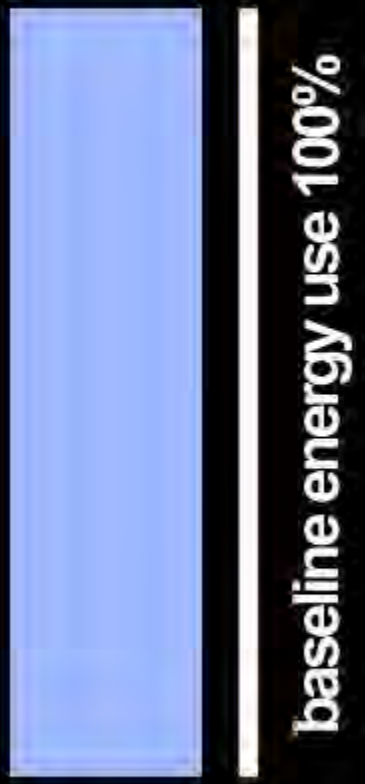
we will teach

Break

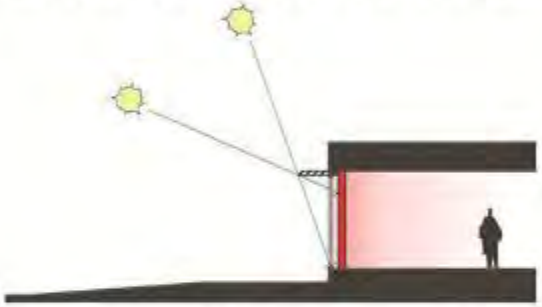
cbecs baseline



Conserve

Building envelope composition; control of natural infiltration; well-designed insulation, etc.

Capture



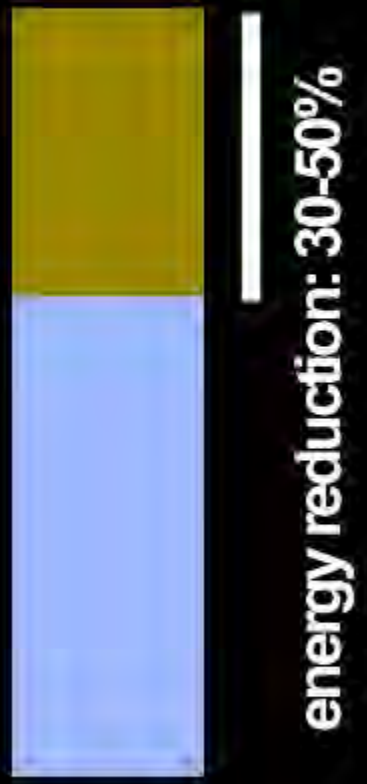
Solar orientation; Daylighting; Natural ventilation; Trombe walls; Transpired walls ; Geothermal, etc.

Create

Photovoltaics; Wind turbines, etc.

conserve

- proper insulation
- informed massing
- air tightness
- managing plug loads
- efficient lighting
- efficient HVAC

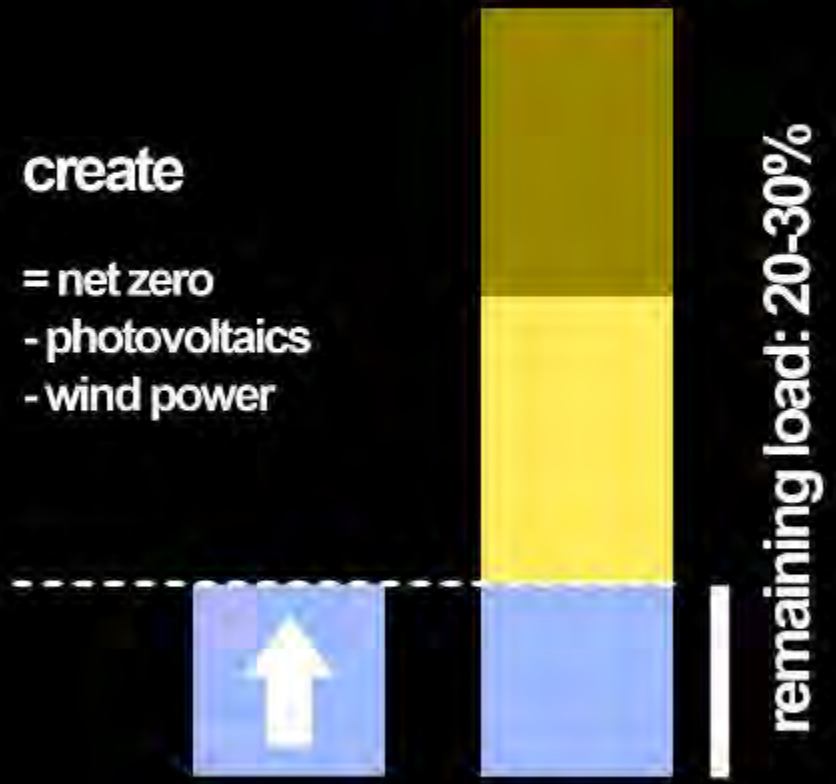


conserve + capture

- solar orientation
- direct solar gain
- lagged solar heating
- natural ventilation
- daylight harvesting
- transpired walls
- geothermal or GSHP

conserve + capture + create

= net zero
- photovoltaics
- wind power



81 kBtu/sf/yr

conserve + capture

20.25 kBtu/sf/yr

+ create

= net zero
- photovoltaics

cbecs baseline

Purposes of Energy Analysis

- Identify targets for Energy reduction
- Provide metrics demonstrating overall building performance by combining:
  - Envelope Performance
  - Mechanical Systems
  - Lighting Systems
  - Renewables
- Provide Predicted Energy Use Intensity (pEUI)
- Understand the project's standing with regard to Net Zero Energy Goals

Buro Happold
Consulting Engineers

Envelope

Proposed Constructions

Construction Type	Construction Name in Model	Description	R-Value as Modeled (ft^2 x Hr x deg F/Btu)	U-Value as Modeled (Btu / Hr x SF x deg F)
Roofs	Roof 02 - Metal Deck Roof	1/4" Roof Membrane, 1/2" Plywood, 6" Polyiso insulation (R-6.17/in), metal deck	R-37.6	0.0261
External Walls Above Grade	External Wall 01 - SIP Wall	10" SIP Panel (R-5/Inch)	R-51.5	0.0191
External Walls Below Grade	N/A	No Below Grade Walls in This Project	-	-
Floors - Exposed	Exposed Floor 01 - Insulated Concrete Slab	3" Concrete Topping Slab, 1" Rigid Insulation (R-5/Inch), 5.25" Lightweight Concrete on Metal Deck, 1'-9" Structural Plenum, 6.5" SIP Panel Soffit	R-42.7	0.0228
Ground Floor Slab	Ground Floor 01 - Slab on Grade	6" Concrete Slab on Grade w/ Perimeter Insulation, 1" Rigid Insulation (R-5/Inch), 3" Concrete Topping Slab	-	F-0.54
Internal Partitions	Internal Partition 01 - Drywall on Metal Stud	.625" Gyp. Bd., 6" Metal Stud, .625" Gyp. Bd.	-	-
Internal Floor Assemblies	Internal Ceiling/Floor 01 - Lightweight Concrete on Metal Deck	3" Concrete Topping Slab, 1" Rigid Insulation (R-5/Inch), 5.25" Lightweight Concrete on Metal Deck	-	-
Glazing - Vertical	External Glazing 01 - Double Paned IGU in Curtain Wall	Double Paned IGU in Metal Frame	-	Glazing U-Value: 0.3116 SHGC: 0.30 **Assembly U-Value:** 0.3734
Glazing - Vertical	External Glazing 02 - Double Paned IGU in Curtain Wall with Shading	Double Paned IGU in Metal Frame	-	Glazing U-Value: 0.3116 SHGC: 0.30 **Assembly U-Value:** 0.3734
Glazing - Internal	Internal Glazing 01 - Single Paned Glass	Single Paned Glass in Metal Frame	-	-

