PERKINS EASTMAN
Human by Design
CMTA

# Net-Positive Education:

The pathway for a high-performance learning environment

# PRESENTERS

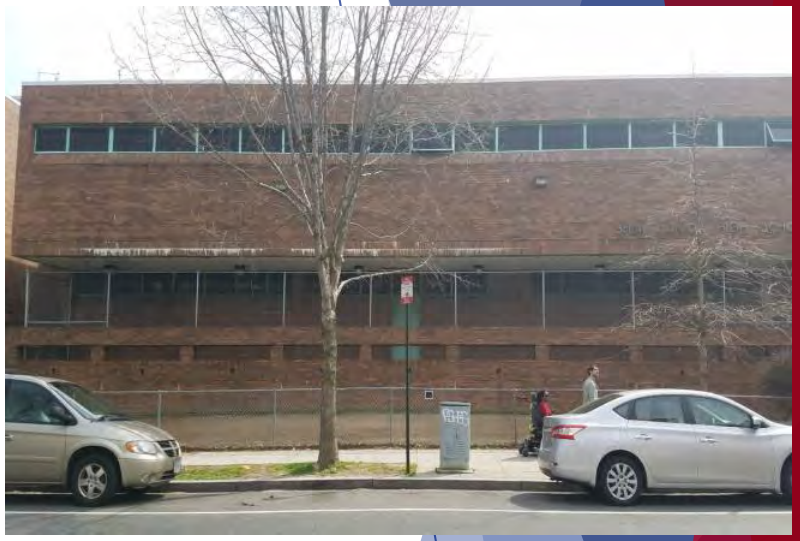
Tony Hans
**CMTA**

Sean O'Donnell
**Perkins Eastman**

Heather Jauregui
**Perkins Eastman**

# INTRODUCTION + CONTEXT

## WEST ELEMENTARY SCHOOL AND BANNEKER HIGH SCHOOL


# DISTRICT OF COLUMBIA PUBLIC SCHOOLS

## MODERNIZATION PROGRAM

- Over $4 Billion has been invested to modernize school facilities in the District since the early 2000s.
- Between $300-$400M is spent annually on Capital construction projects.
  - On average, opening 3-4 schools annually.
- By 2025 all schools will have received a significant Capital investment.


Watkins ES

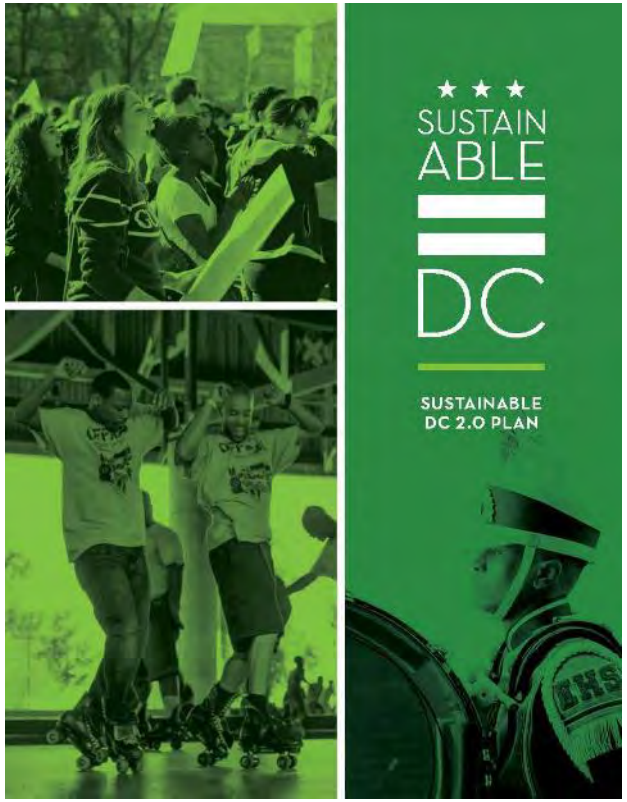

Jefferson MS


Roosevelt HS

# DISTRICT OF COLUMBIA PUBLIC SCHOOLS

## SUSTAINABILITY GOALS

- All school projects in the modernization program are required to meet LEED Gold requirements.
- DCPS currently has 34 LEED schools
  - The first DCPS NetZero projects are under construction.
- Sustainable DC 2.0 Plan – targets NZE standards by 2026
- District-wide power purchase agreement for solar
- Building Energy Performance Standards (BEPS) – starting in 2021.

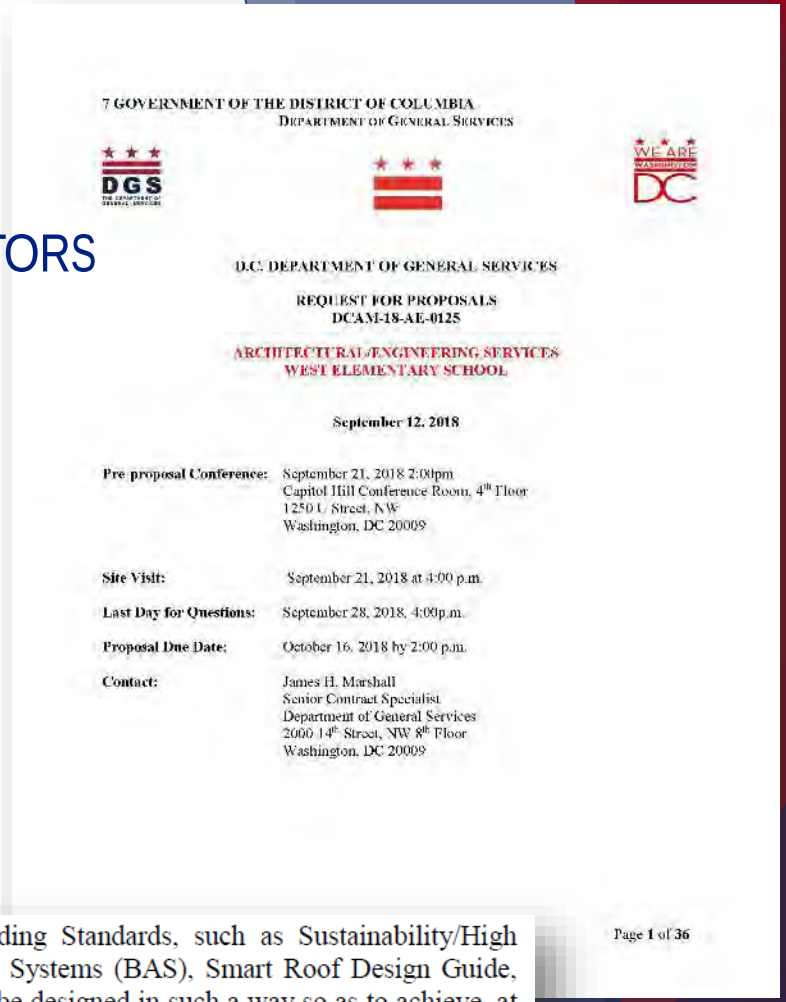




# SELECTION PROCESS

## CRITERIA FOR SUCCESS IN SELECTING ARCHITECTS AND CONTRACTORS

- RFP was released in Fall 2018 with specific language dedicated to achieving Net-zero
- Collaborated with other DC Agencies in establishing the right criteria when evaluating AE Teams.
  - Department of Energy and Environment (DOEE)
  - Department of Consumer and Regulatory Affairs (DCRA) – Green Building Division
  - Department of General Services (DGS) – Sustainability & Energy
- Number #1 selection criteria - Passion and Commitment to achieving Net-zero.



7 GOVERNMENT OF THE DISTRICT OF COLUMBIA
DEPARTMENT OF GENERAL SERVICES

D.C. DEPARTMENT OF GENERAL SERVICES

REQUEST FOR PROPOSALS
DCAM-18-AE-0125

ARCHITECTURAL/ENGINEERING SERVICES
WEST ELEMENTARY SCHOOL

September 12, 2018

| | |
|---|---|
| Pre-proposal Conference: | September 21, 2018 2:00pm<br>Capitol Hill Conference Room, 4th Floor<br>1250 U Street, NW<br>Washington, DC 20009 |
| Site Visit: | September 21, 2018 at 4:00 p.m. |
| Last Day for Questions: | September 28, 2018, 4:00p.m. |
| Proposal Due Date: | October 16, 2018 by 2:00 p.m. |
| Contact: | James H. Marshall<br>Senior Contract Specialist<br>Department of General Services<br>2000 14th Street, NW 8th Floor<br>Washington, DC 20009 |

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The A/E firm shall consider all DGS FM Building Standards, such as Sustainability/High Performance Best Practices, Building Automation Systems (BAS), Smart Roof Design Guide, and NREL Net Zero Guidelines. The Project shall be designed in such a way so as to achieve, at a minimum, LEED for Schools – Gold certification and must meet the requirements of the recently adopted International Green Construction Code and DOEE storm water management requirements. As part of the LEED certification, we will require the innovation LEED Pilot Credit – Integrative Process for Health Promotion (https://www.usgbc.org/credits/new-construction-core-and-shell-schools-new-construction-retail-new-construction-healthc-106), the Green Roof Credit Program addressed, and Energy Star Certification. In addition, the District is particularly interested in West Elementary becoming a Net Zero energy building and require the A/E firm to explore net zero strategies in the building's design. The A/E firm shall apply for and achieve Energy Start Certification and file the DOEE Green Roof grant application.

# NZE SCHEDULE AND BUDGET

## ON TIME AND ON BUDGET

- DC's Capital Improvement Plan (CIP) is a six year plan that identifies project budgets per Fiscal Year. The CIP includes projects from DCPS and all other agencies that require Capital funding for projects.
  - The majority of Capital funding is obtained through low interest General Obligation (GO) bonds.
- As a result, the West Modernization budget had been set for several years prior to DCPS considering the Net-zero goal.
- Total project budget was $78M and we had a little less than three of years for design and construction of an Elementary School.
  - Scheduled to open August 2021
- Goal – do NOT impact schedule or approved budget

Current Site Plan


Proposed Site Plan

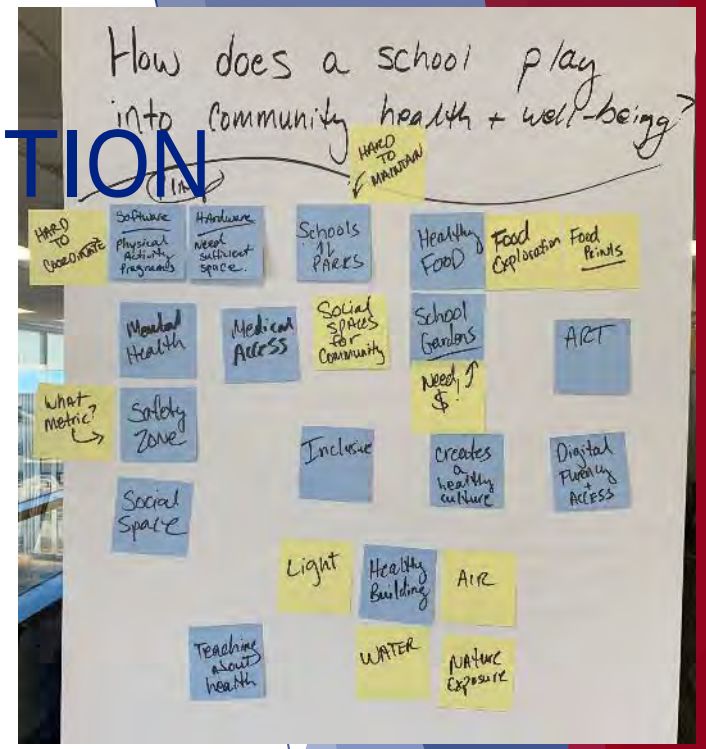
# WELLNESS AT DCPS

## WELLNESS POLICIES FOR DCPS FACILITIES

"A HEALTHY and POSITIVE school environment is fundamental to student success and effective learning – not secondary to it."

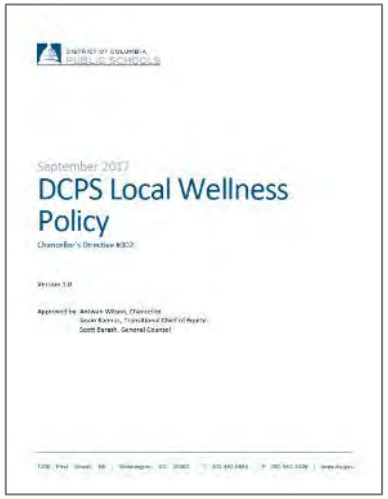
# INTEGRATING NZE AND HEALTH PROMOTION

## INTEGRATIVE PROCESS FOR HEALTH PROMOTION AND WELL




- In addition to the direct impact that the natural and built environment can have on human health through exposure to environmental hazards, features of our built environments at multiple spatial scales, such as stair design, accessibility of sidewalks, parks, walkability, and supermarkets, play a proven role in determining critical health behaviors[1], such as rates of daily physical activity[2] and dietary choices[3], and factors that impact health such as social capital[4] . **Where we live, work, learn, and play impacts our health.**

