdown outside operating hours is also possible in operating rooms, considering a pre-purge phase of 30 min at design volume flow. Target recirc fan efficieny of <0.25 W/CFM
  - Component cooling/decentralized recirc air units with cooling rather than cooling large volumes of air
- Avoid unnecessarily high-pressure losses
  - Plan compact duct networks
  - Locate AHU's close to consumption for decreased pressure losses
  - Find a compromise between spatial proximity of functional areas and technical rooms and the shortest possible outside air and exhaust air ducts

STERILIZATION BEST PRACTICES

- The largest share of energy in washer-disinfectors is used to heat the water. This is therefore also where the main potential for savings lies.
- An obvious and available measure is the economical use of water.
- By adjusting the water quantities to the standing time before the rinsing process (the cleaning effort increases with longer standing times) and the type of items to be cleaned, it is possible to work with reduced water quantities.
- Energy savings of 20% are possible through the intelligent use of water. In-house Central Sterile Supply Dept (CSSD) and short distances to the operating department, for example, shorten downtimes.

STERILIZATION BEST PRACTICES CONT'D

- An interesting solution is offered by tank systems that allow reuse of the hot deionized water (93 °C) from the disinfection phase. By means of a valve circuit, this water is collected in a separate tank and can be used a second time in large-scale cleaning machines, which exclusively clean transport trolleys and containers.
- Alternatively, the heat contained in the wastewater can also be used in an additional heat recovery system not located in the unit or with the aid of a heat pump system. For this purpose, a bypass circuit must ensure that heavily contaminated water from the pre-rinse does not pass through the heat exchanger and contaminate it.
- Up to 70 % of the energy is transferred to the cooling water by the process control with cyclic vacuum phases and steam surges in the vacuum system (in the condenser and via the pump).
- Considerable amounts of heat go into the warm wastewater during the cleaning process and to the cooling circuit of the vacuum system during steam sterilization. With suitable technical solutions, at least some of this could be used in other processes, e.g. for heating the hot drinking water.

MRI’S

- Requests **for standardized energy parameters** from manufacturers, enabling efficiency comparisons could be included in bid docs as an additional requirement.
- Further potential savings lie in **more efficient cooling** of the MRI on the building side.
- Significant savings would be possible by using new superconducting materials if the superconducting effect already occurs at higher temperatures and helium cooling could be dispensed with.

COMPUTED TOMOGRAPHY

- Compared to previous generation, consumption of current devices is 30% lower.
- Further energy savings in standby mode and through more efficient device components (power supply units, cooling, etc.)
- An automatic switch-off and rapid switch-on of individual components, could additionally improve efficiency.
- The energy demand per study of current devices when switched off when not in active use (nights and weekends) is about 1.4 kWh

OTHER EQUIPMENT

- Medical refrigerators: The average energy use converted to a volume of 18 cubic ft is around 800 kWh/yr. A household refrigerator, of comparable size and Energy Star efficiency but without the safety mechanisms required for medical refrigerators, consumes 55% less than this.

- Medical freezers: Adjust set points on -80C freezers to -70C

- Lower VAV Fume Hood sashes when not in use to reduce energy use by 40%

OTHER EQUIPMENT

- Use solid state rather than gas lasers. Solid state lasers are more energy efficient and last longer than gas lasers. Gas lasers also generate a lot of heat, requiring the rooms in which they reside to be kept much cooler than most other spaces, which can put a strain on the AC in the building.

- Turn off biosafety cabinets when not in use. BSCs can consume 15 kWh/day - about half as much as a house! Note that UV sterilizers need only be on for 30 minutes at most in tissue culture hoods. Specify TC hoods have timers on them to ensure that the UV light is turned off after 30 minutes.

- Compressed air: The supply of compressed air is associated with high energy losses. Devices operated with compressed air should be minimized/avoided.The estimated compressed air energy demand for the Klinikum Frankfurt Höchst is about 186 $W.ft^2yr$.