Internal Power Consumption / Heat Gains

Internal Gains

Space Use	Proposed Lighting Power Density [W/SF]	Proposed Equipment Power Density [W/SF]	Occupant Loads Modelled Occupancy Density [SF/Person]	Heat Gain / Person Sensible [Btu/h per Person]	Heat Gain / Person Latent [Btu/h per Person]
Standard Spaces					
Active storage	0.80	0.20	-	-	-
Classroom/ Lecture/ Training	1.17	1.00	30.0	183.75	116.25
Conference/ Meeting/ Multipurpose	1.30	1.00	20.0	250	200
Corridor/ Transition	0.50	0.20	-	-	-
Dining area	0.90	0.50	16.8	206.25	206.25
Dressing/ Locker/ Fitting room	0.60	0.50	14.8	250	200
Food preparation	1.2	1.5	382.7	275	275
Gymnasium/ Exercise center - Exercise area	1.5	0.5	151.9	710	1090
Library - Reading area	0.86	1.50	37.5	250	200
Lounge/ Recreation	1.2	1	53.2	250	200
Office - Enclosed	0.50	1.50	200.0	183.75	116.25
Office - Open plan	0.95	1.50	200.0	183.75	116.25
Restrooms	0.5	0	-	-	-
Stairs - Active	0.54	0.00	-	-	-
Unique Spaces					
Main Bar Third Space	0.70	0.00	-	187.5	187.5
North Wing Classrooms	0.73	1.00	9.08		
Middle Wing Classrooms	0.79	1.00	6.62		
South Wing Classrooms	1.17	1.00	8.75		
Kid's Kitchen	1.17	1.00	33.88		
Music Classroom	1.17	1.00	-		
Performance Music Classroom	1.17	1.00	6.83		
Computer Lab	0.86	4.15	3.89	183.75	116.25
Art Classroom	1.11	1.00	5.46	187.5	150
Administrative Offices	0.50	1.50	-	187.5	150

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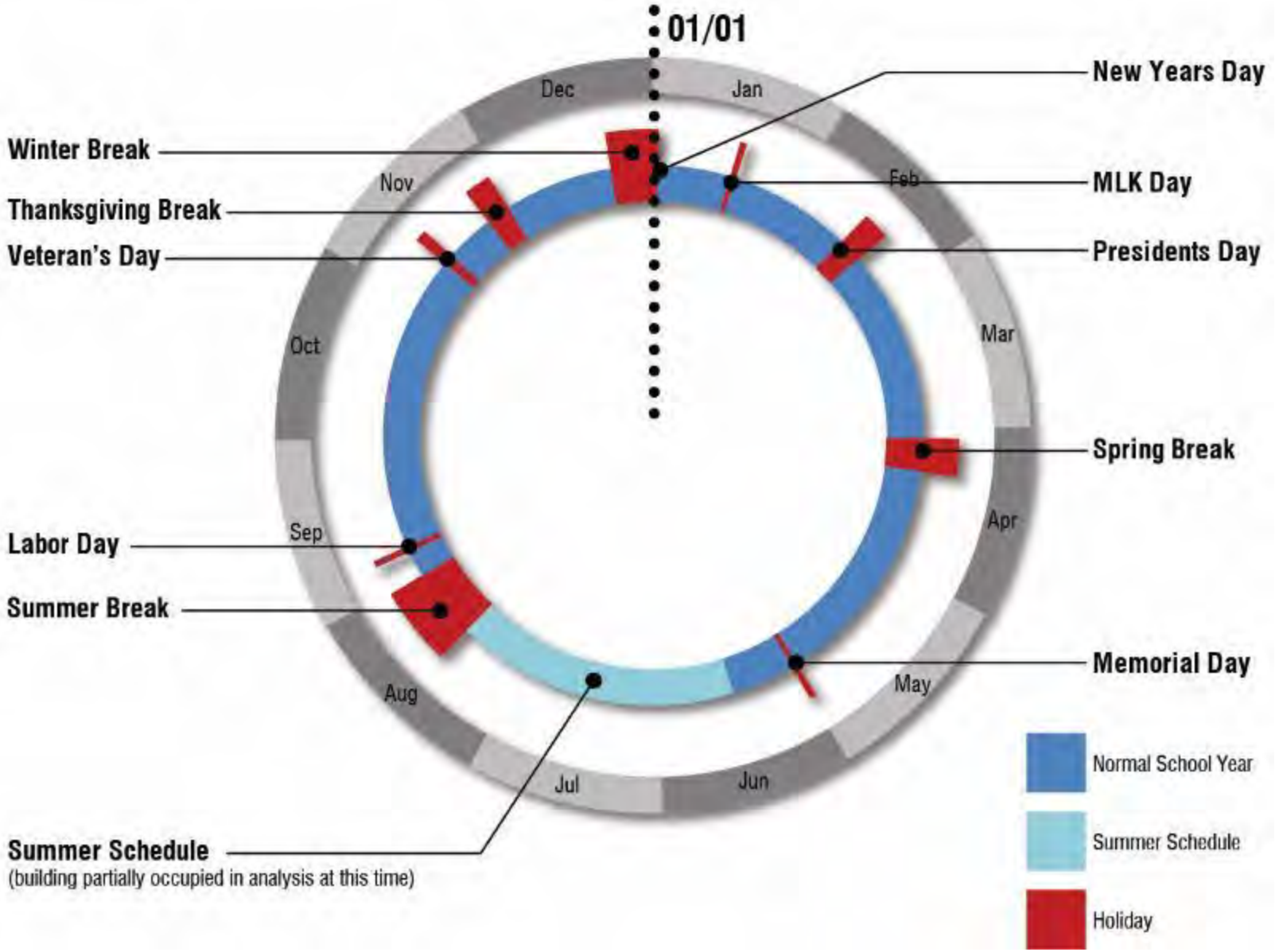
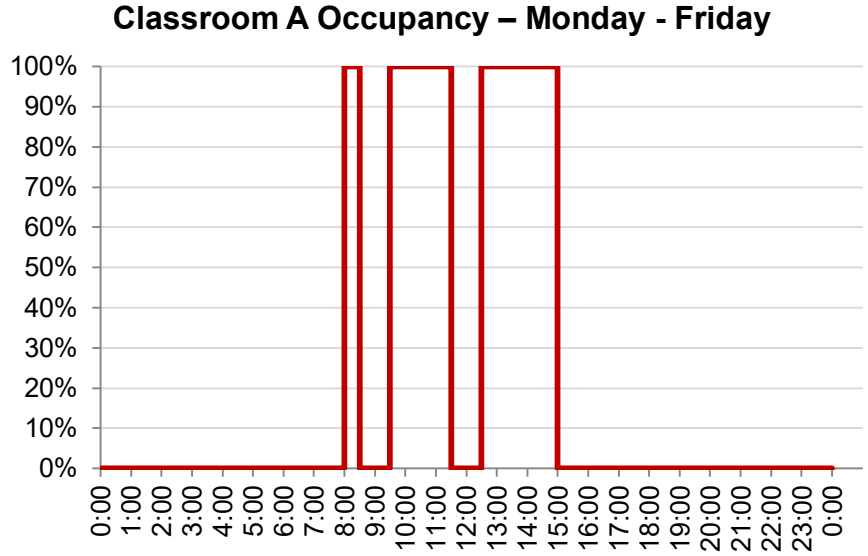
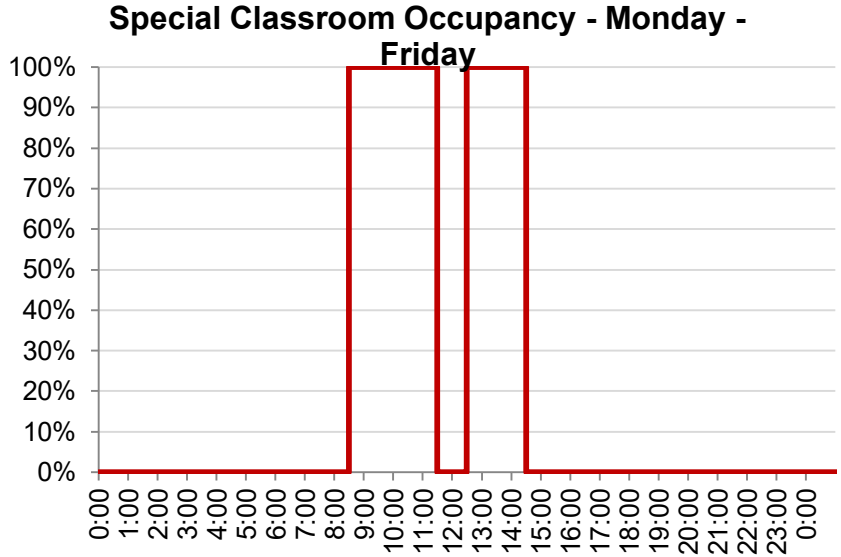
Annual Schedule