*(Integrative Process for Health Promotion)*





# PROJECT KICK-OFF

# Net Zero Energy Positive Education™

# MLK STUDY | PRE & POST OCCUPANCY OUTCOMES

## General Satisfaction

**100% PROUD**
TO WORK IN THIS BUILDING

**97%**
SAY THE NEW BUILDING IS
**A BETTER PLACE TO SPEND THEIR DAY**
THAN THE OLD BUILDING

**90% AGREE**
THE DESIGN OF THE SCHOOL
**SUPPORTS EDUCATION**

**100% AGREE**
THE DESIGN OF THE SCHOOL
**CREATES A PLEASANT PLACE**
TO WORK AND LEARN


Today a Reader, Tomorrow a Leader
Books We've Shared
Vivid Vocabulary
READ

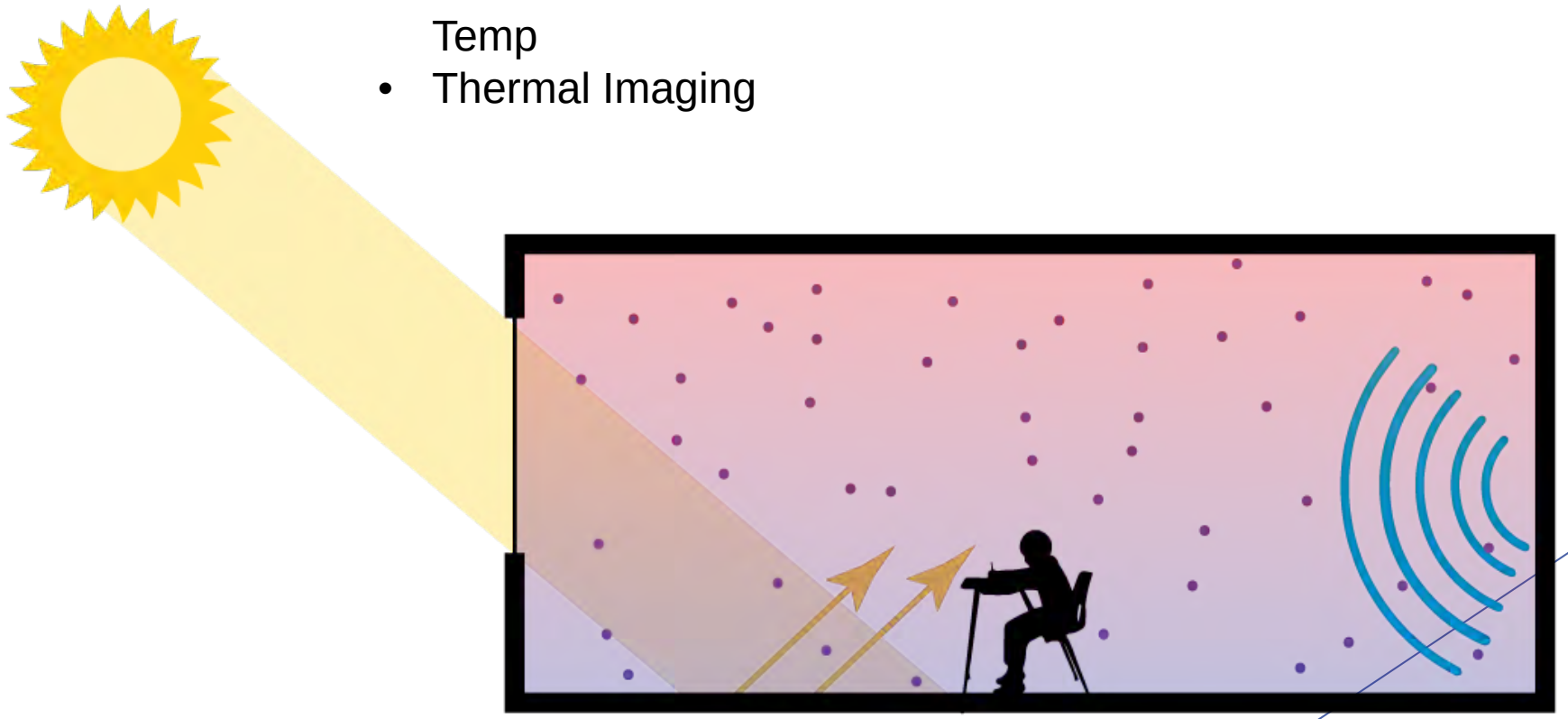
# INDOOR ENVIRONMENTAL QUALITY

**DAYLIGHT**
- Distribution
- Glare

**THERMAL COMFORT**
- Air Temperature
- Humidity
- Radiant Surface Temp
- Thermal Imaging

**ACOUSTICS**
- Background Noise
- Occupied Noise

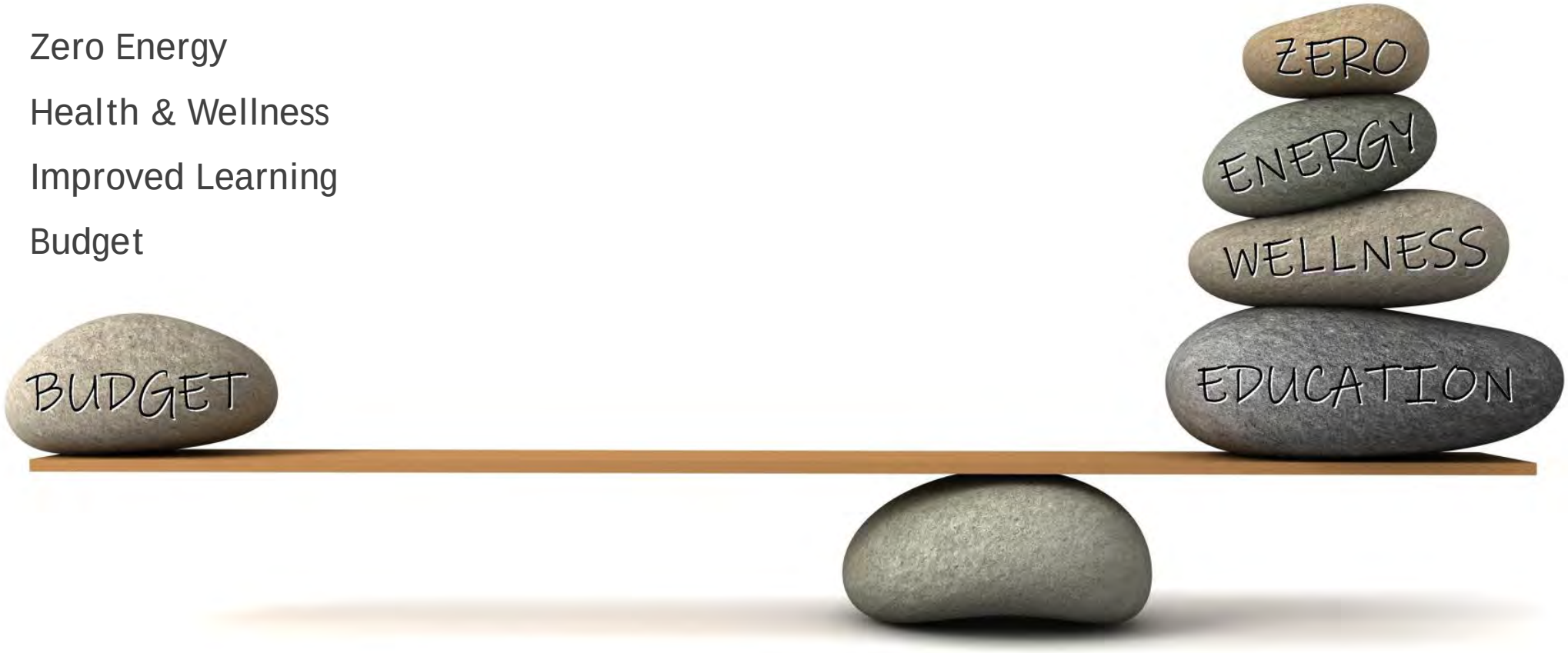
**AIR QUALITY**
- CO2



# SETTING PROJECT GOALS

## MOVING TO A PERFORMANCE BASED GOAL

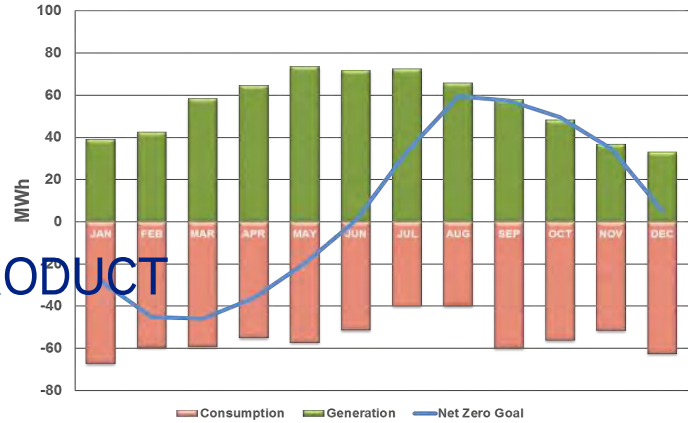
1. Zero Energy
2. Health & Wellness
3. Improved Learning
4. Budget



# SCHEDULE

## A DIFFERENT PROCESS FOR A DIFFERENT PRODUCT

- Upfront involvement
  - NZE Introduction
  - Educational Curriculum Workshop
  - Building Tours (Kitchen, HVAC, Equip/IT/AV, Operations)
  - Charrette – Food Service
  - Charrette – HVAC
  - Charrette – Equipment/IT/AV
  - Charrette – Daylight + Envelope
- Post-Occupancy Support

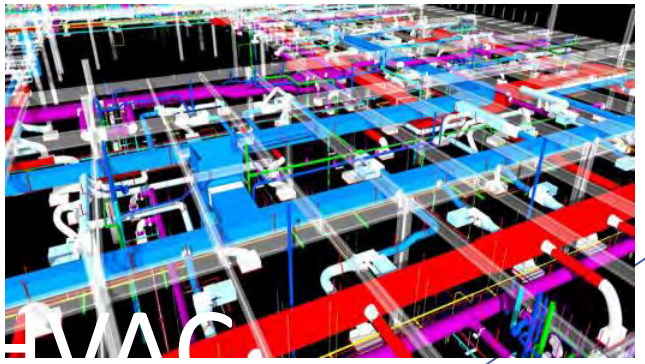



Zero Energy

Kitchen

Lighting


Technology



HVAC

Photovoltaics

# NZE DESIGN PROCESS

# WEST ELEMENTARY SCHOOL

WASHINGTON, DC


**88,500 sf**
**550 students**
**22 EUI Target**

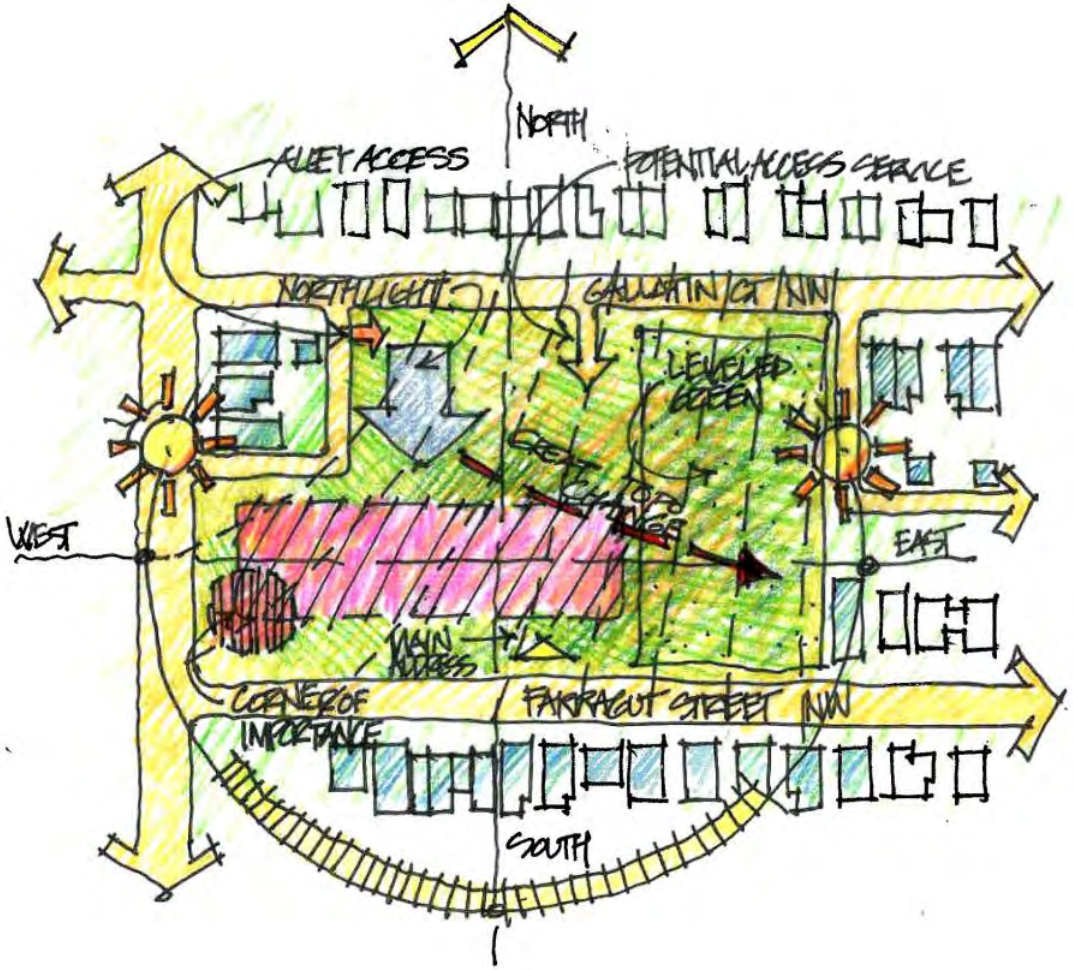
# BANNEKER HIGH SCHOOL

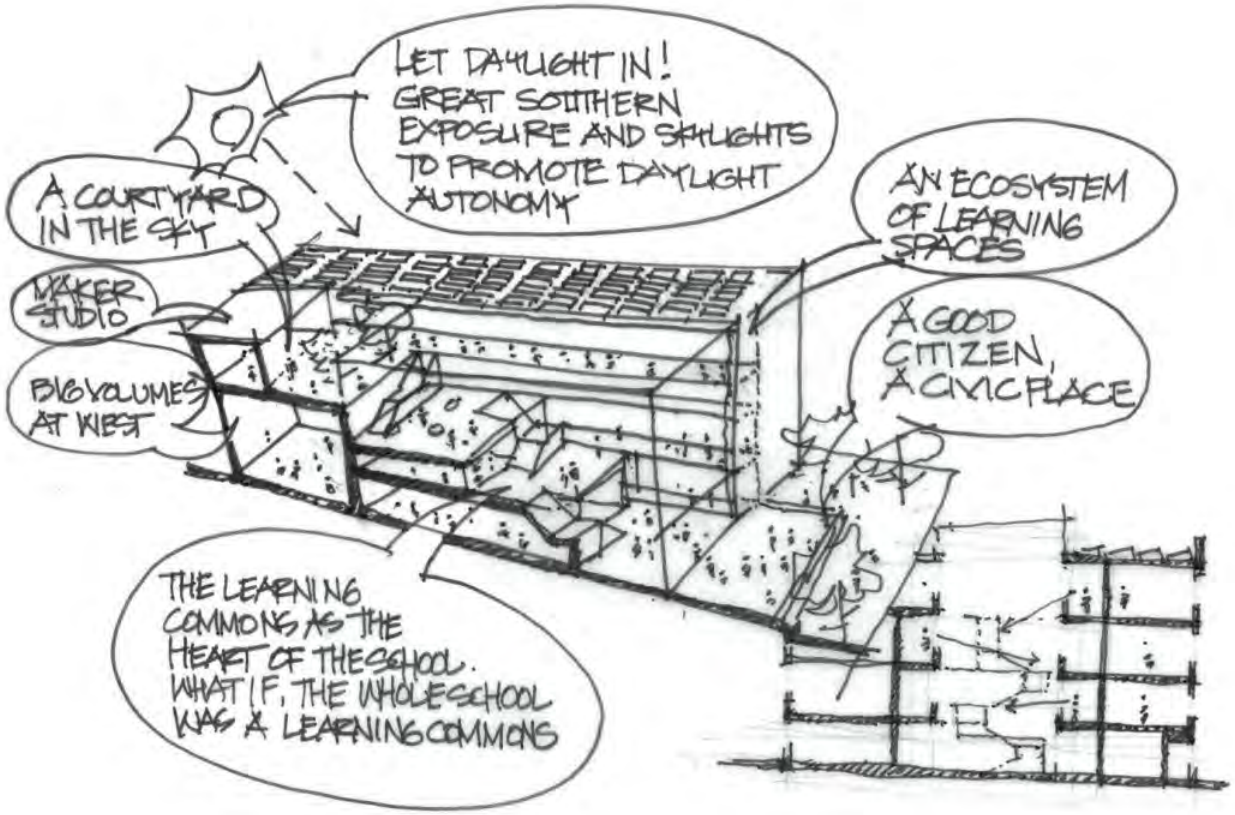
WASHINGTON, DC


**174,732 sf**
**800 students**
**22 EUI Target**

# BIG IDEA

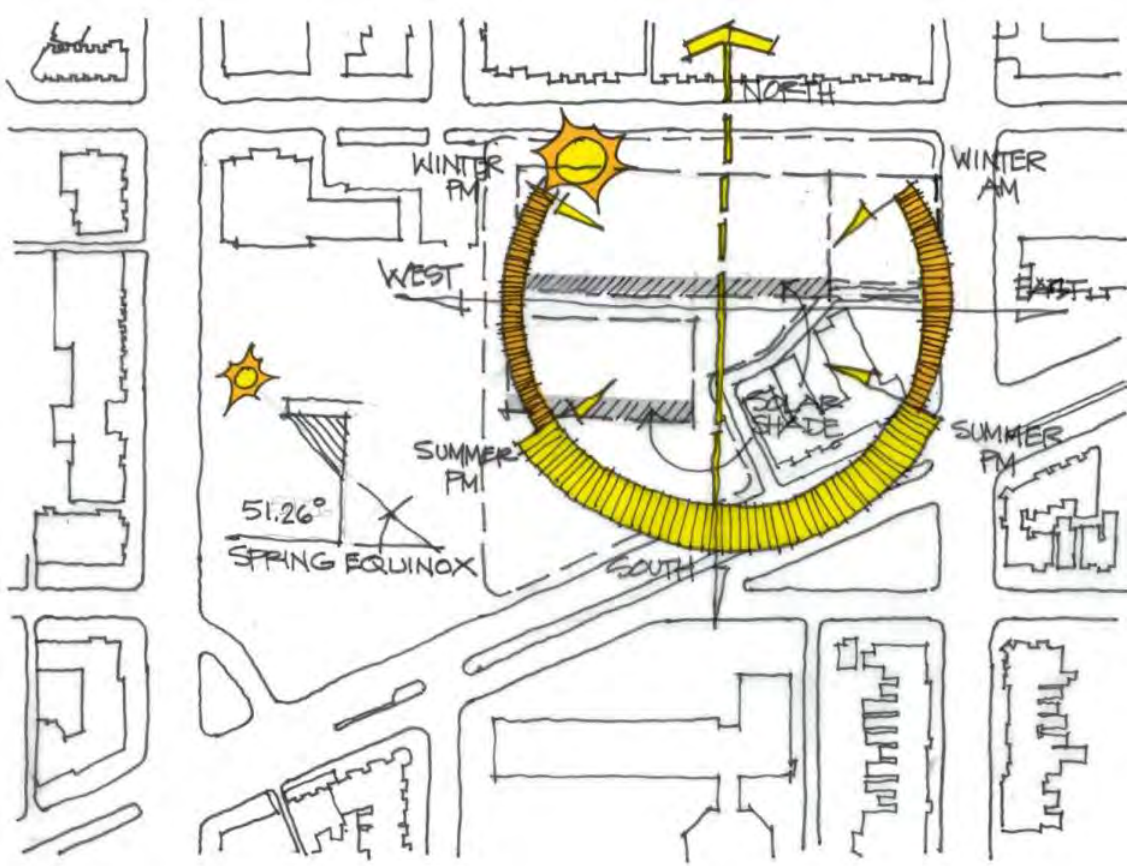
## APPROACHING NET ZERO FROM DAY 1

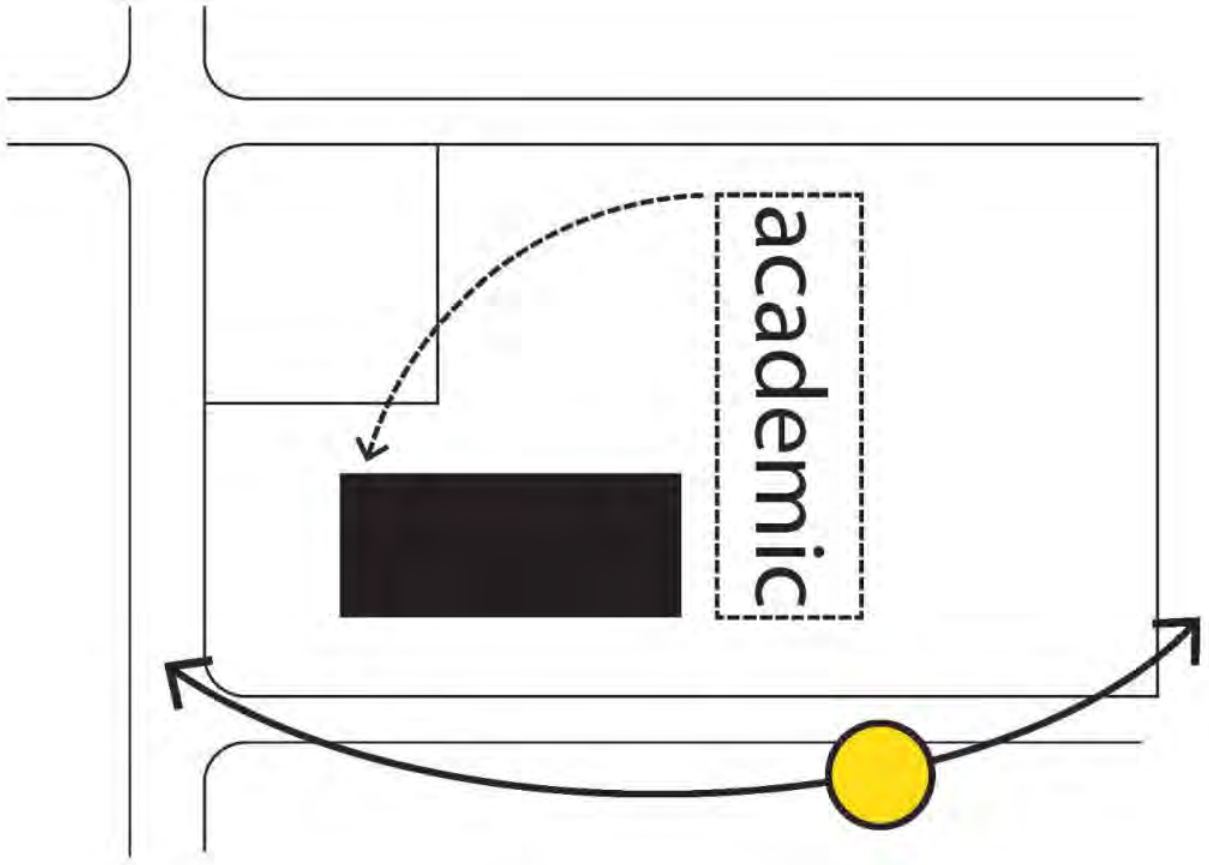


# OPTIMIZING SOLAR ORIENTATION

## DESIGNING TO ACHIEVE NET ZERO ENERGY



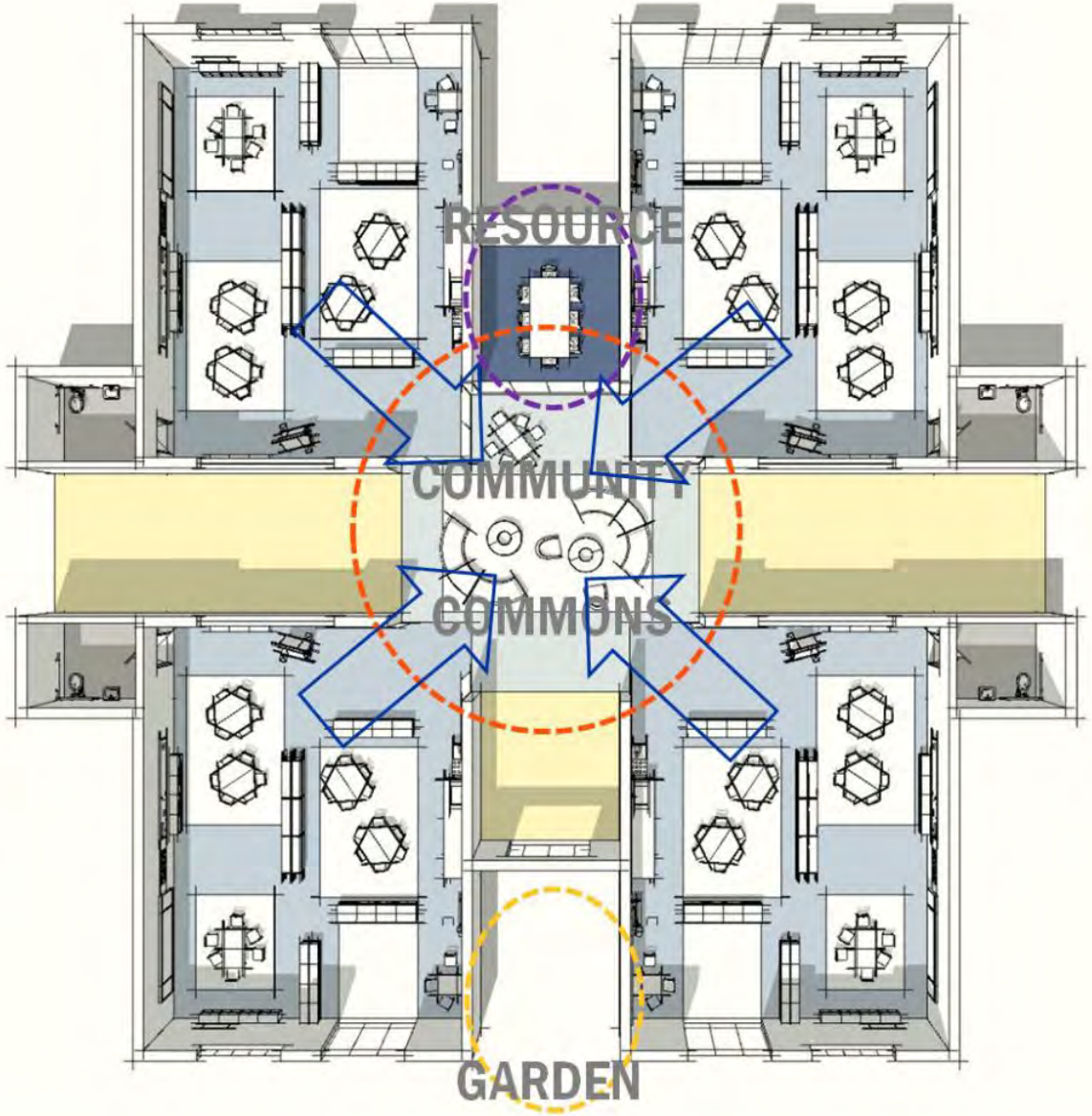




Orienting instructional spaces to the north or south will:

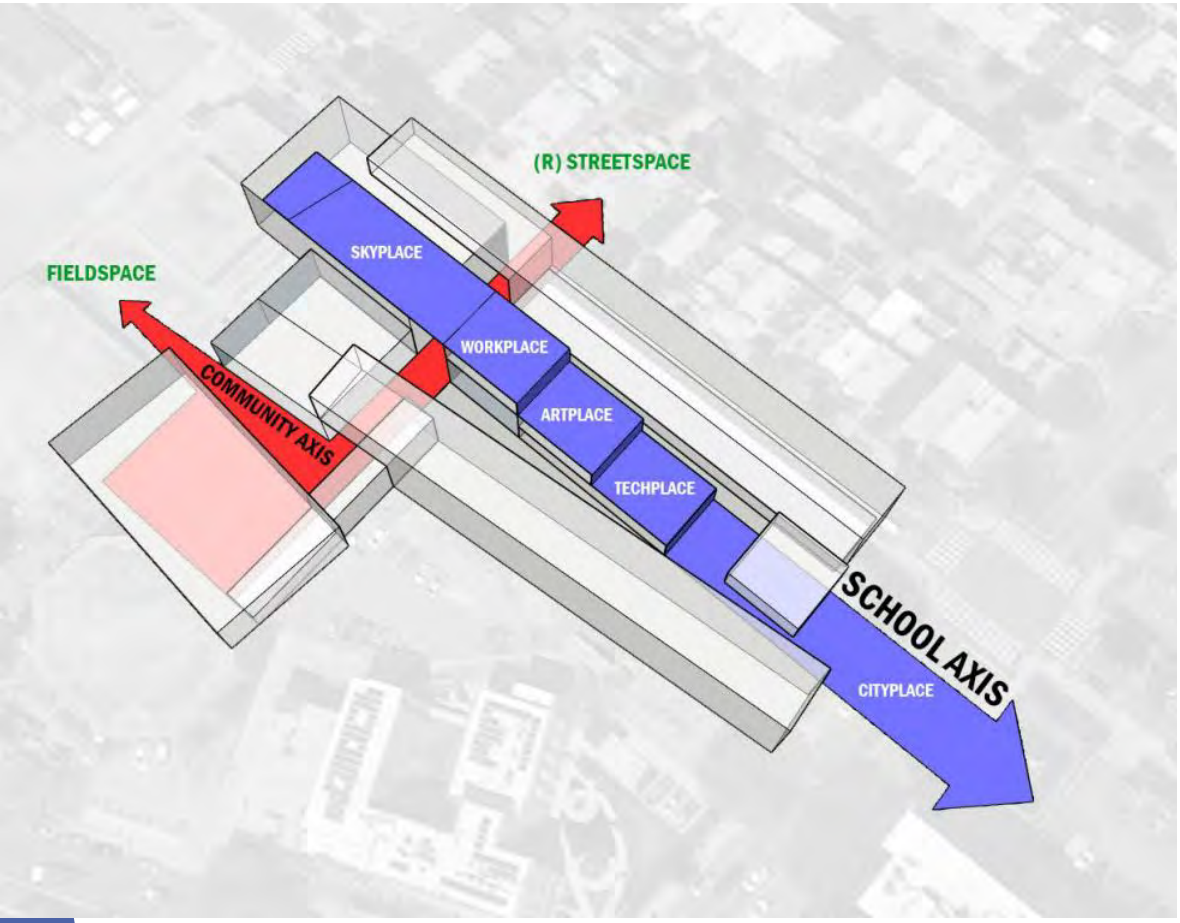
- Reduce heat gain on facades
- Reduce energy consumption
- Control amount and quality of light, reducing glare

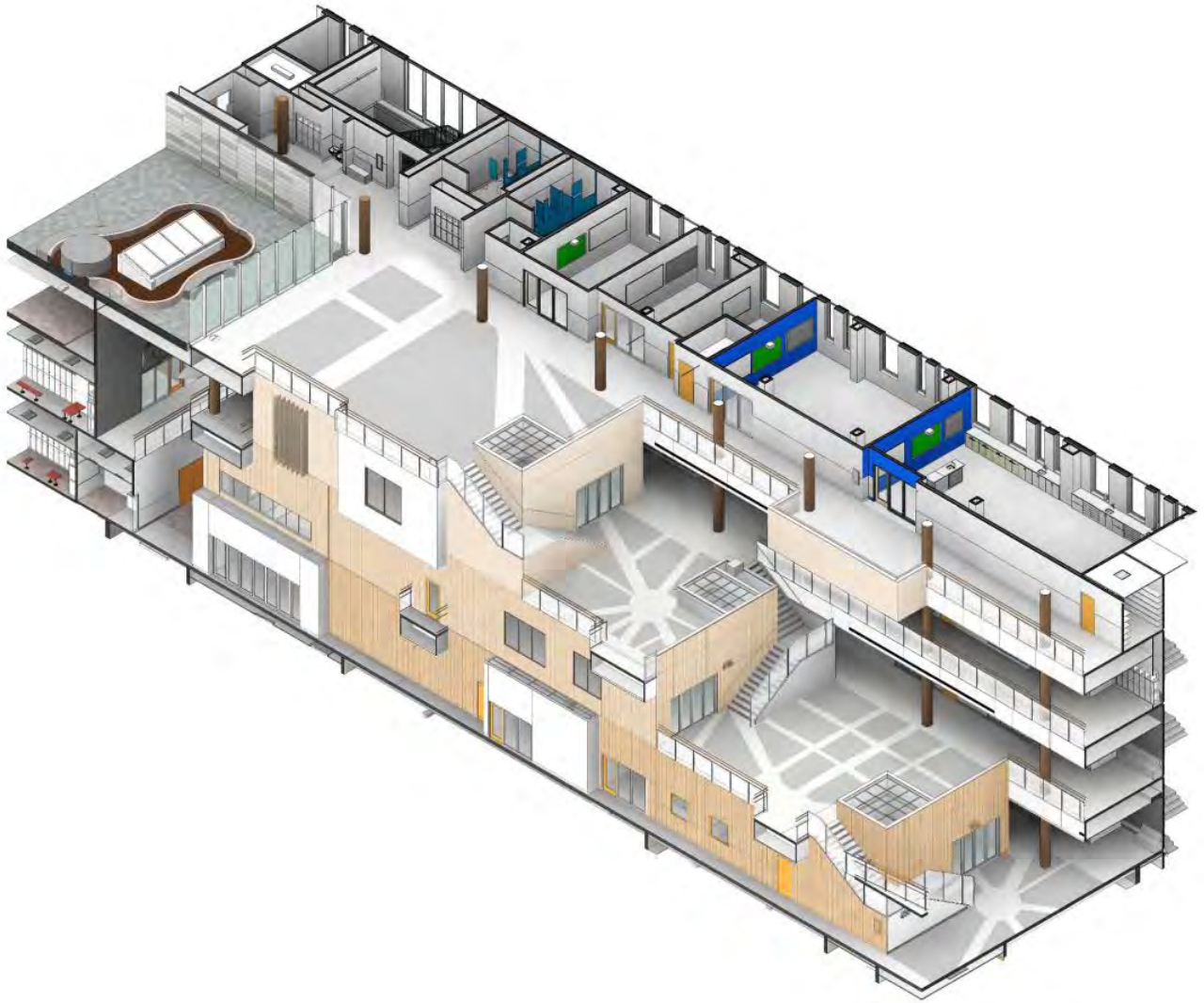
# HYBRID OPEN/CLOSED CLASSROOM & HOUSE



# UNIVERSITY CAMPUS FEEL AND ARTICULATING STAIR

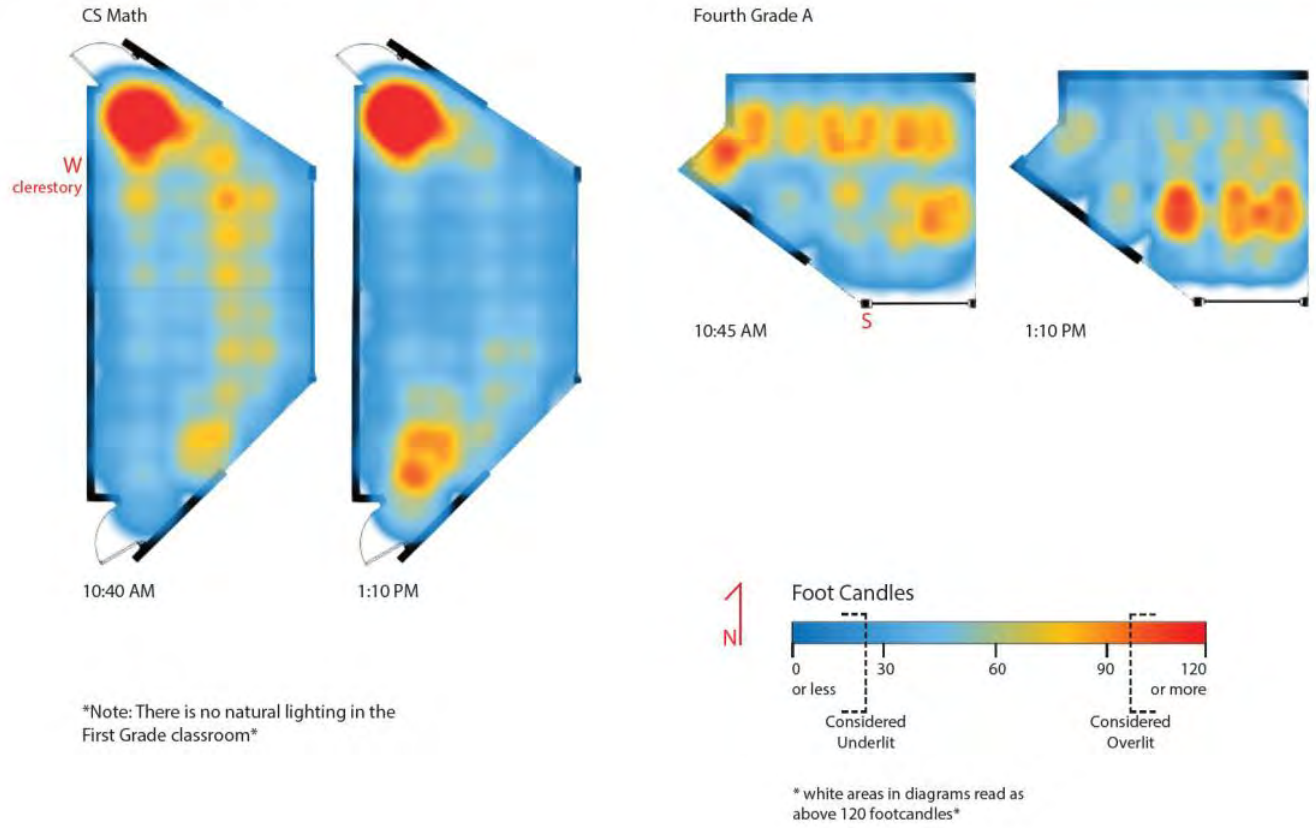


# DAYLIGHT AND WELLBEING

## DAYLIGHT AFFECTS STUDENT CONCENTRATION AND WELLBEING

West
Indoor Environmental Quality
Daylight




*Note: There is no natural lighting in the First Grade classroom*

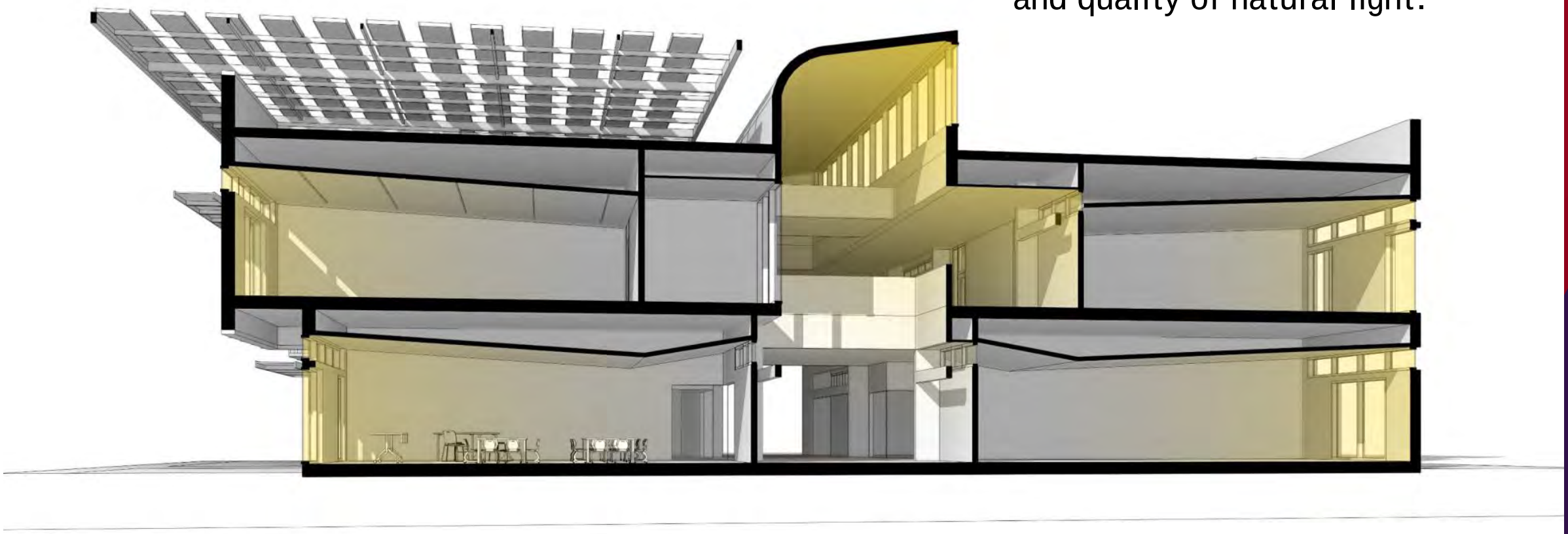
* white areas in diagrams read as above 120 footcandles*

(W) CS Math (R) Afternoon

Students in classrooms with windows perform **20% faster on math tests** and **26% faster on reading tests** than students in windowless classrooms.

# OPTIMIZE DAYLIGHT & VIEWS

Providing the right amount and quality of natural light.