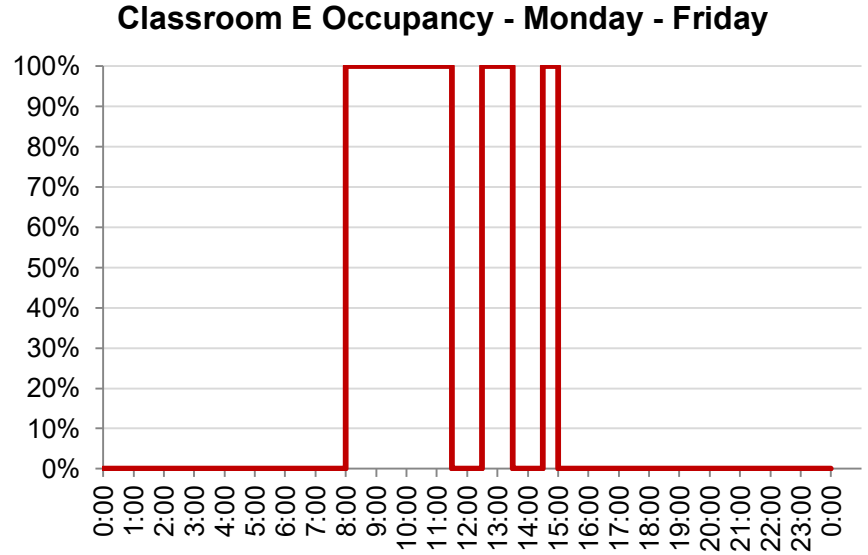


Setting Daily Schedules

Daily School Year Classroom Schedules

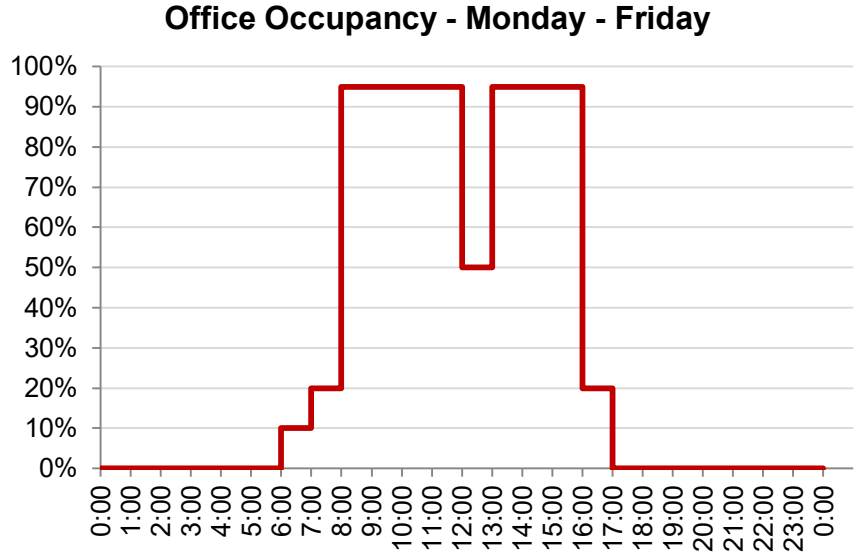


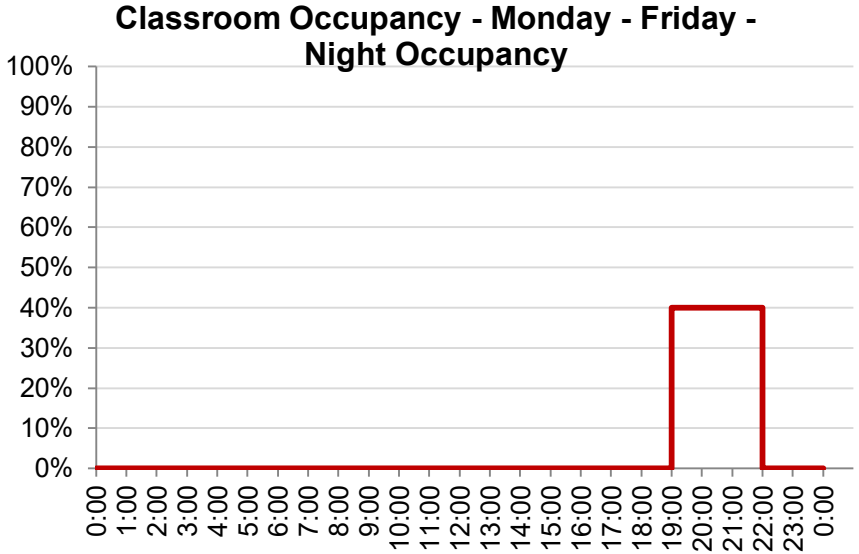


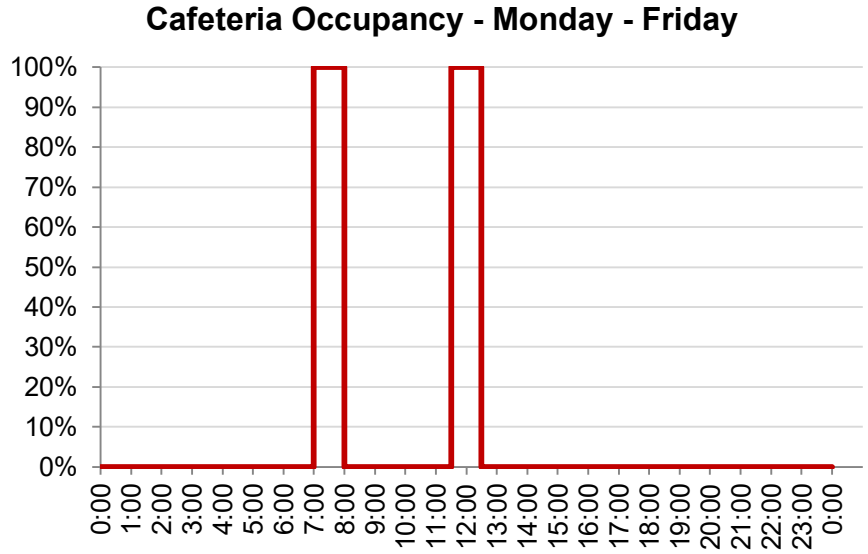


- Building is assumed to be occupied Monday to Friday from 8:00am to 3:00pm for normal school days
- Classrooms empty out while students are attending special classes (gym, music, art, library, kid's kitchen)
- Special classrooms are assumed to be occupied from 8:30 until 2:30 except for during the lunch break.