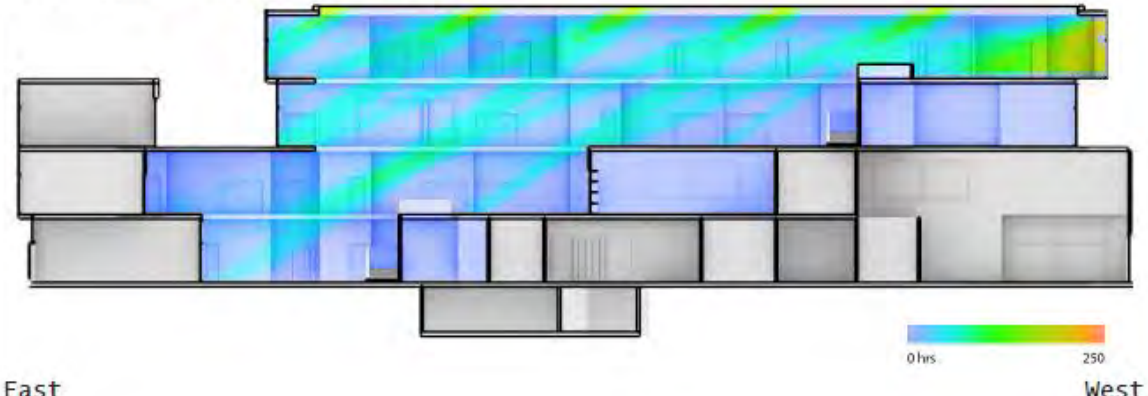
# OPTIMIZE DAYLIGHT & VIEWS

## *North Facing Analysis Surface*

*Variation: Split Flat Skylight*

Spatial Daylight Autonomy (sDA_300/50)

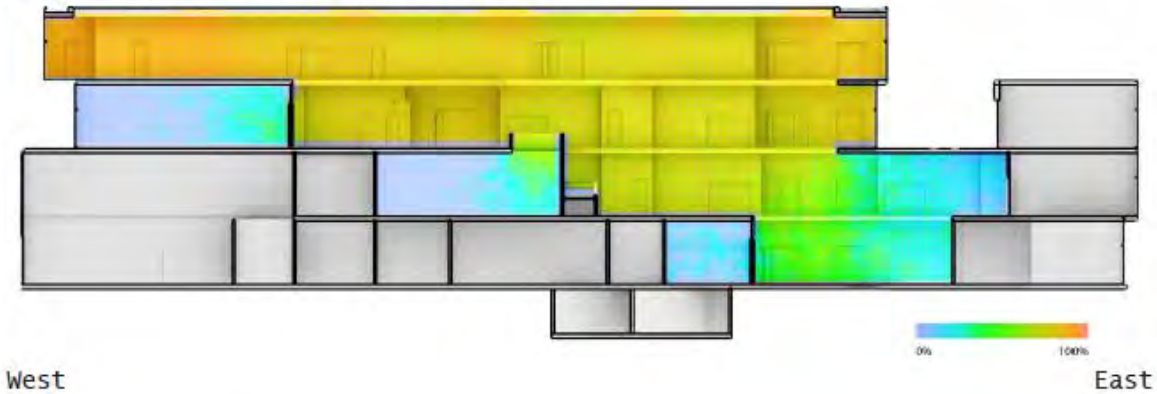

Annual Solar Exposure (ASE_1000/250)



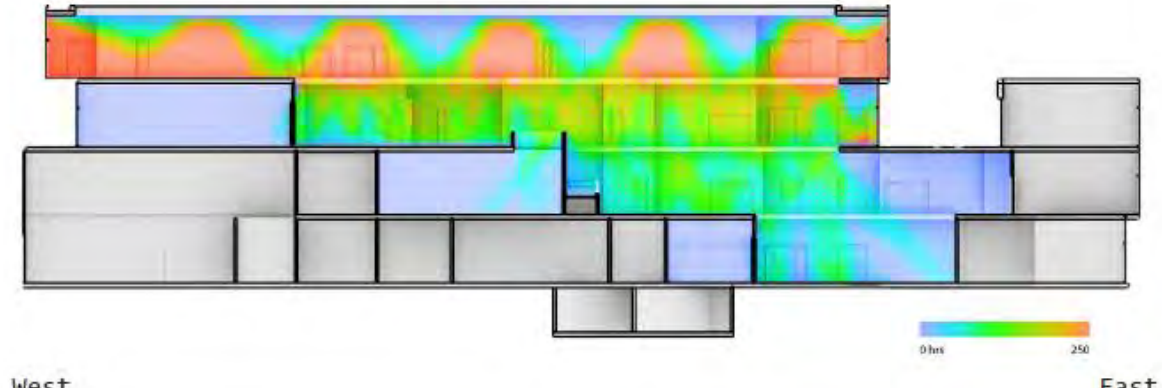

## *South Facing Analysis Surface*

*Variation: Split Vertical PV Northern Sawtooth (and Bigger Lightwells)*

Spatial Daylight Autonomy (sDA_300/50)

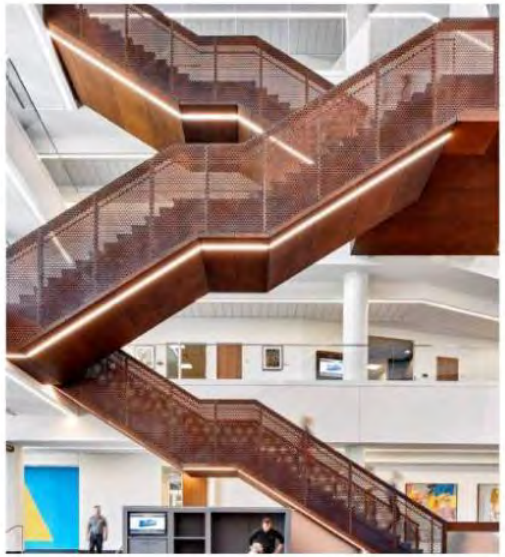


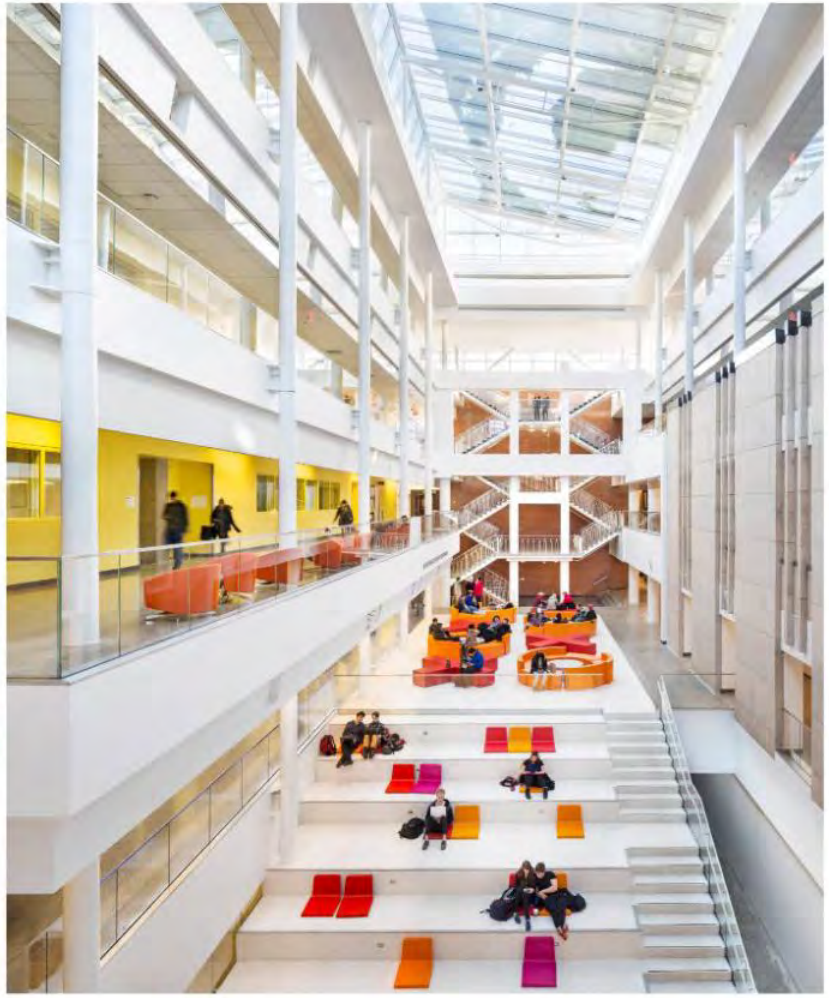

Annual Solar Exposure (ASE_1000/250)



# HOLISTIC WELLNESS

## PROVIDING STUDENT WELLNESS





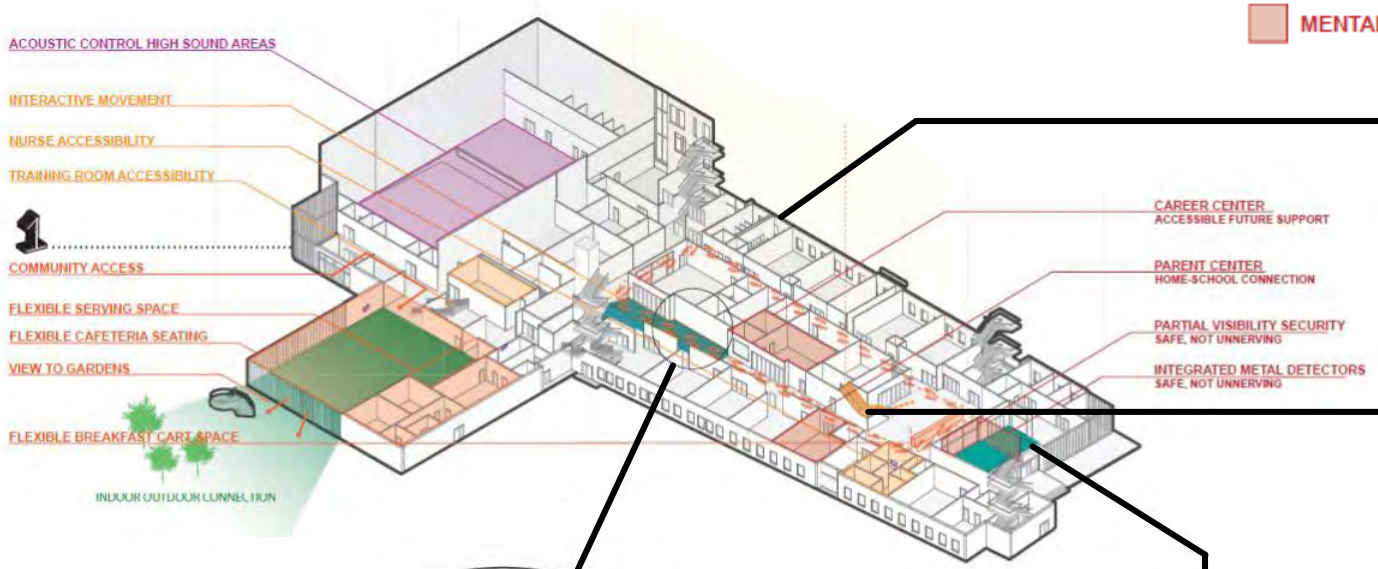
# HOLISTIC WELLNESS

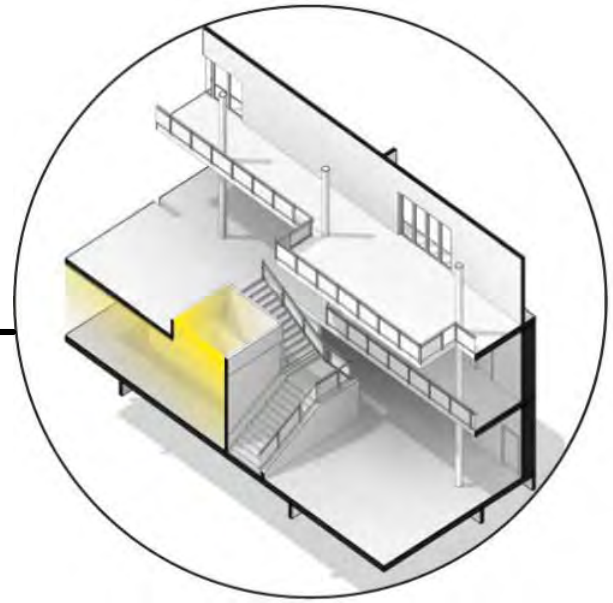
- Holistic Design:
  - Tangible Improvements

- Performance based Solutions:
  - Air Quality
    - 30%+ increase in OA
    - Increased Filtration
    - UV-C Lighting
    - OA Air Quality Alarm
  - Water Quality:
    - Quarterly Testing
    - All potable water receives additional filtering and UV disinfection
  - Nutrition:
    - Highly promoted Fruits and Vegetables
    - All nutritional information is present at point of purchase
    - No hydrogenated oils
    - Accommodates 6 special diets incl gluten free and vegan
    - Organic fruits and vegetables
    - Connection to local greenhouse to grow produce
  - Lighting:
    - Maximized daylight throughout the building
  - Thermal performance testing:
    - Yearly Comfort level tests dry bulb temperature, relative humidity, and mean radiant temperatures