Daily Schedules





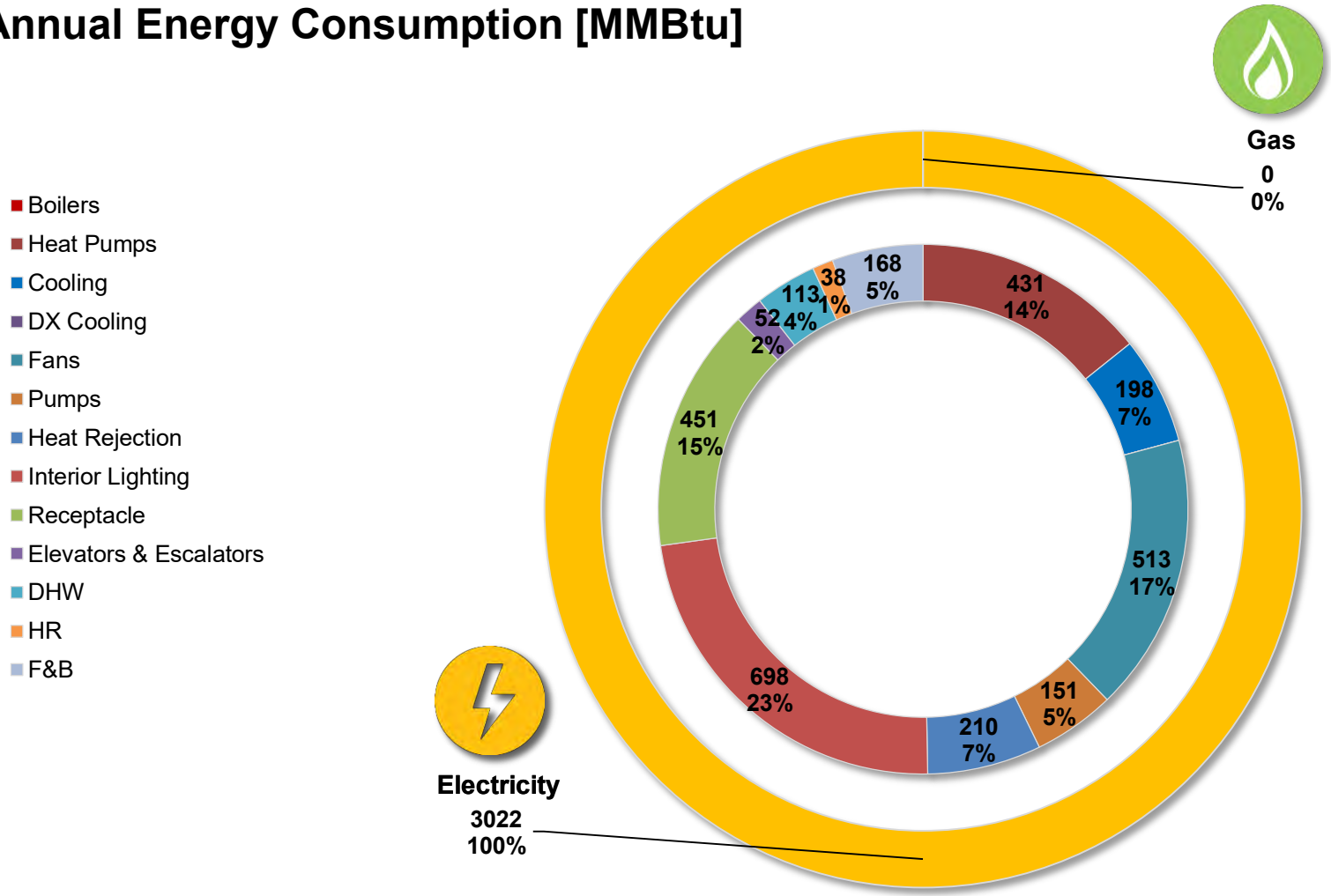


- Offices are assumed in use from 6:00am to 5:00pm
- Cafeteria assumes minimal use outside breakfast and lunch hours
- 20% of classrooms are assumed to be in use from 6:00pm to 10:00pm at a lower occupancy than during the day.

Proposed Building

SED Design

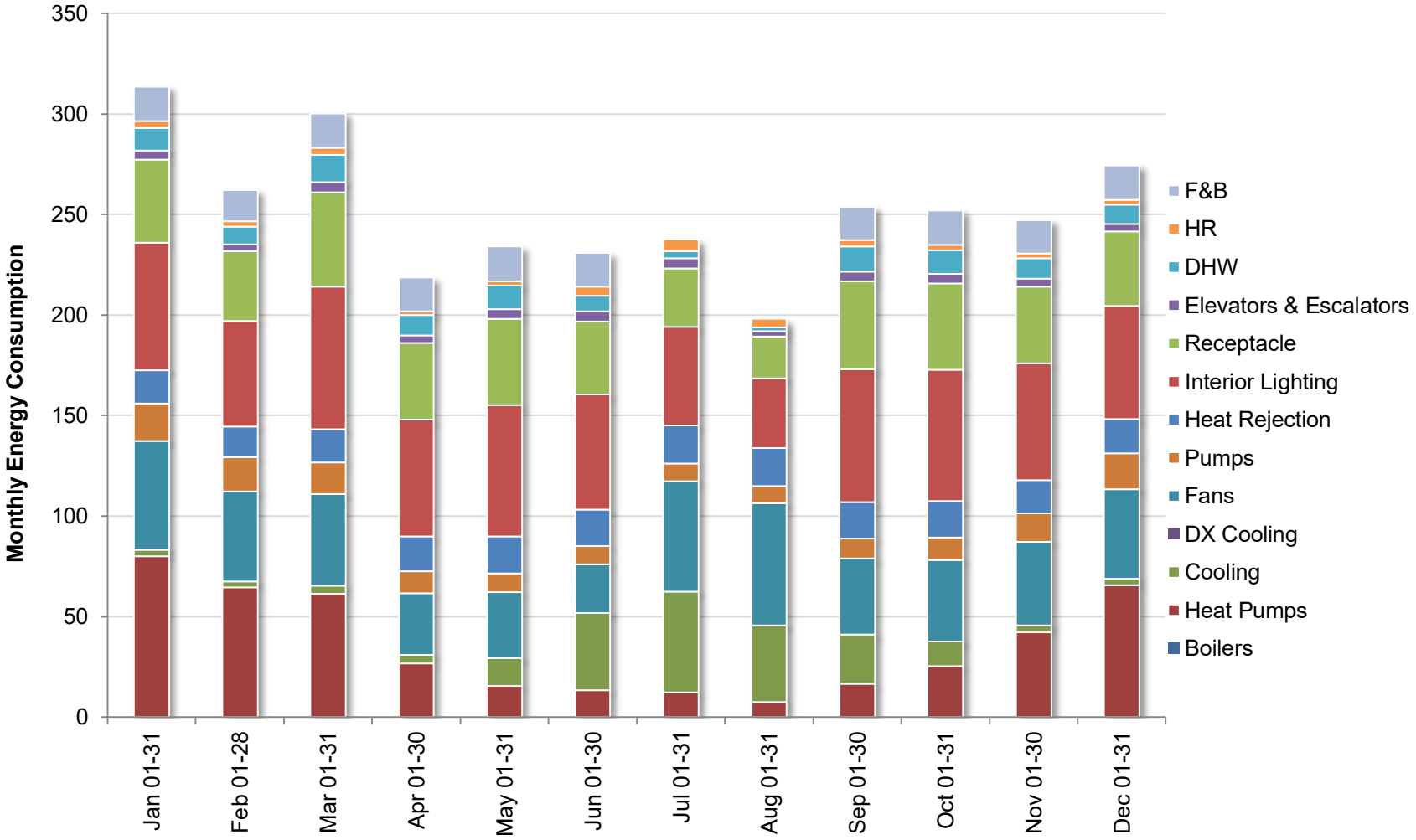
Annual Energy Consumption [MMBtu]