# HOLISTIC WELLNESS

PHYSICAL ACTIVITY
FOOD & NUTRITION
WATER & HYDRATION
ENVIRONMENTAL QUALITY
MENTAL & EMOTIONAL HEALTH



ACCESS TO DAYLIGHT

SPACIAL OPPORTUNITIES
FOR STRESS RELIEF

SMOOTH ENTRANCE EXPERIENCE

PHYSICAL ACTIVITY THROUGH
CENTRAL STAIRCASE

# OVERLAPPING PROCESS

## TRADITIONAL DESIGN APPROACH

ARCHITECTURE TEAM

ARCHITECTURAL DESIGN

MEP TEAM

MECHANICAL/ELECTRICAL/PLUMBING DESIGN

GENERAL CONTRACTOR

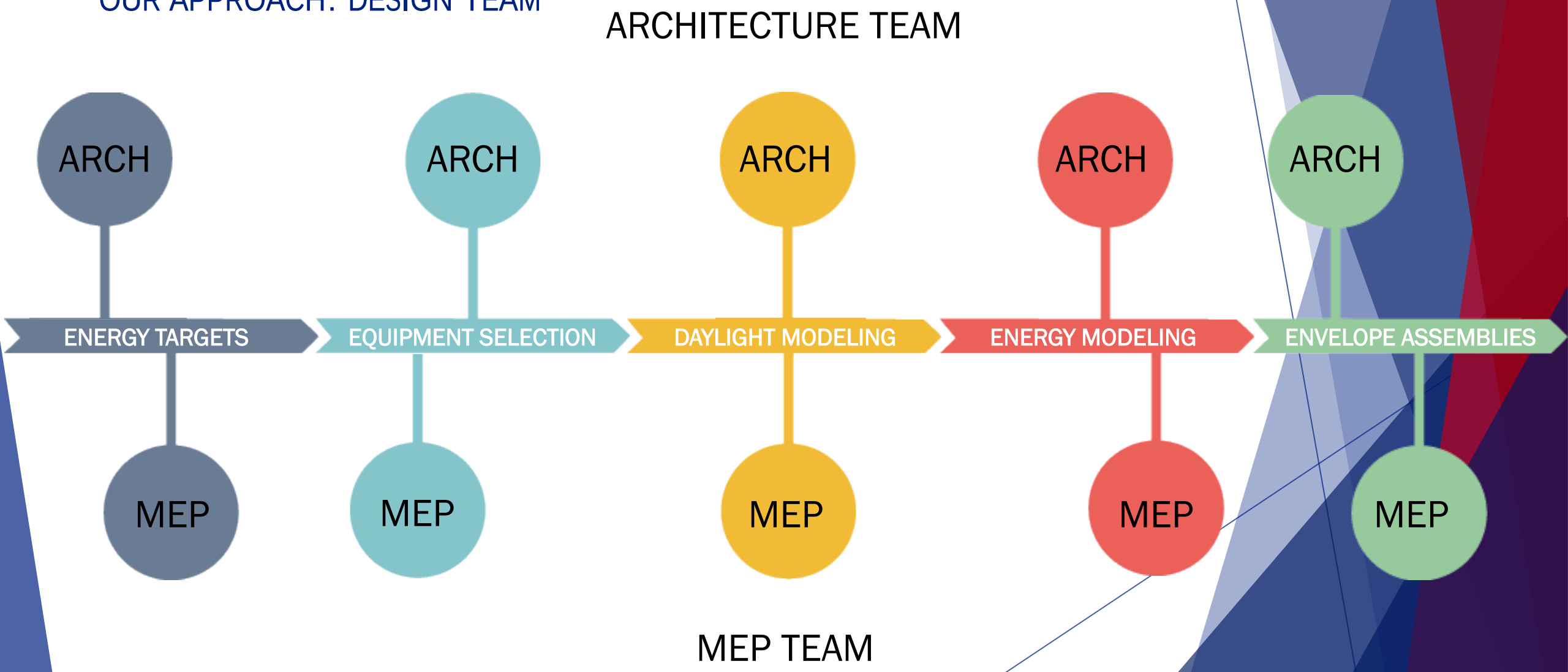
BUILDING OF THE PROJECT

COMMISSIONING AGENT

SYSTEMS REVISION AND TESTING

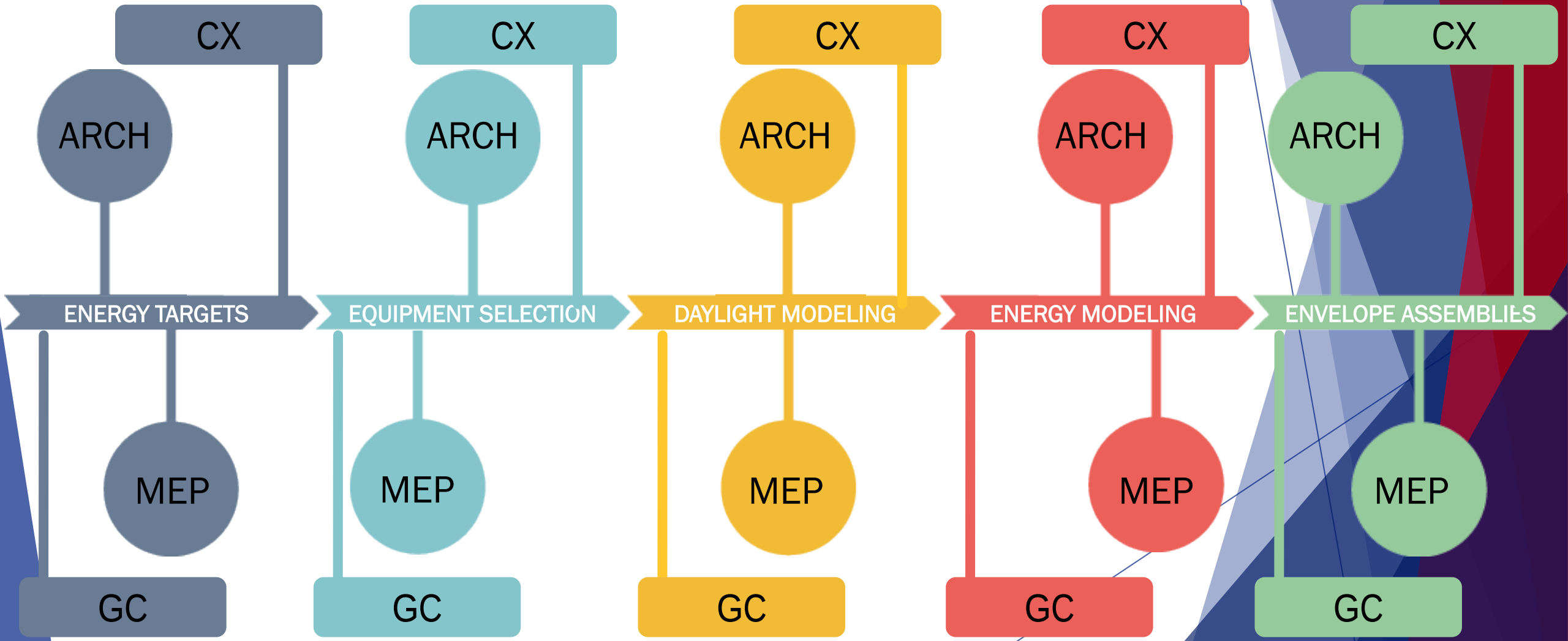
# OVERLAPPING PROCESSES

## OUR APPROACH: DESIGN TEAM

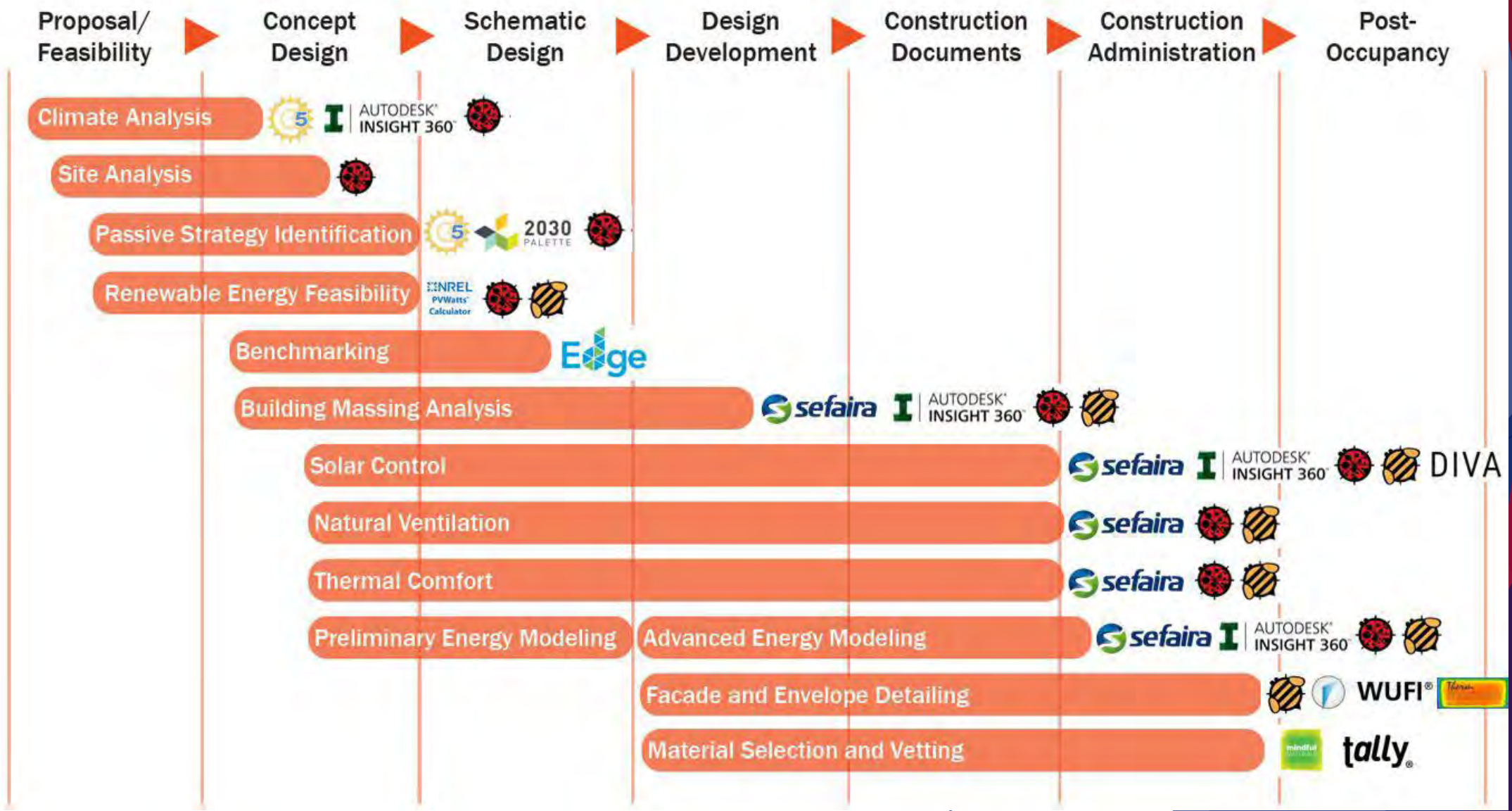


# OVERLAPPING PROCESSES

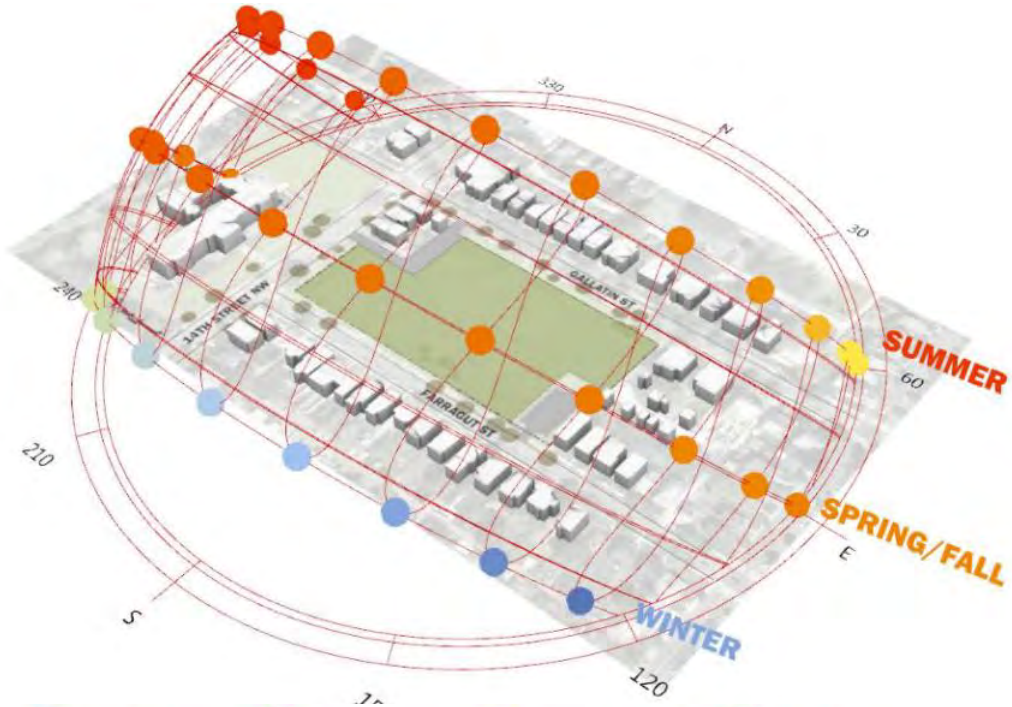
## OUR APPROACH: CONSTRUCTION TEAM

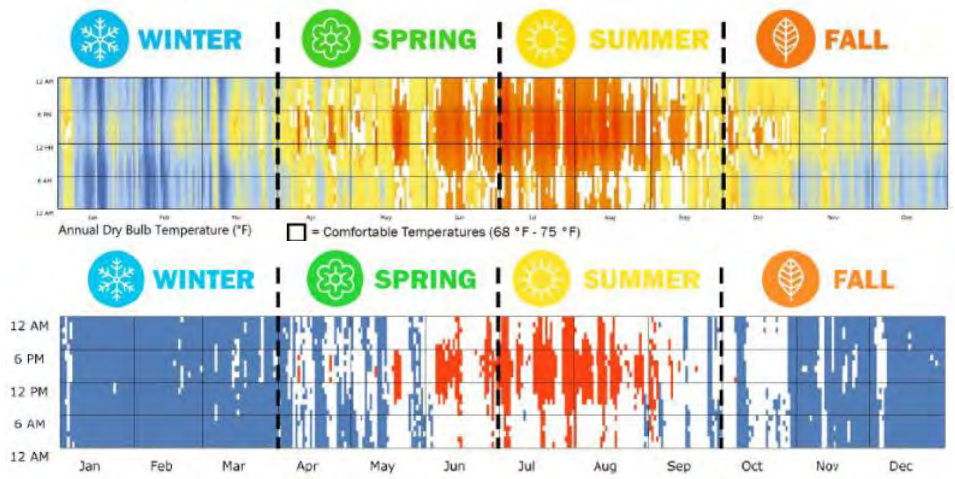


# TOOLS FOR DIFFERENT STAGES OF DESIGN

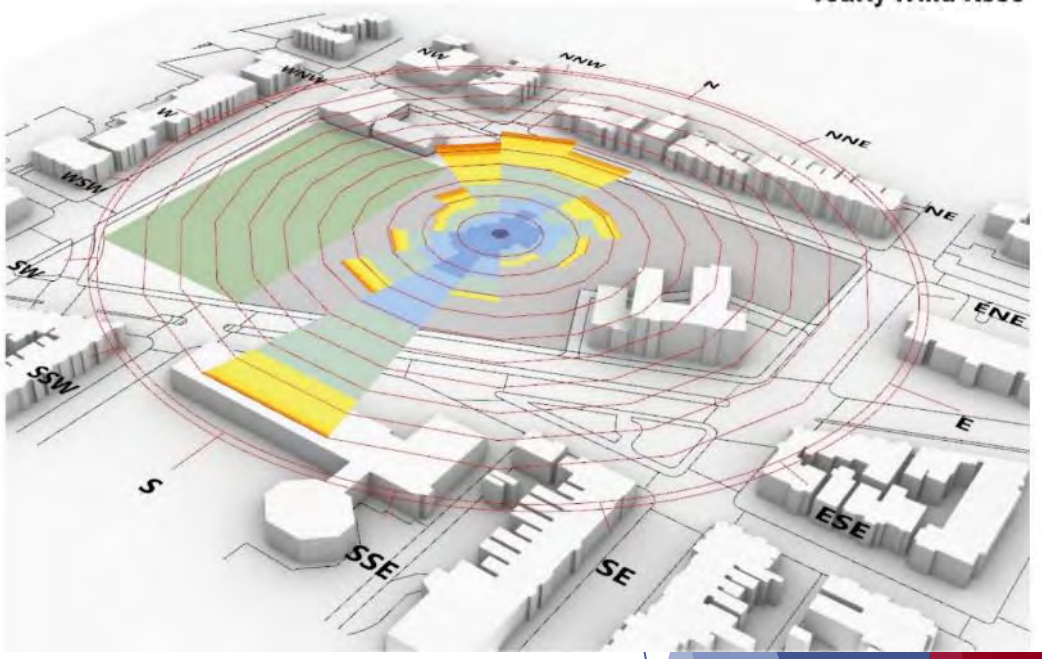


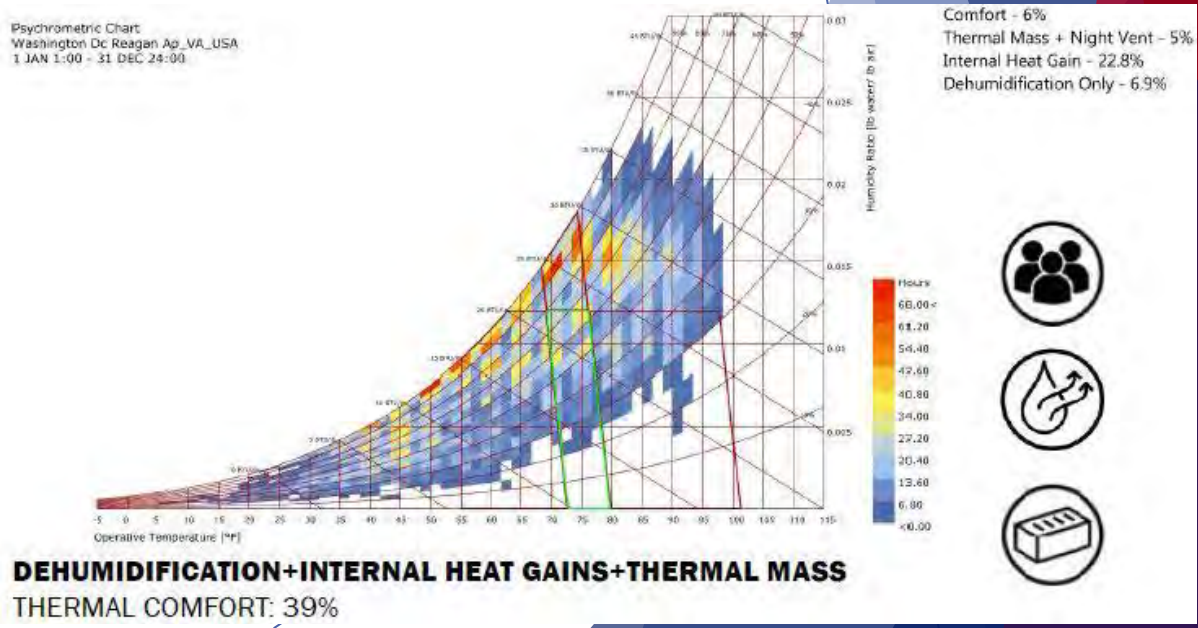
# CLIMATE ANALYSIS




Yearly Wind Rose

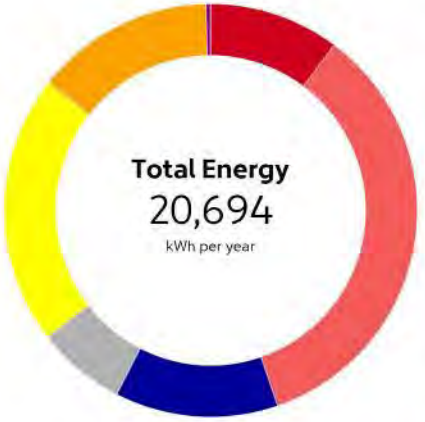


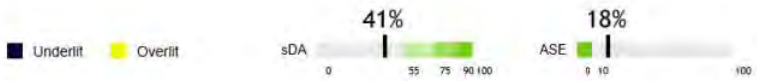
# PROPER CLASSROOM ORIENTATION

**OPTION 1:** NORTH-SOUTH CLASSROOMS

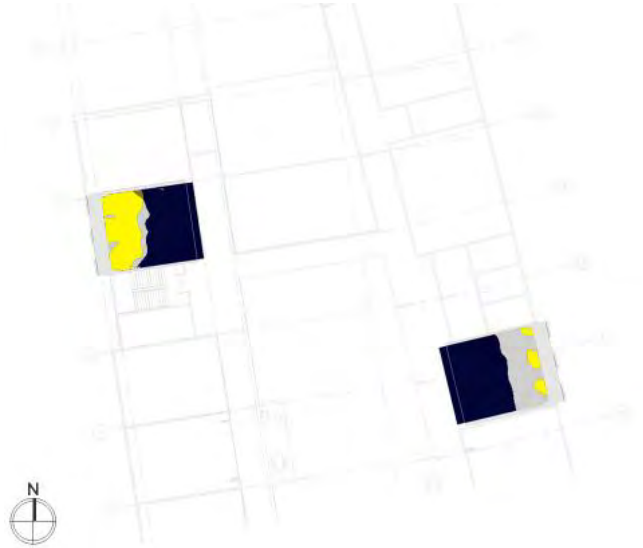

Annual Energy Use



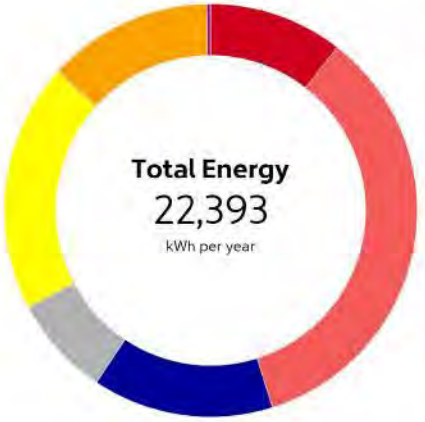

| Segment | kWh per year | % of total use |
|---|---|---|
| **Heating** | **9,257** | **45 %** |
| AHU | 2,112 | 10 % |
| Zones | 7,145 | 35 % |
| Humidification | 0 | 0 % |
| **Cooling** | **2,650** | **13 %** |
| AHU | 2,650 | 13 % |
| Heat Rejection | 0 | 0 % |
| Zones | 0 | 0 % |
| **Fans** | **1,442** | **7 %** |
| AHU | 1,442 | 7 % |
| Zones | 0 | 0 % |
| **Interior** | **7,275** | **35 %** |
| Lighting | 4,365 | 21 % |
| Equipment | 2,910 | 14 % |
| **Pumps** | **70** | **0 %** |



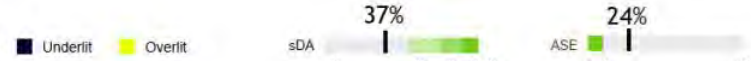

**OPTION 2:** EAST-WEST CLASSROOMS




Annual Energy Use

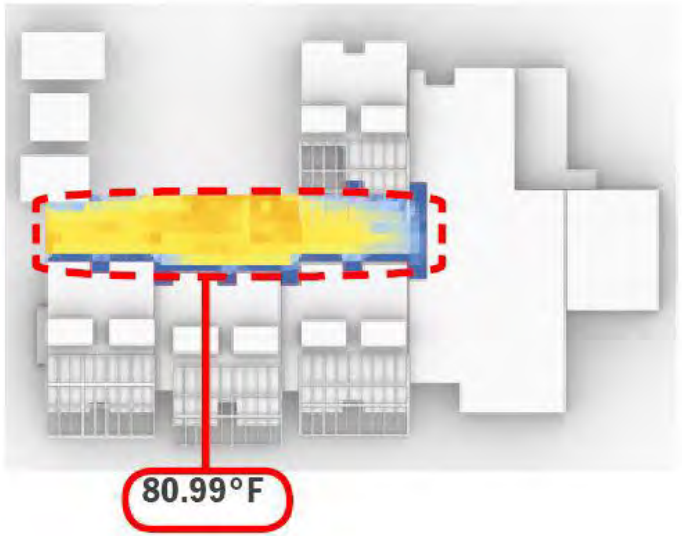



| Segment | kWh per year | % of total use |
|---|---|---|
| **Heating** | **10,111** | **45 %** |
| AHU | 2,351 | 10 % |
| Zones | 7,760 | 35 % |
| Humidification | 0 | 0 % |
| **Cooling** | **3,179** | **14 %** |
| AHU | 3,179 | 14 % |
| Heat Rejection | 0 | 0 % |
| Zones | 0 | 0 % |
| **Fans** | **1,765** | **8 %** |
| AHU | 1,764 | 8 % |
| Zones | 1 | 0 % |
| **Interior** | **7,275** | **32 %** |
| Lighting | 4,365 | 19 % |
| Equipment | 2,910 | 13 % |
| **Pumps** | **63** | **0 %** |

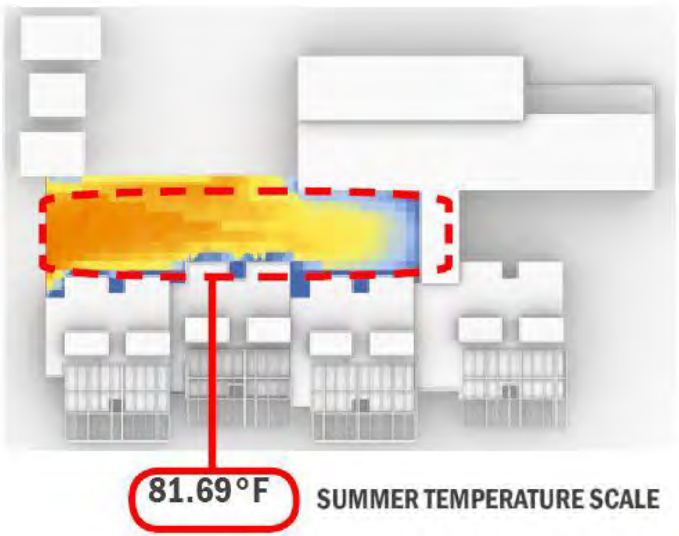


# THERMAL COMFORT

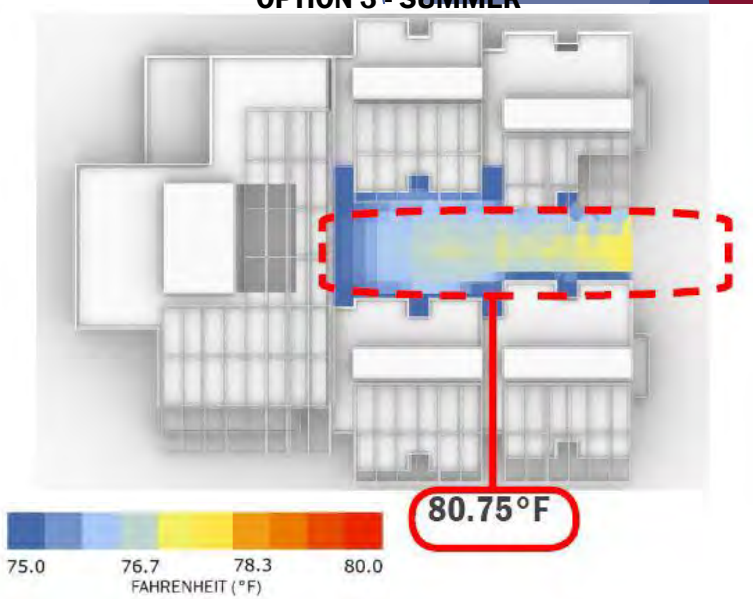
**OPTION 1 - SUMMER**



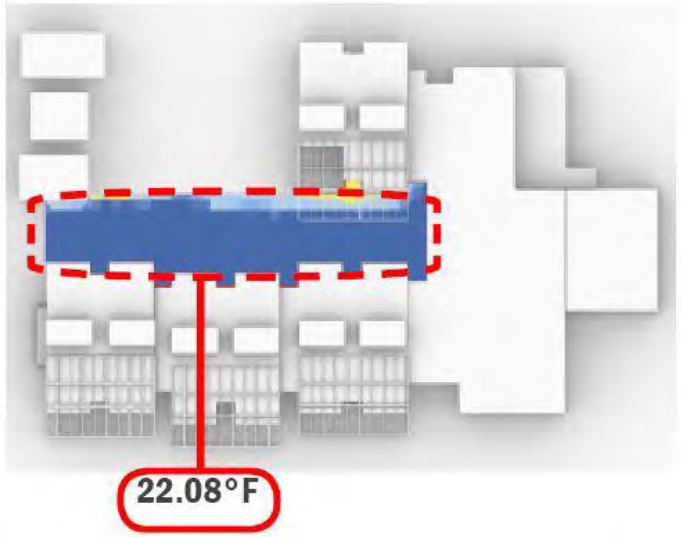

**OPTION 2 - SUMMER**



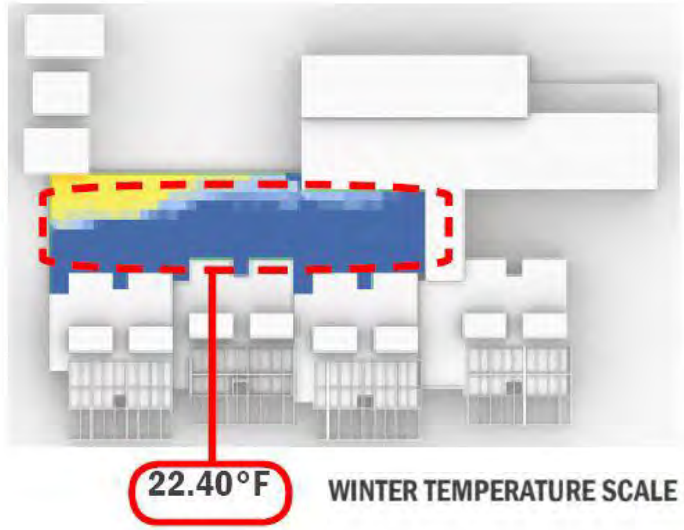

**OPTION 3 - SUMMER**




**OPTION 1 - WINTER**

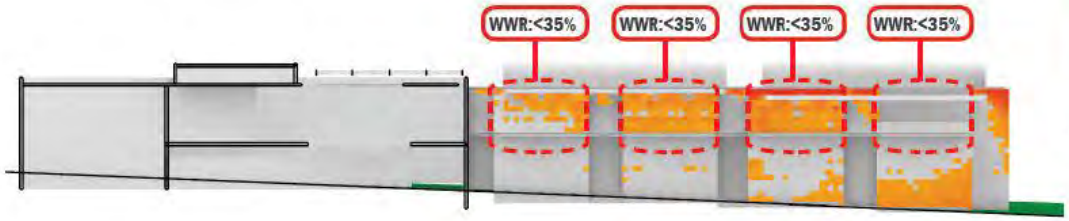



**OPTION 2 - WINTER**

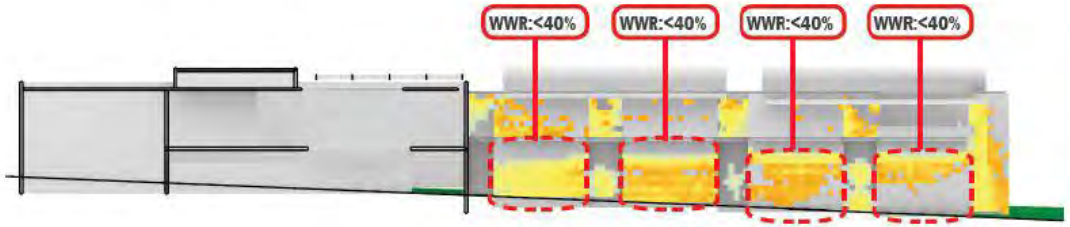



**OPTION 3 - WINTER**

# OPTIMUM WINDOW-TO-WALL RATIO

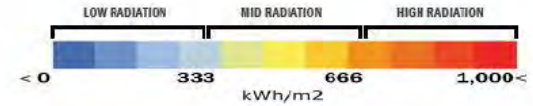


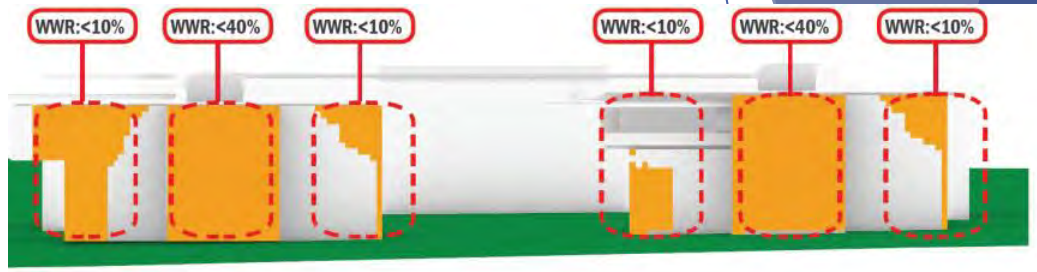

**HIGH RADIATION:**
1,843 SQ FT
27%




**MID RADIATION:**
2,806 SQ FT
43%


**LOW RADIATION:**
2,041 SQ FT
30%

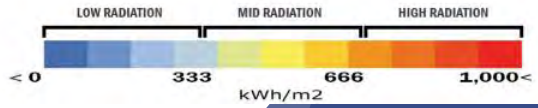


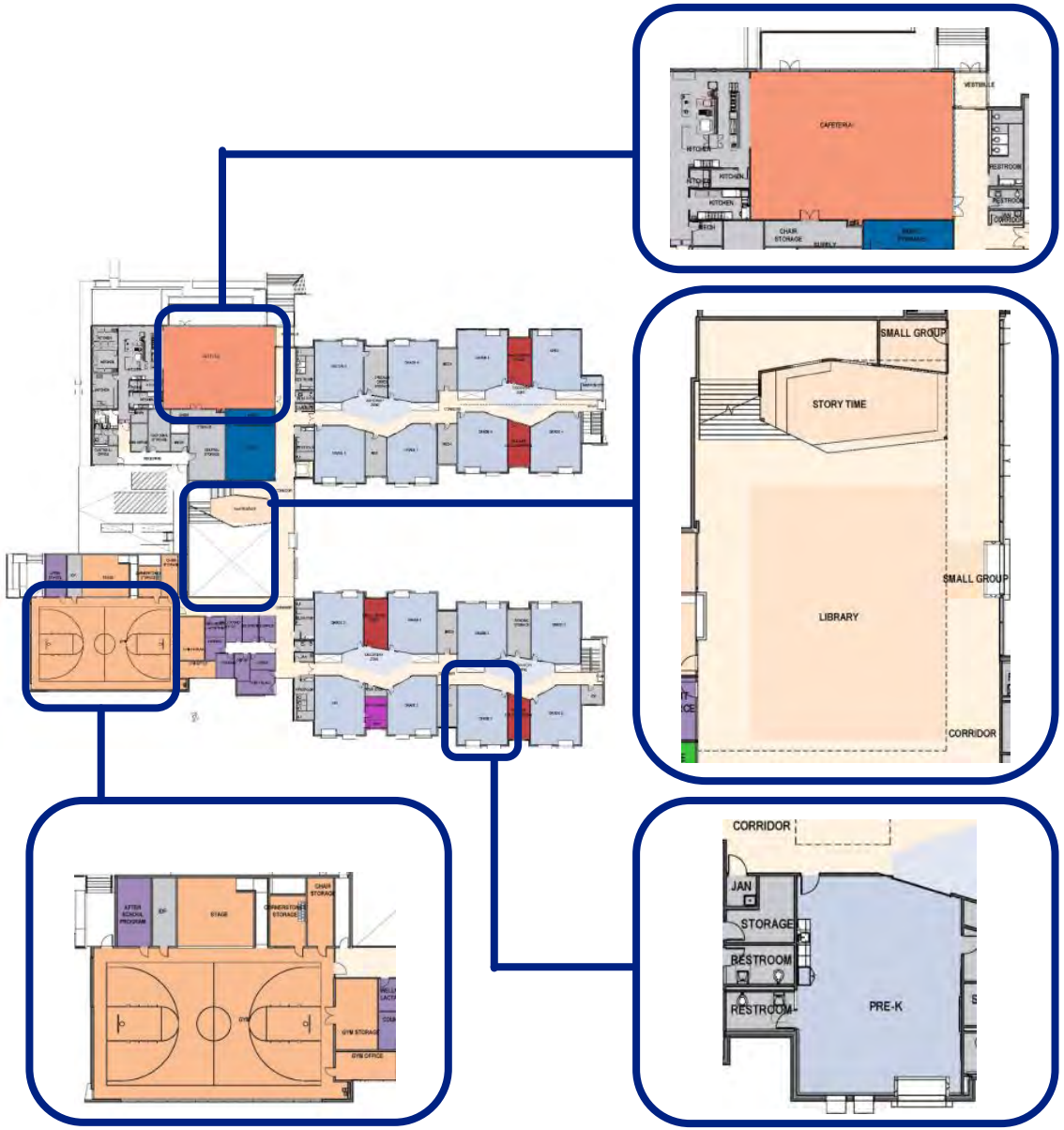

**HIGH RADIATION:**
3,651 SQ FT
51%

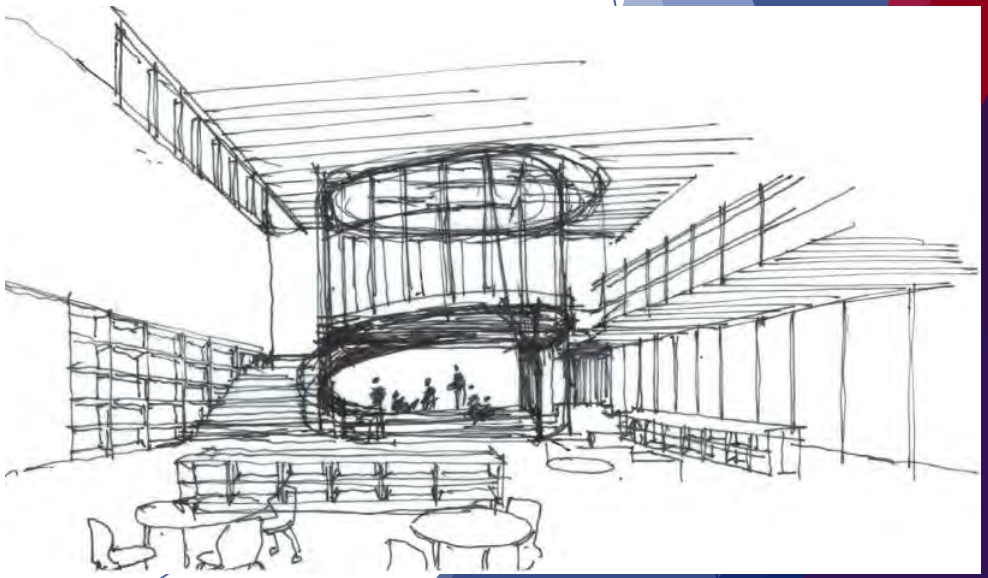

**MID RADIATION:**
2,461 SQ FT
34%


**LOW RADIATION:**
1,062 SQ FT
15%



# ENVELOPE / DAYLIGHT

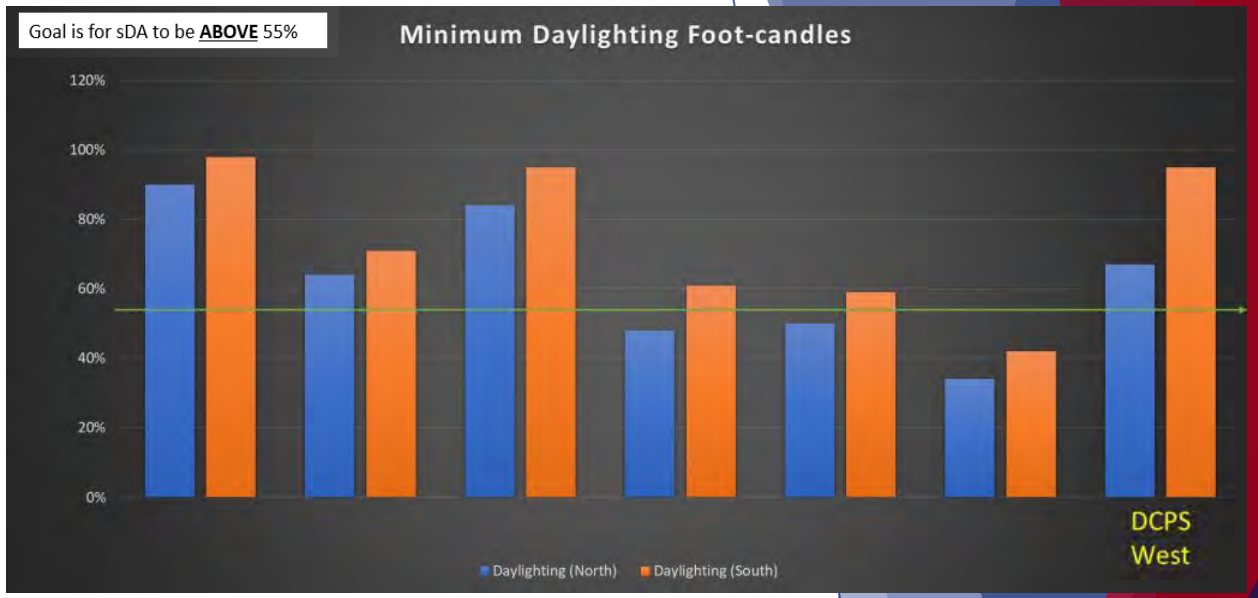


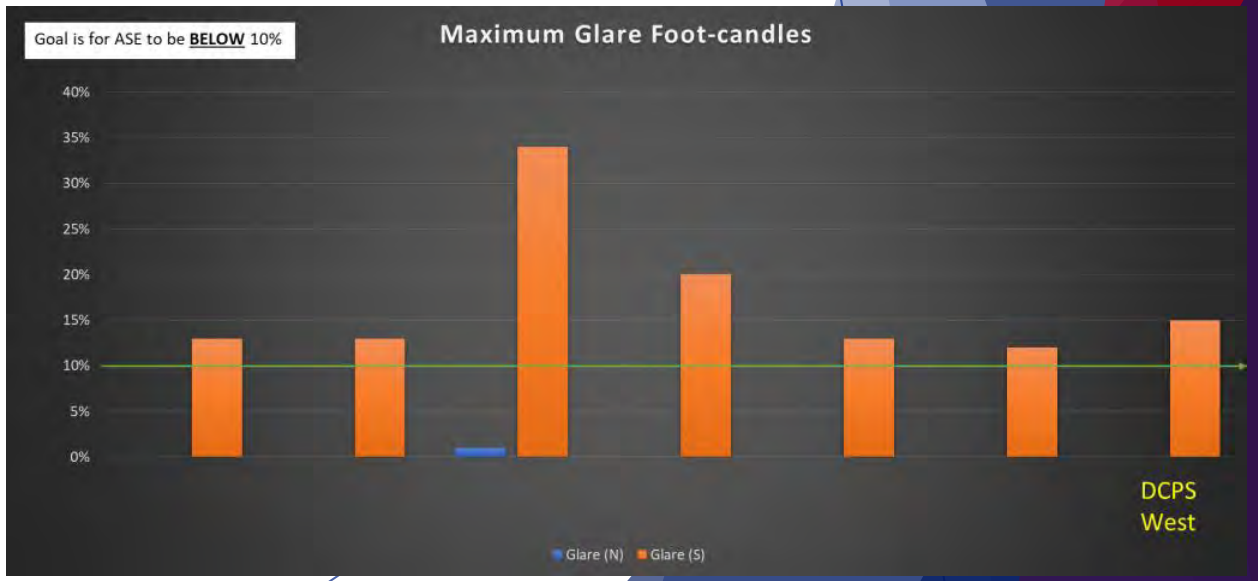



# DAYLIGHTING

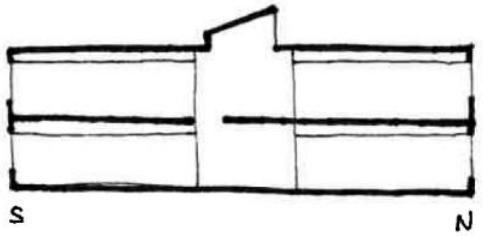
## REDUCE ENERGY, IMPROVE HEALTH

- Initial Concept: Best of PE/CMTA projects to inform new West Classroom Design
- Merged with Vision for Neighborhoods
- Incorporated Iterative Design to Inform and Improve Building Design (through 7 phases…)
- Importance of getting good data for inputs!