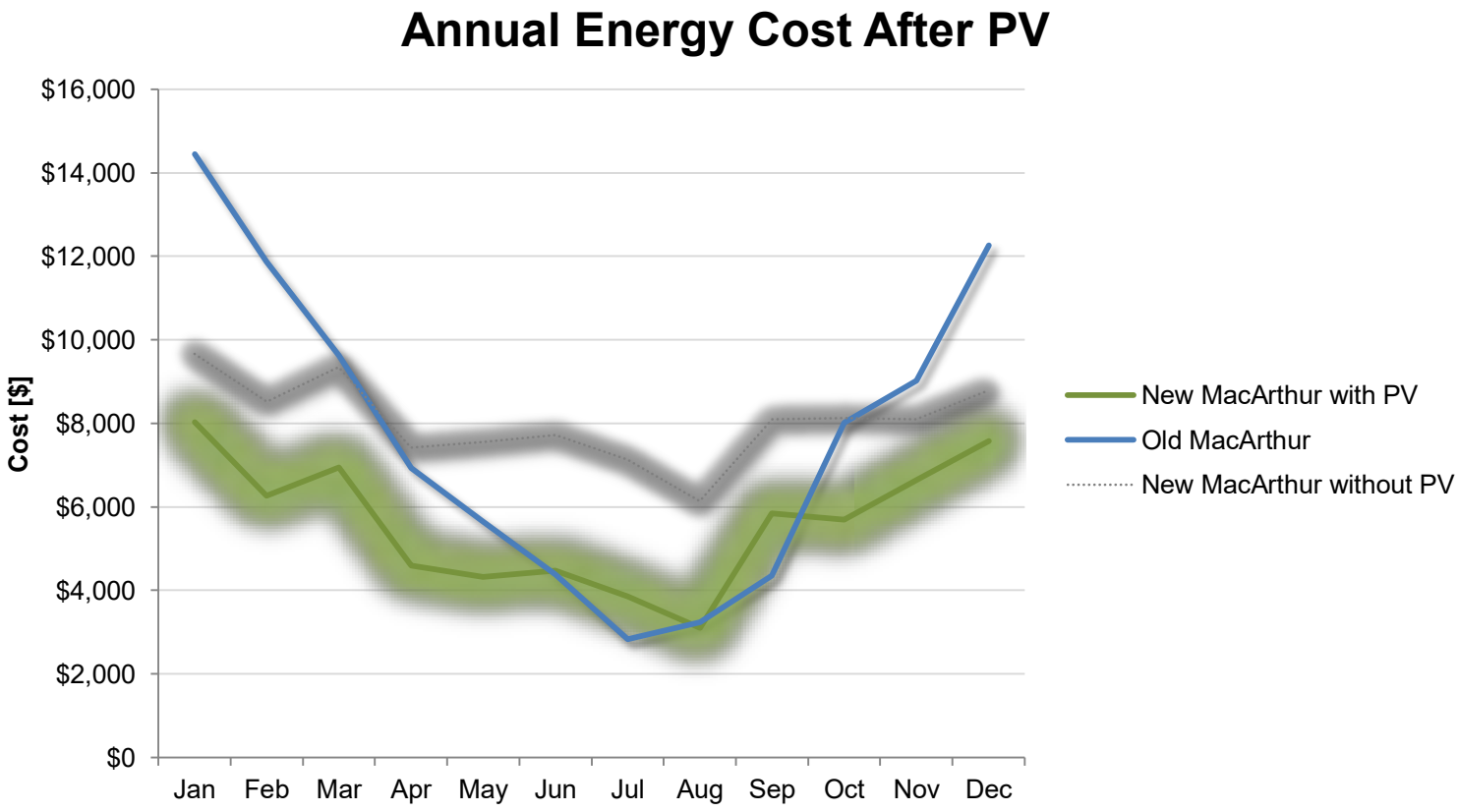
Site pEUI: **21 kBtu/SF** **(w/ PV 10 kBtu/SF)**

Proposed Building

Monthly Energy Consumption [MMBtu]



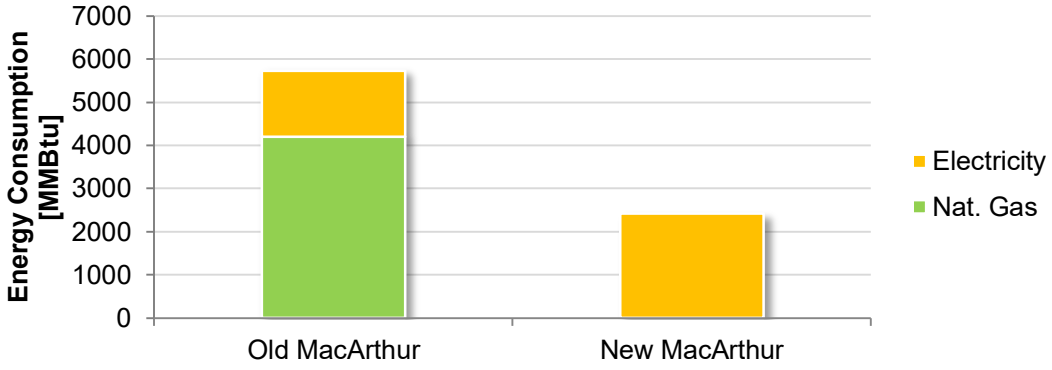
New v. Old – With Photovoltaic Array



Note: Old MacArthur cost data based upon 2010 utility cost information

Old v. New without Cooling

Energy Consumption



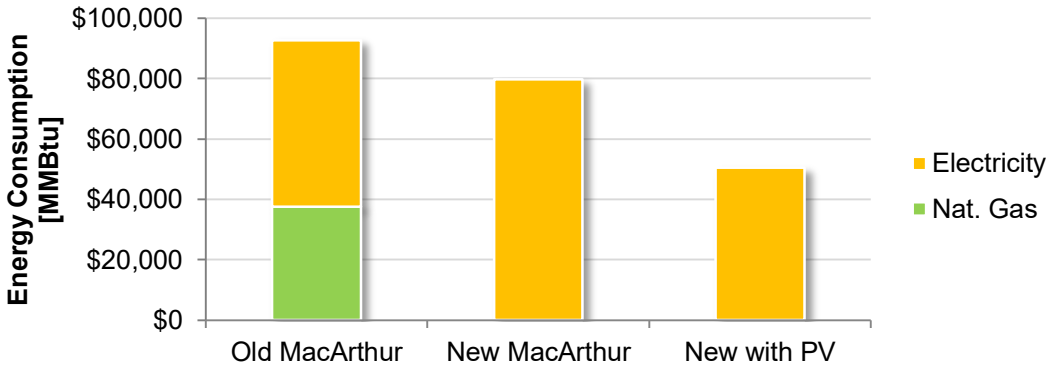
pEUI – Old v. New

Old **68.9** kBtu/SF

New **19.7** kBtu/SF

New + PV **7.5** kBtu/SF

Energy Cost



Energy Cost Intensity

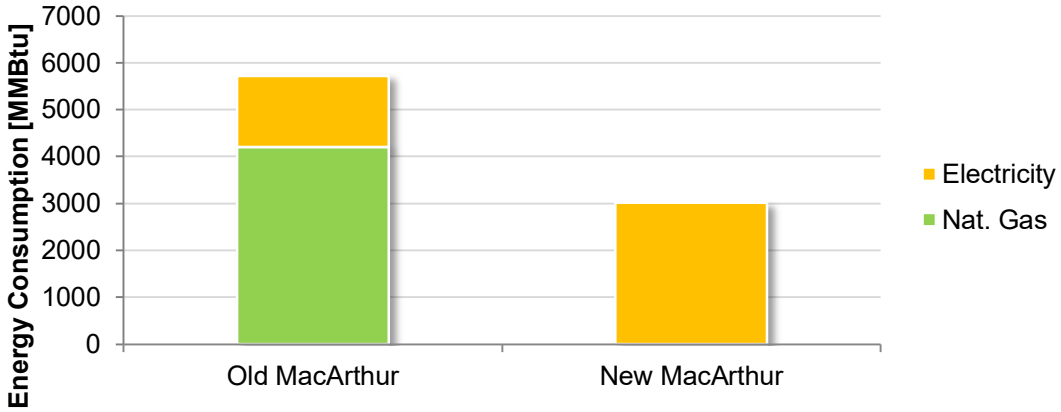
Old **$1.12** /SF

New **$0.65** /SF

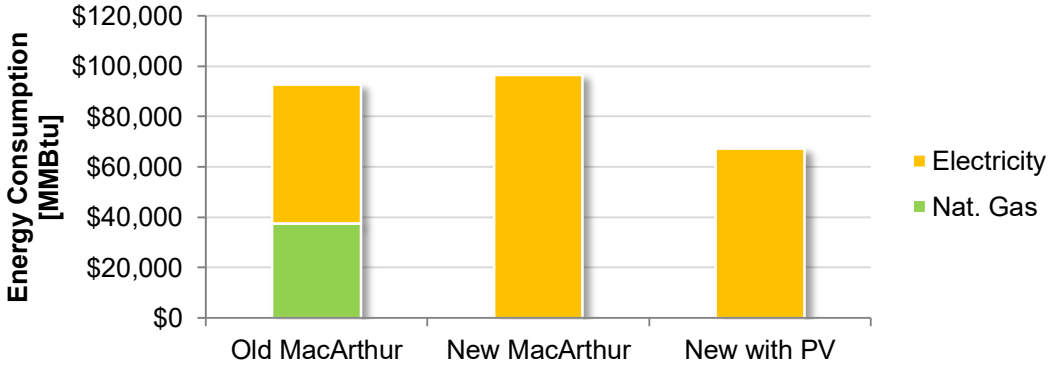
New + PV **$0.41** /SF

Old v. New

Energy Consumption



Energy Cost



pEUI – Old v. New

Old **68.9** kBtu/SF

New **24.5** kBtu/SF

New + PV **13.7** kBtu/SF

Energy Cost Intensity

Old **$1.12** /SF

New **$0.78** /SF

New + PV **$0.55** /SF

MacArthur Energy Usage / Cost

	BASELINE	AS DESIGNED	OUTCOME
CBECS	80 EUI	10 EUI (With PV)	87% REDUCTION
NYSERDA **(without PV)**	40.6 EUI $154,689/ YEAR	21.7 EUI (without PV) $82,679 / YEAR	47% REDUCTION ($72,010) SAVINGS
NYSERDA **(with PV)**	40.6 EUI $154,689/ YEAR	10 EUI $38,101/ YEAR	75% REDUCTION ($116,588) SAVINGS

Over 25 years,
$3,000,000 in savings, average of $120,000/year


Good Day
Ready to Learn
Think About
Teacher's Choice
CRUSH IT.