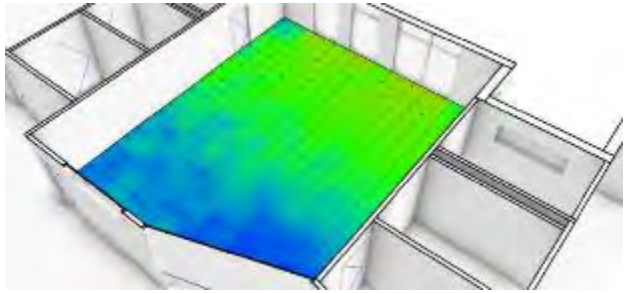


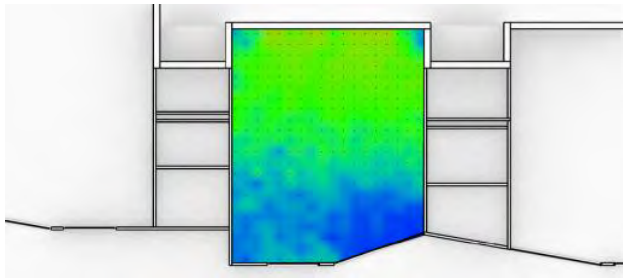



# STRATEGIES TO OPTIMIZE DAYLIGHT




**BASELINE**



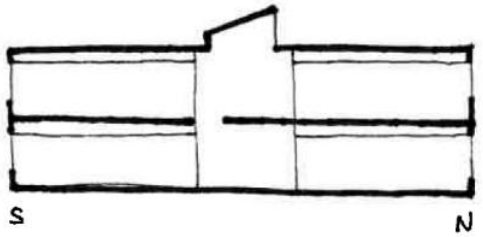


**DAYLIGHT (SDA):** 17%

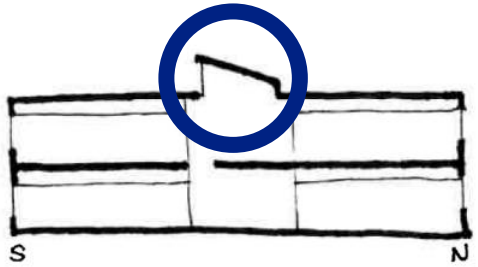
**GLARE (ASE):** 0%

**WINDOW RATIO:** 25%

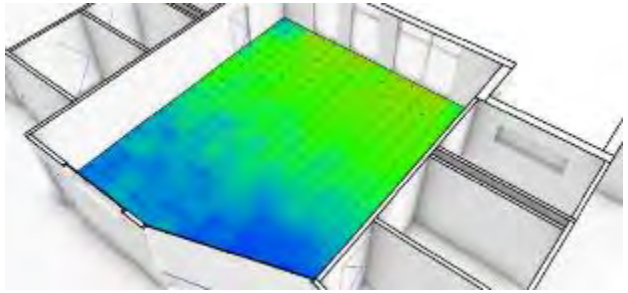
# STRATEGIES TO OPTIMIZE DAYLIGHT

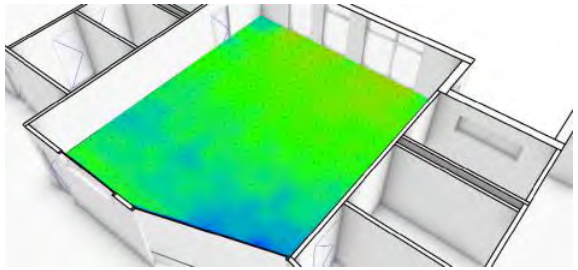


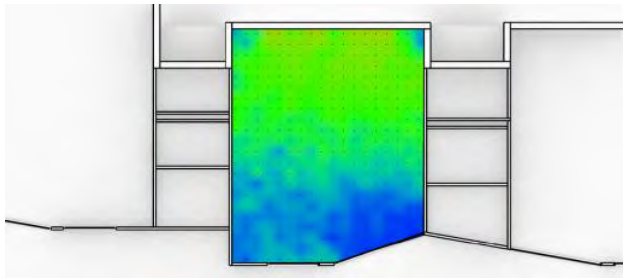

**BASELINE**

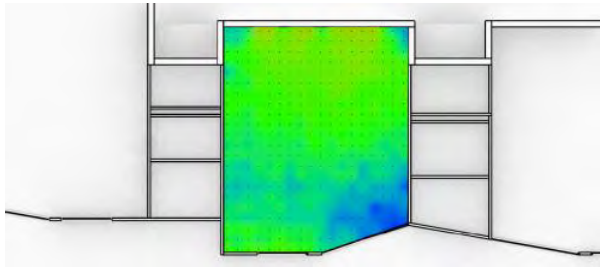



**SOUTH FACING CLERESTORY**









**DAYLIGHT (SDA):** 17%

**GLARE (ASE):** 0%

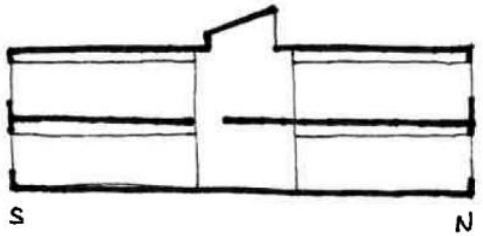
**WINDOW RATIO:** 25%

**DAYLIGHT (SDA):** 29%

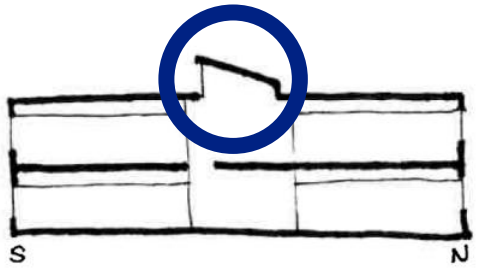
**GLARE (ASE):** 0%

**WINDOW RATIO:** 25%

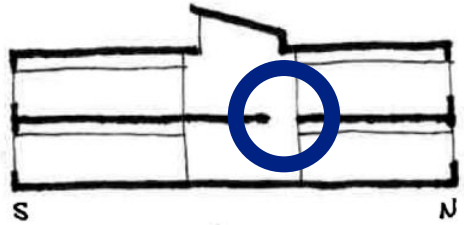
# STRATEGIES TO OPTIMIZE DAYLIGHT



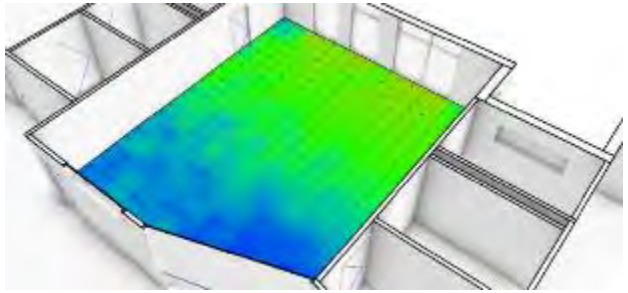

**BASELINE**

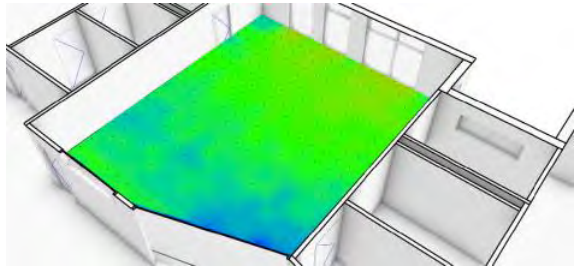


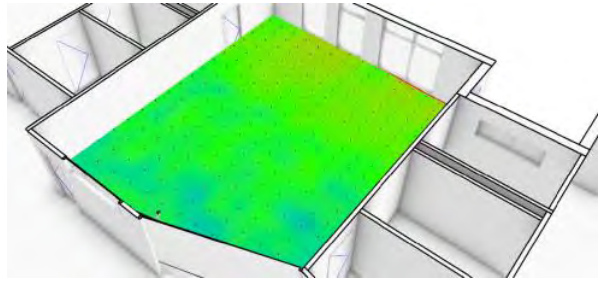

**SOUTH FACING CLERESTORY**

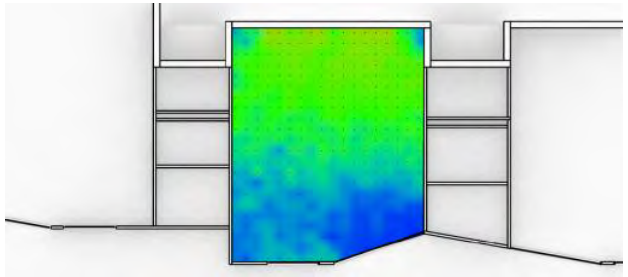


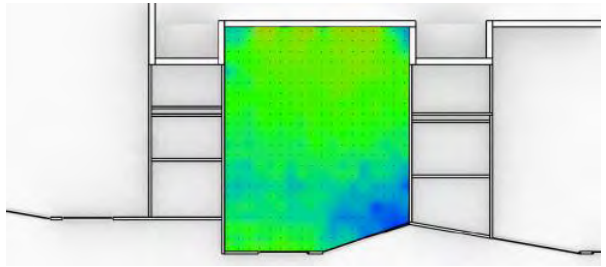

**NORTH LIGHT WELLS**

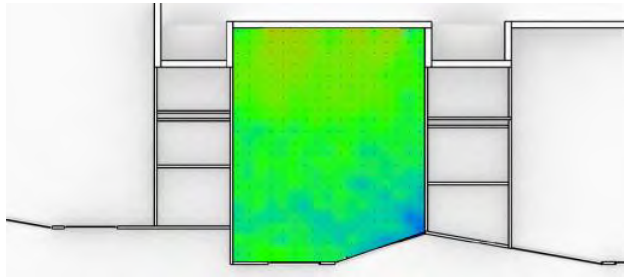












**DAYLIGHT (SDA):** 17%

**GLARE (ASE):** 0%

**WINDOW RATIO:** 25%

**DAYLIGHT (SDA):** 29%

**GLARE (ASE):** 0%

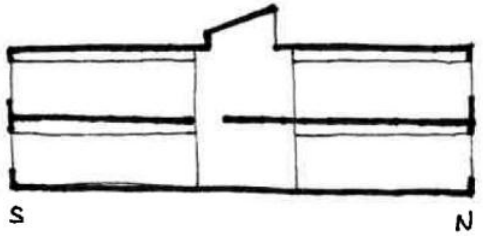
**WINDOW RATIO:** 25%

**DAYLIGHT (SDA):** 40%

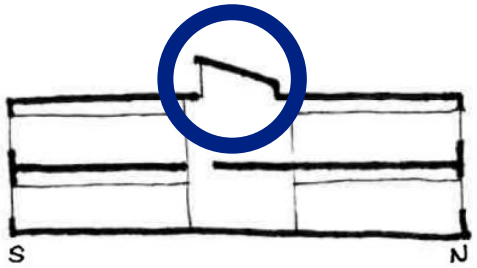
**GLARE (ASE):** 1%

**WINDOW RATIO:** 25%

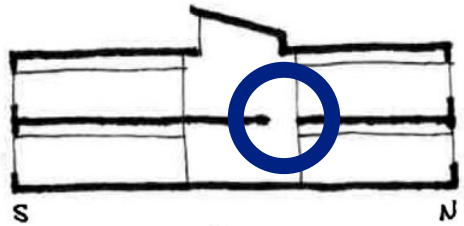
# STRATEGIES TO OPTIMIZE DAYLIGHT



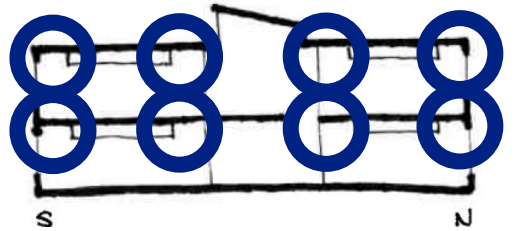

**BASELINE**



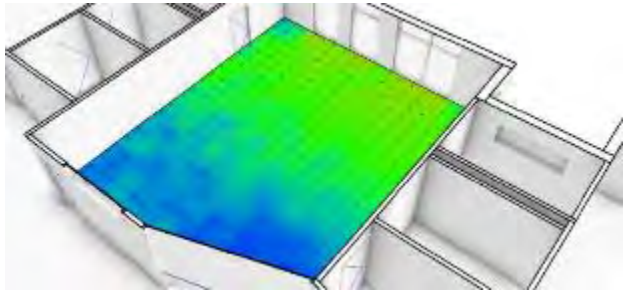

**SOUTH FACING CLERESTORY**

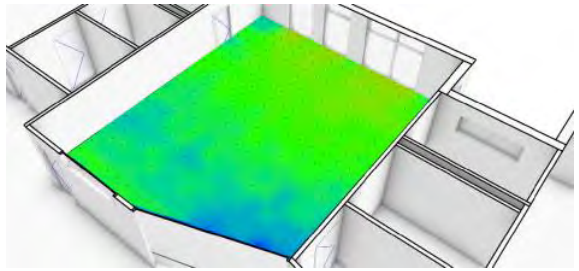


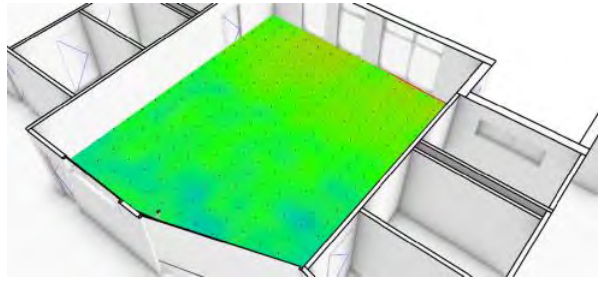

**NORTH LIGHT WELLS**

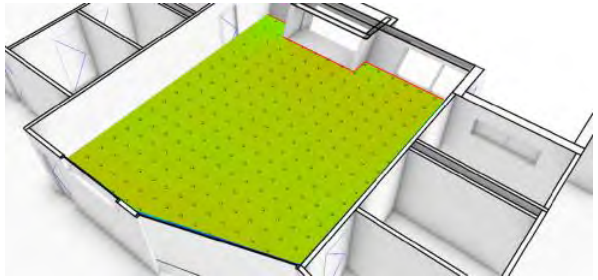


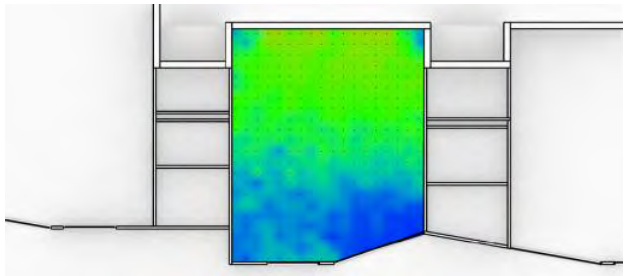

**RECESSED CEILINGS + NOOKS**

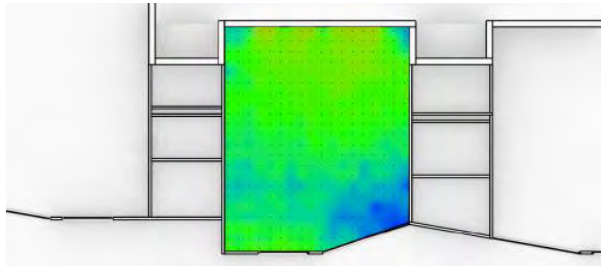


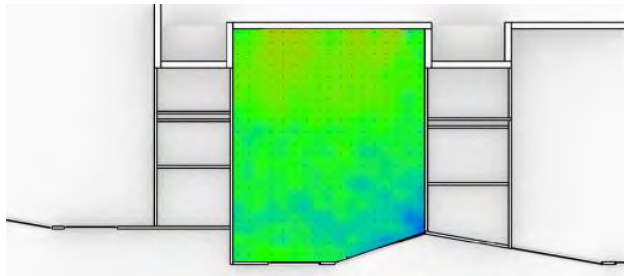


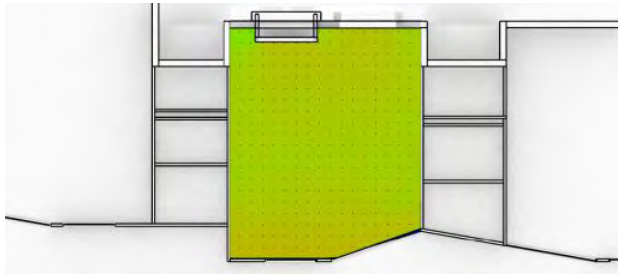












**DAYLIGHT (SDA):** 17%
**GLARE (ASE):** 0%
**WINDOW RATIO:** 25%

**DAYLIGHT (SDA):** 29%
**GLARE (ASE):** 0%
**WINDOW RATIO:** 25%

**DAYLIGHT (SDA):** 40%
**GLARE (ASE):** 1%
**WINDOW RATIO:** 25%

**DAYLIGHT (SDA):** 62%
**GLARE (ASE):** 3%
**WINDOW RATIO:** 25%


CLOCK
CAFE
CITY
PLACE

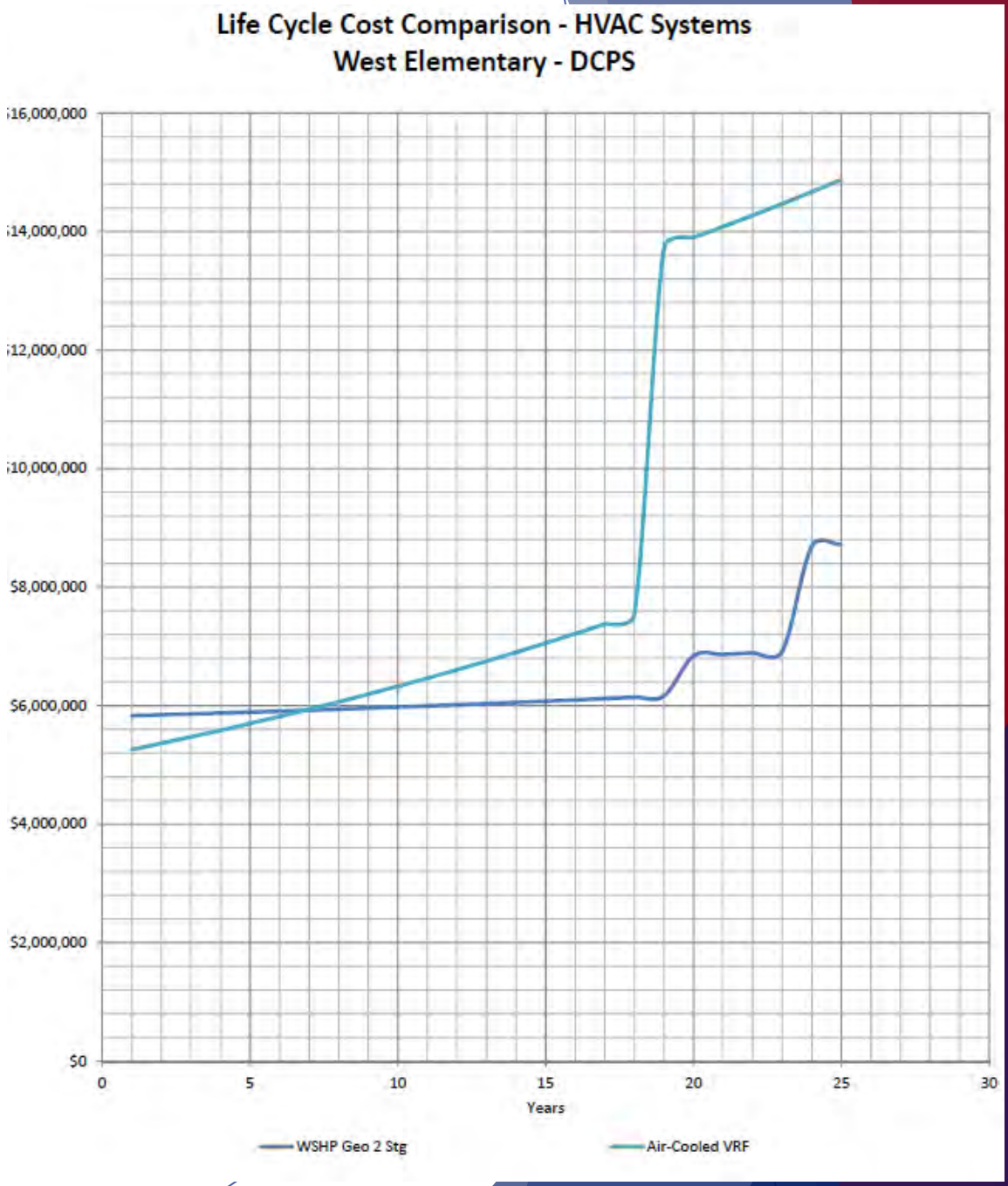
# HVAC SYSTEMS

## MULTIPLE HVAC SYSTEMS VETTED

**Geothermal vs Water-Cooled VRF vs Air-Cooled VRF**

- Owner Operations and Maintenance staff preferred Geothermal Systems over VRF
- Geothermal and Water Cooled VRF had similar First Cost
- Air-Cooled VRF approx. estimated $660,000 less expensive, Geothermal bid lower than estimated
- Geothermal: $90,000/yr Annual Energy Savings
- Geothermal was less than 7 year payback