control & variability
in
thermal gradation

Gradient Design

1. Exterior Passive

2. Interior Passive

3. Interior Mixed

4. Interior Active

control

classrooms

offices

ENERGY USAGE

media center

cafeteria

gym

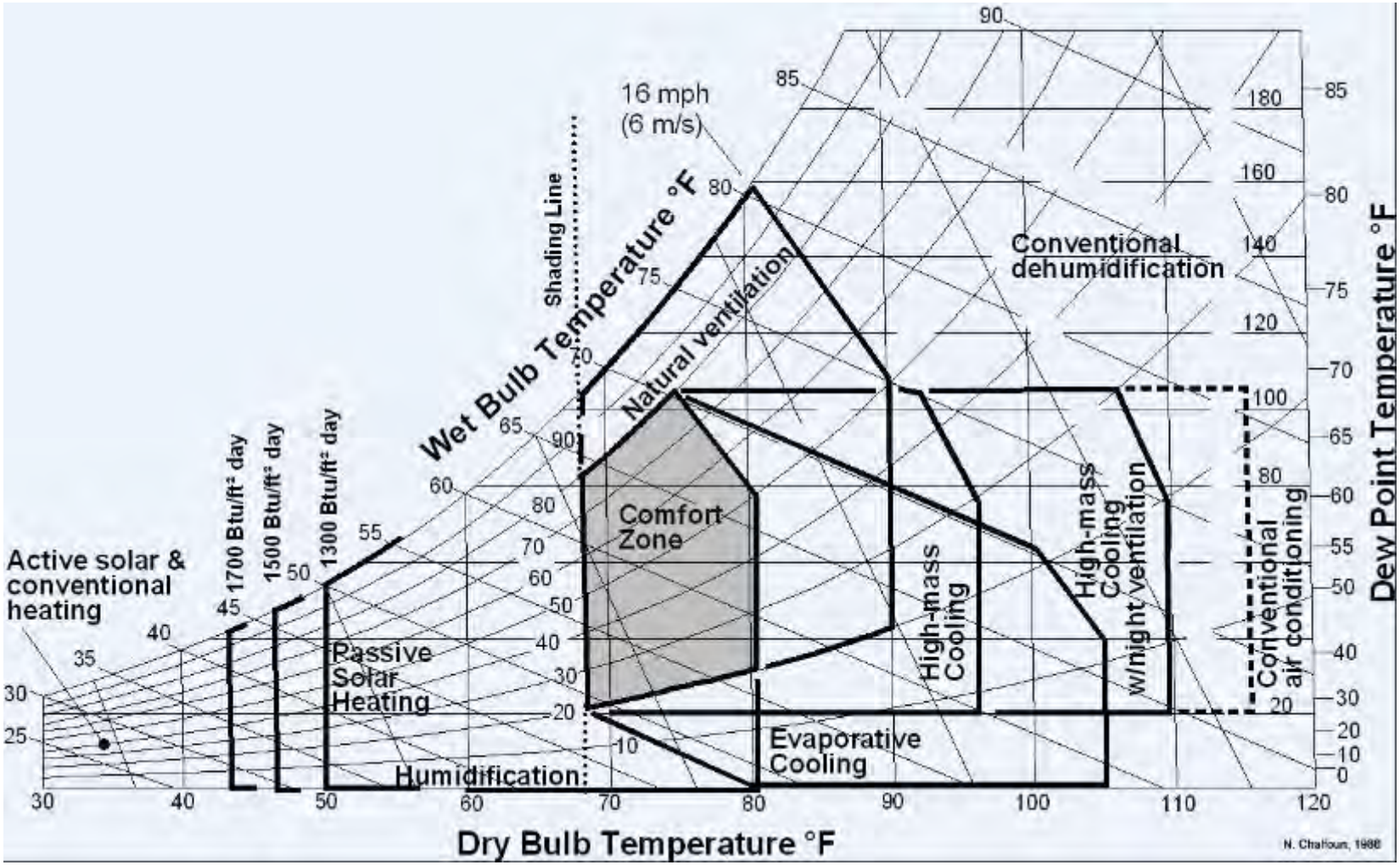
lobby

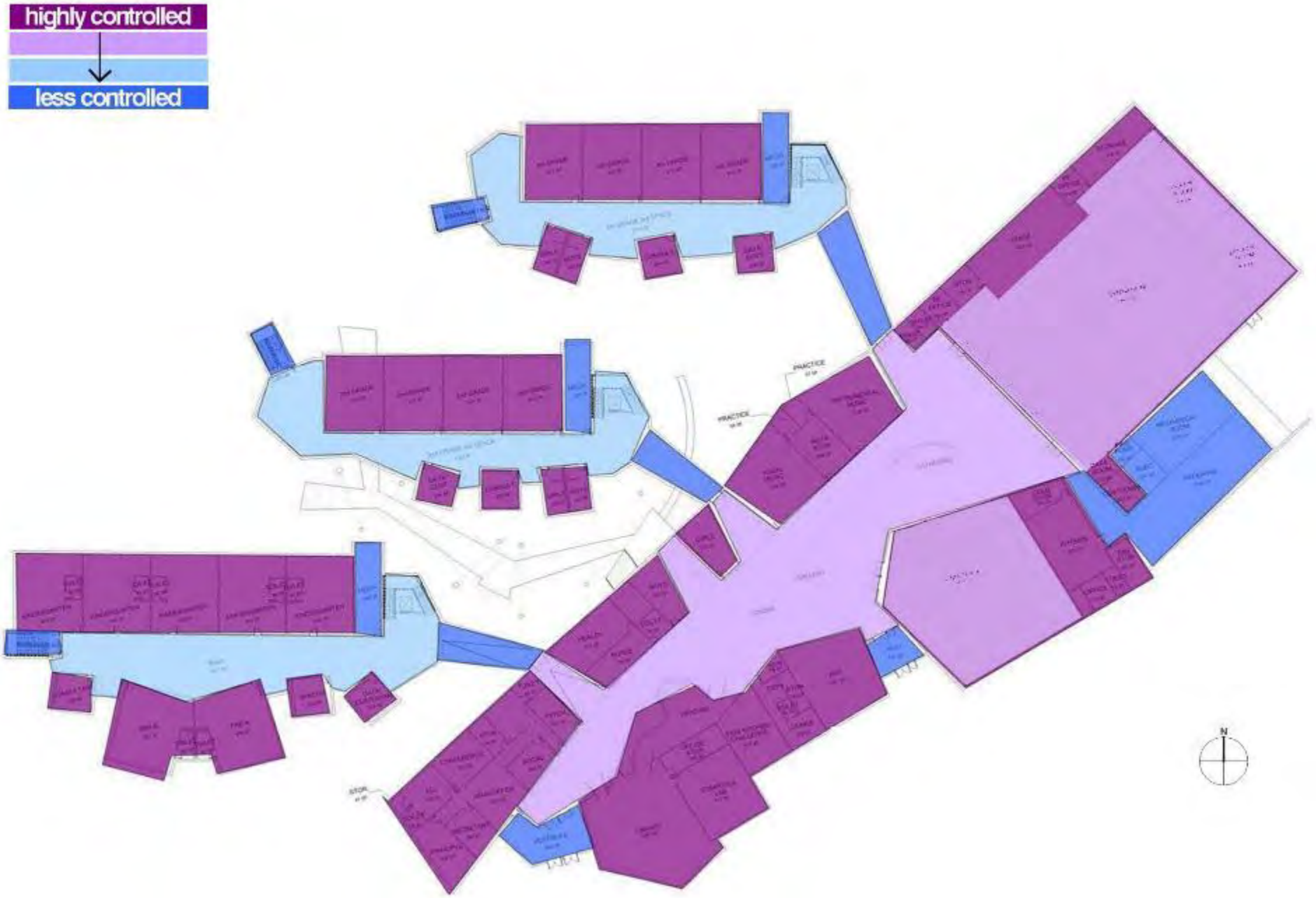
corridors / 3rd spaces

stairwells

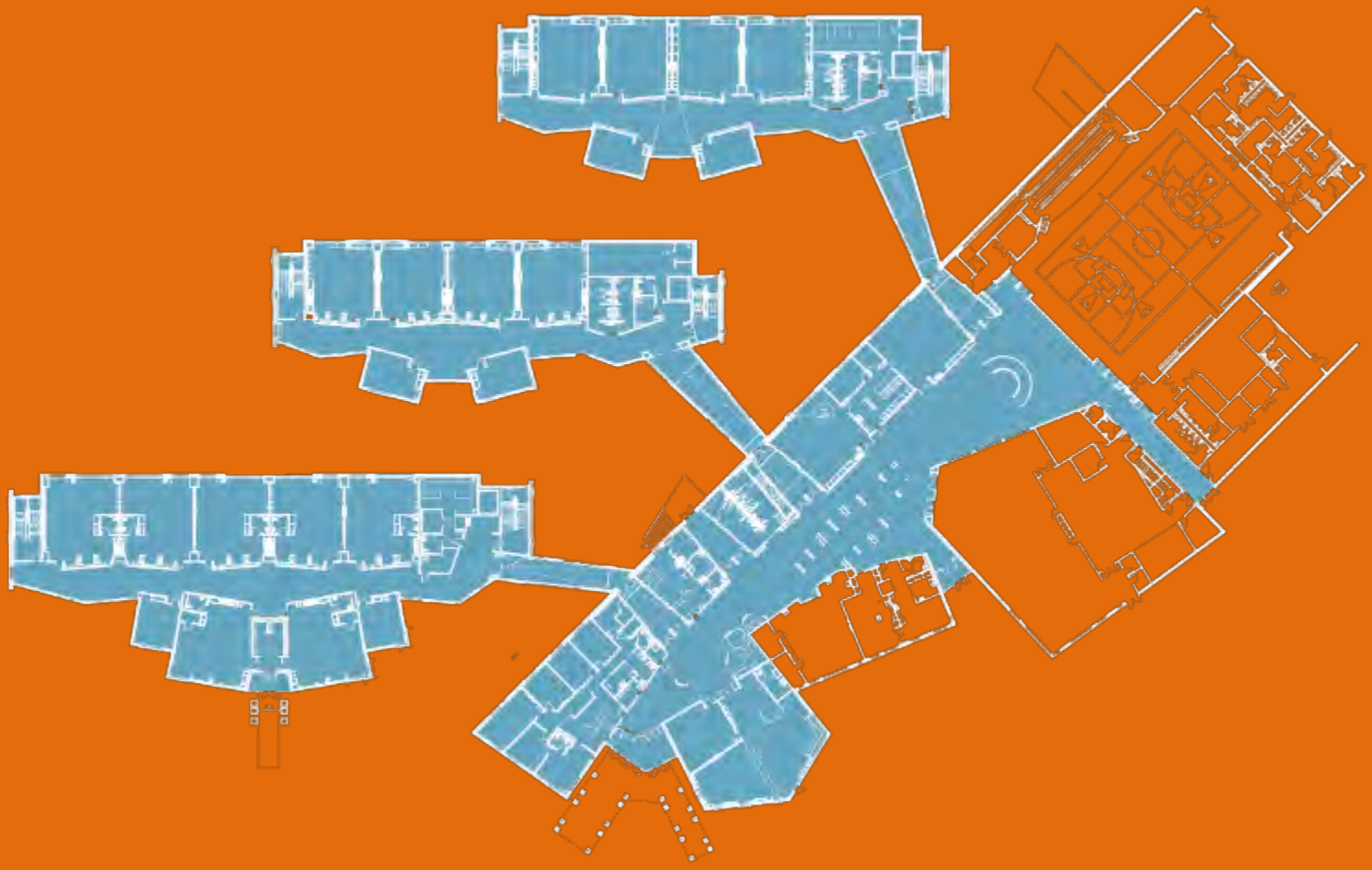
variability

Psychrometric Climate Analysis/Comfort Ranges




highly controlled
less controlled
N

Mechanical Systems



Induction Units & Displacement Ventilation

Mechanical Systems

Variable Air Volume System

Induction Units

Mechanical Systems

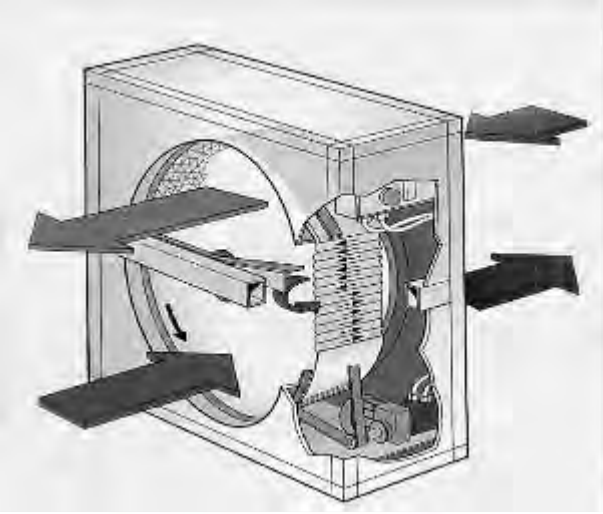
Variable Air Volume with Radiant Heating

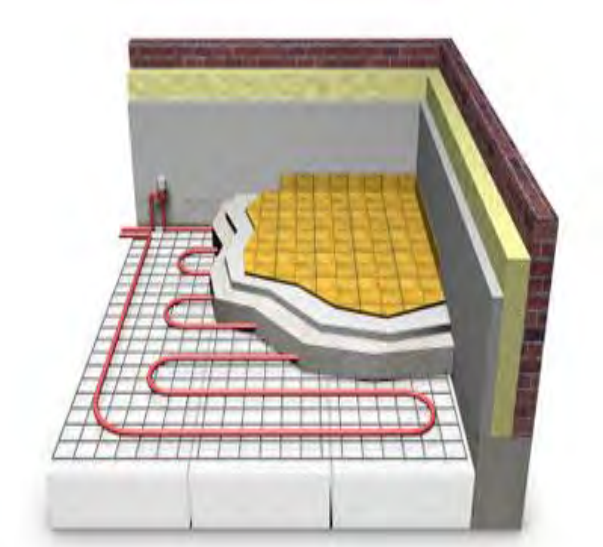
Variable Air Volume System

Induction Units

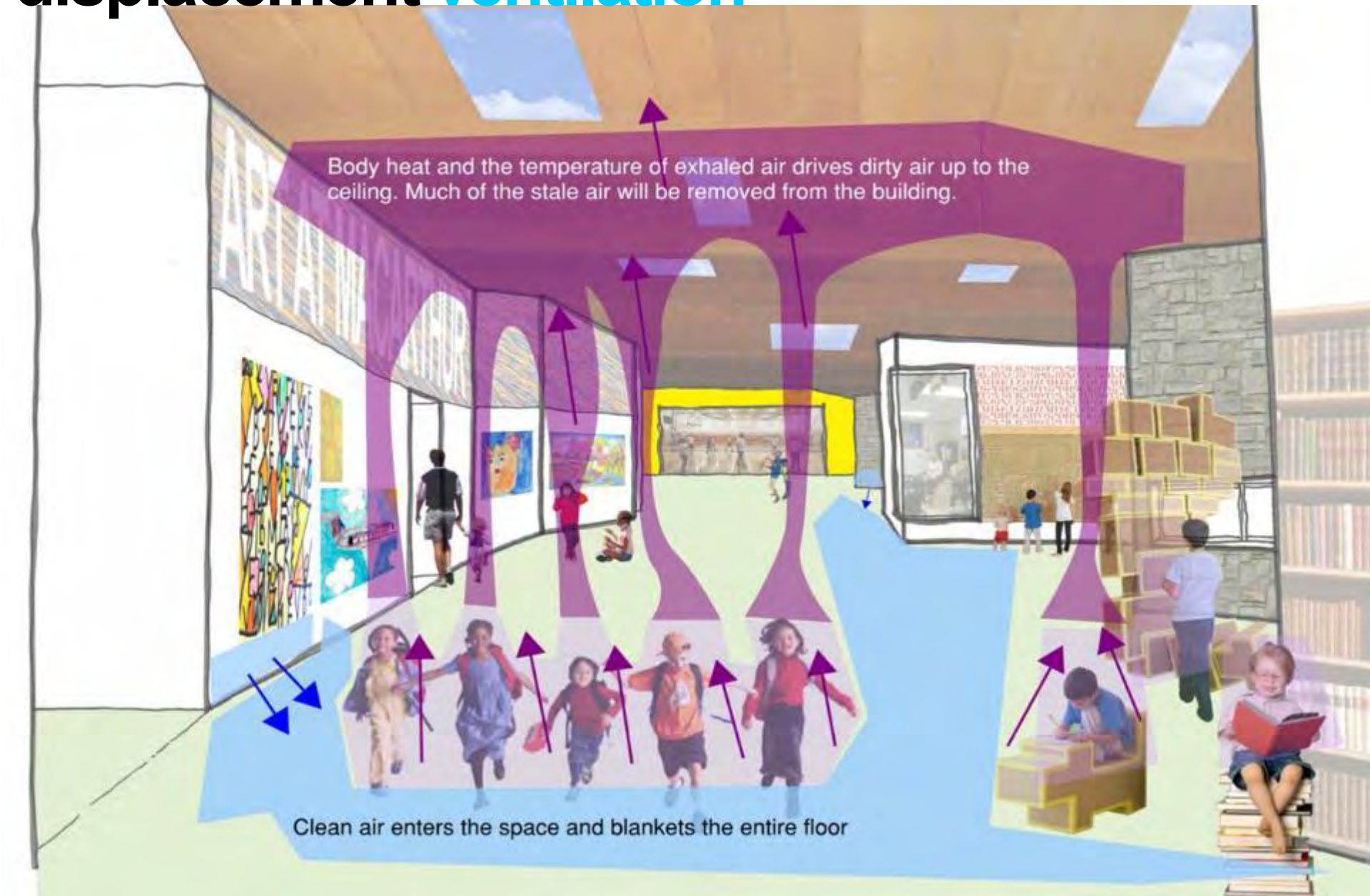
Mechanical Systems

- Classrooms / Main Wing (AHU-A,B,C,D): DOAH w/ enthalpy wheel serving 2 pipe induction units in the classrooms. Classrooms have radiant floor heating. Admin offices are served by Active Chilled Beams.
- Gym and Cafeteria (AHU-E,F,G): OAHU with enthalpy wheel serving overhead variable air volume boxes. Radiant floor at Cafeteria.
- Geothermal heating and cooling (steady state source temperature in these studies)
- Variable speed pumps / fans
- Radiant slabs
- Instantaneous point of use electric hot water heaters





displacement ventilation



displacement ventilation