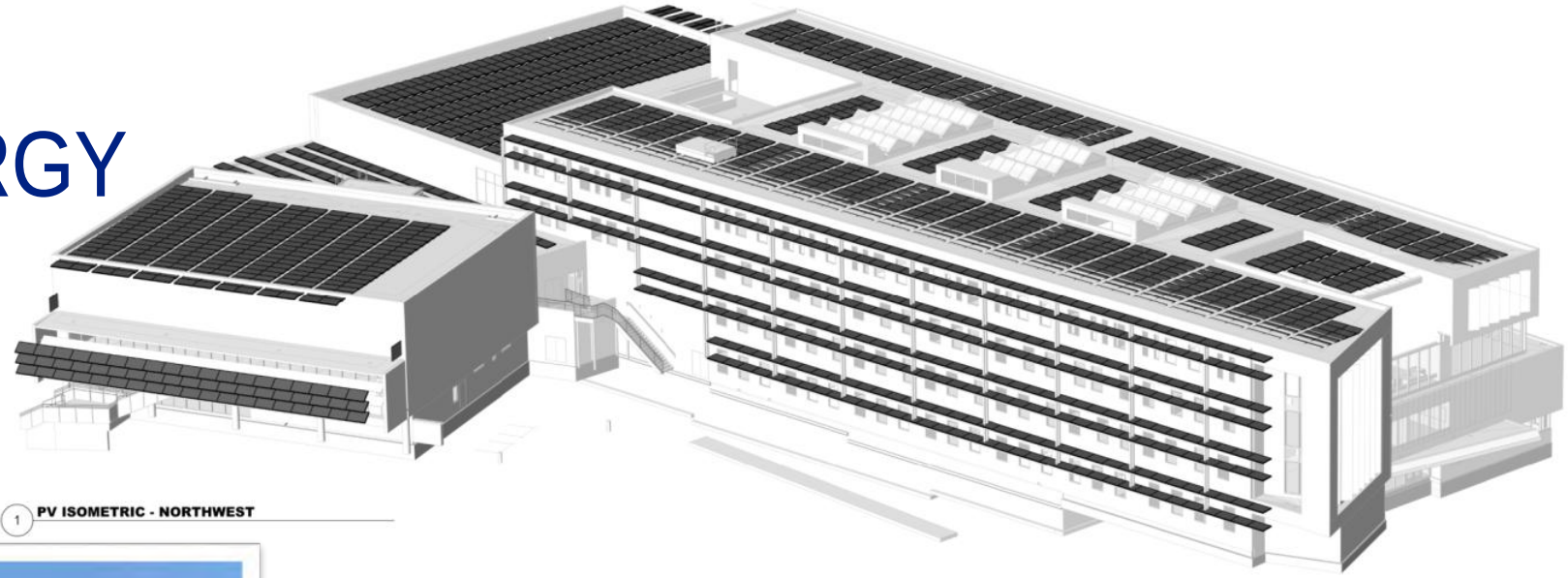
- Geothermal was $6M savings over 25 years Life Cycle

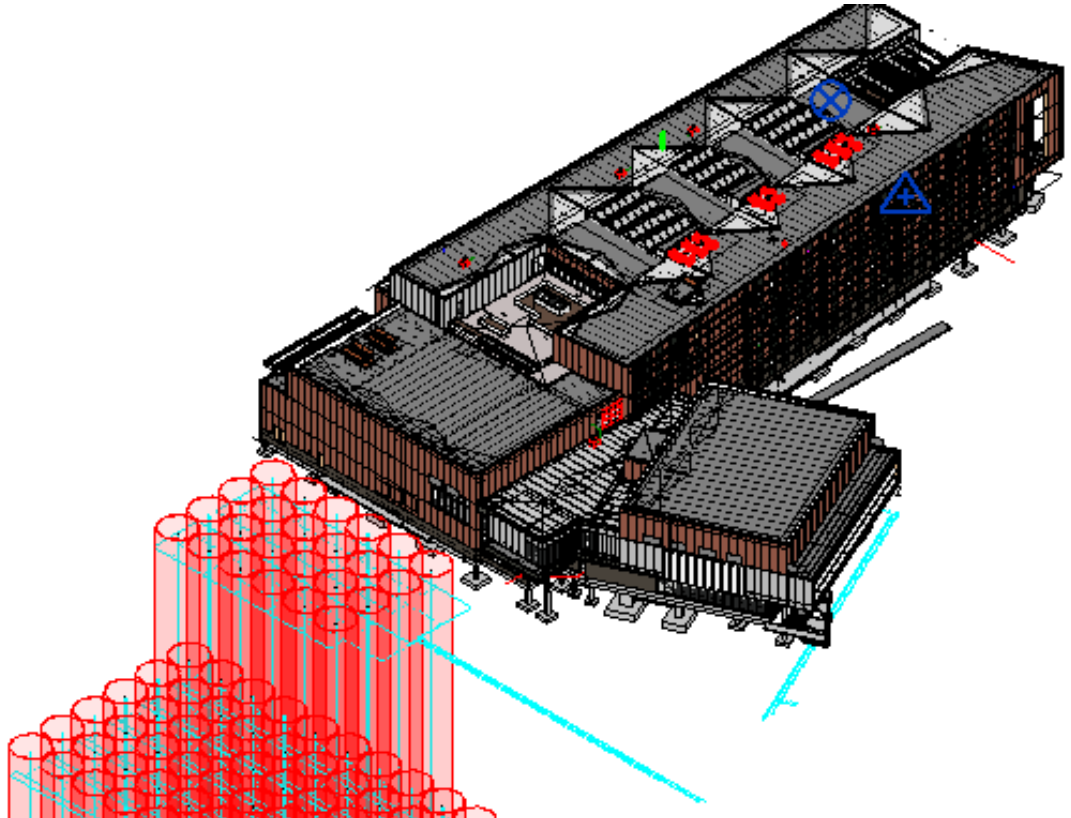


# RENEWABLE ENERGY

## GEOTHERMAL AND PV

- Drastic Energy Reduction
- LCCA
- BEPS / Carbon Reduction
- Renewables



# TOTAL ENERGY CONSUMPTION

**Team Collaboration**

High Performance Envelope

+

Passive Solar Design

+

Improved Lighting Design

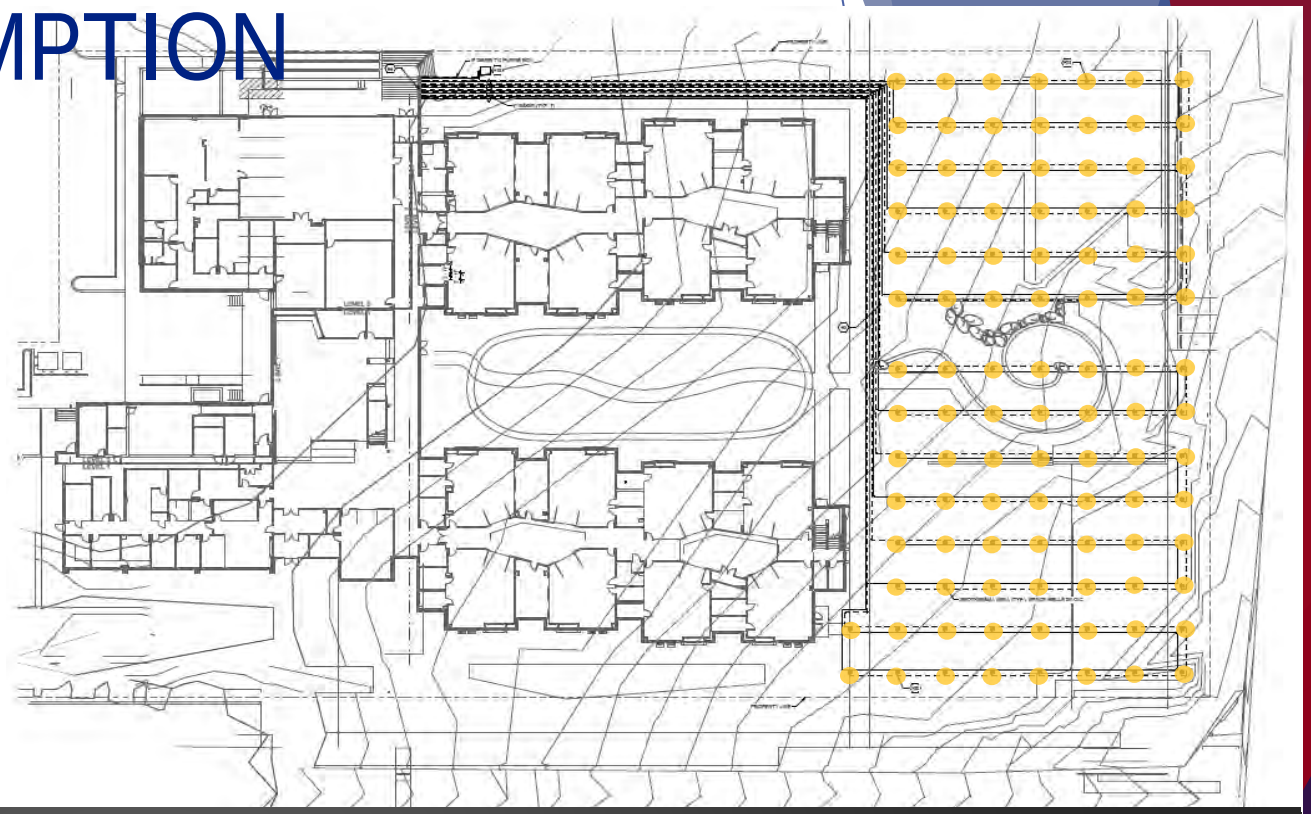
+

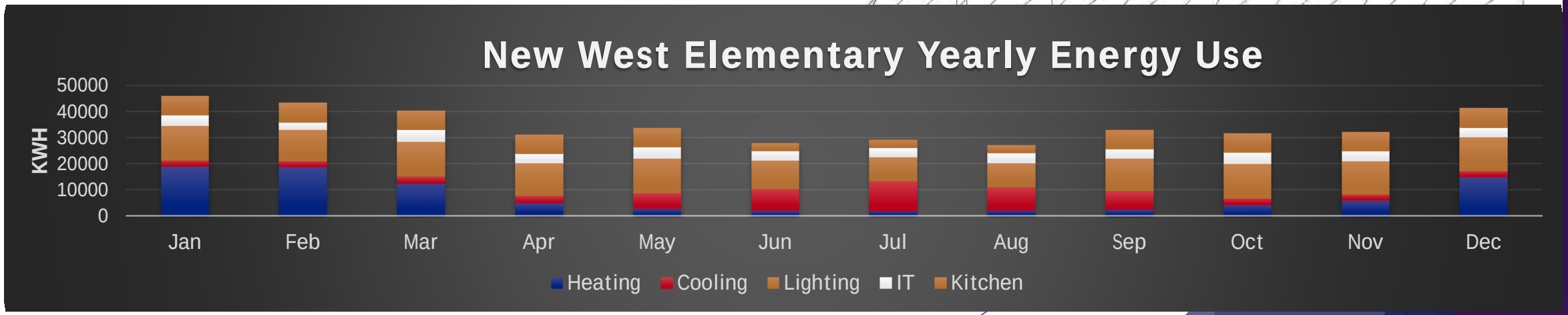
High Performance Kitchen

=

Reduced HVAC Tonnage and Consumption

75% Reduction from past projects





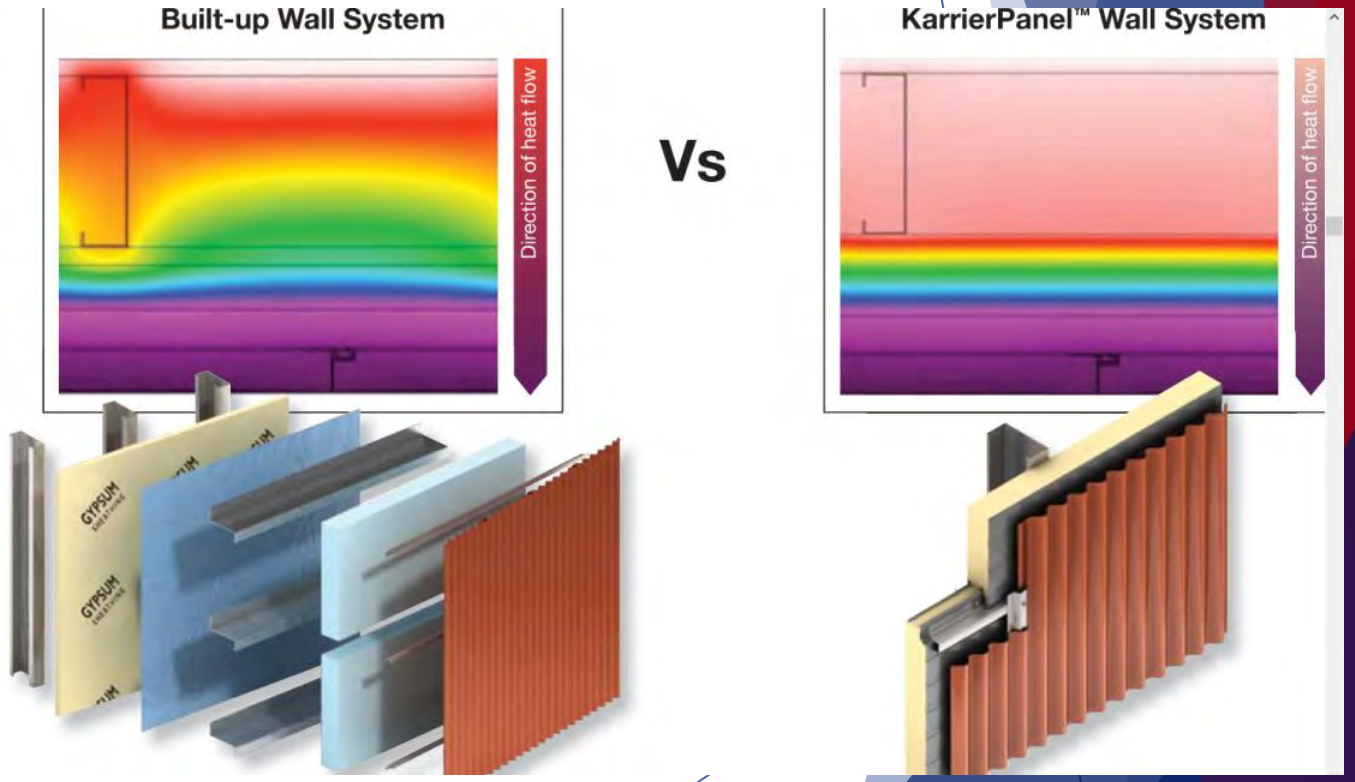

# NZE CONSTRUCTION

# ENVELOPE DESIGN CONSIDERATION

**WALLS WITH BENCHMARK KARRIER INSULATION PANELS**

**4" PANEL R-28.8**

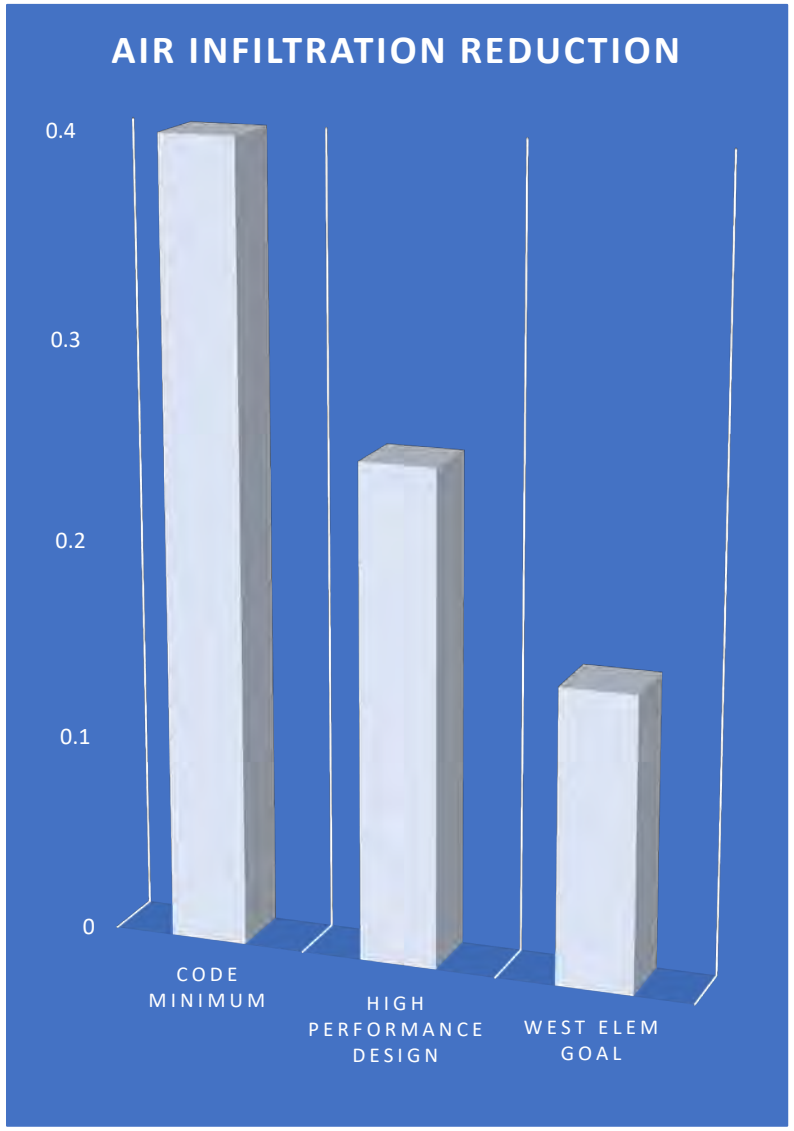
**AIR INFILTRATION 0.003 CFM/SQFT AT 6.24 PSF**




## KarrierPanel' s features:

1. Weather barrier, insulating core and interior vapor barrier all in one.
2. Polyisocyanurate foam core retains original insulating value over time
3. KarrierRail replaces the panel clip system and does not penetrate the air vapor barrier.
4. Lightweight,
5. Panel length up to 52' to minimize number of stack joints

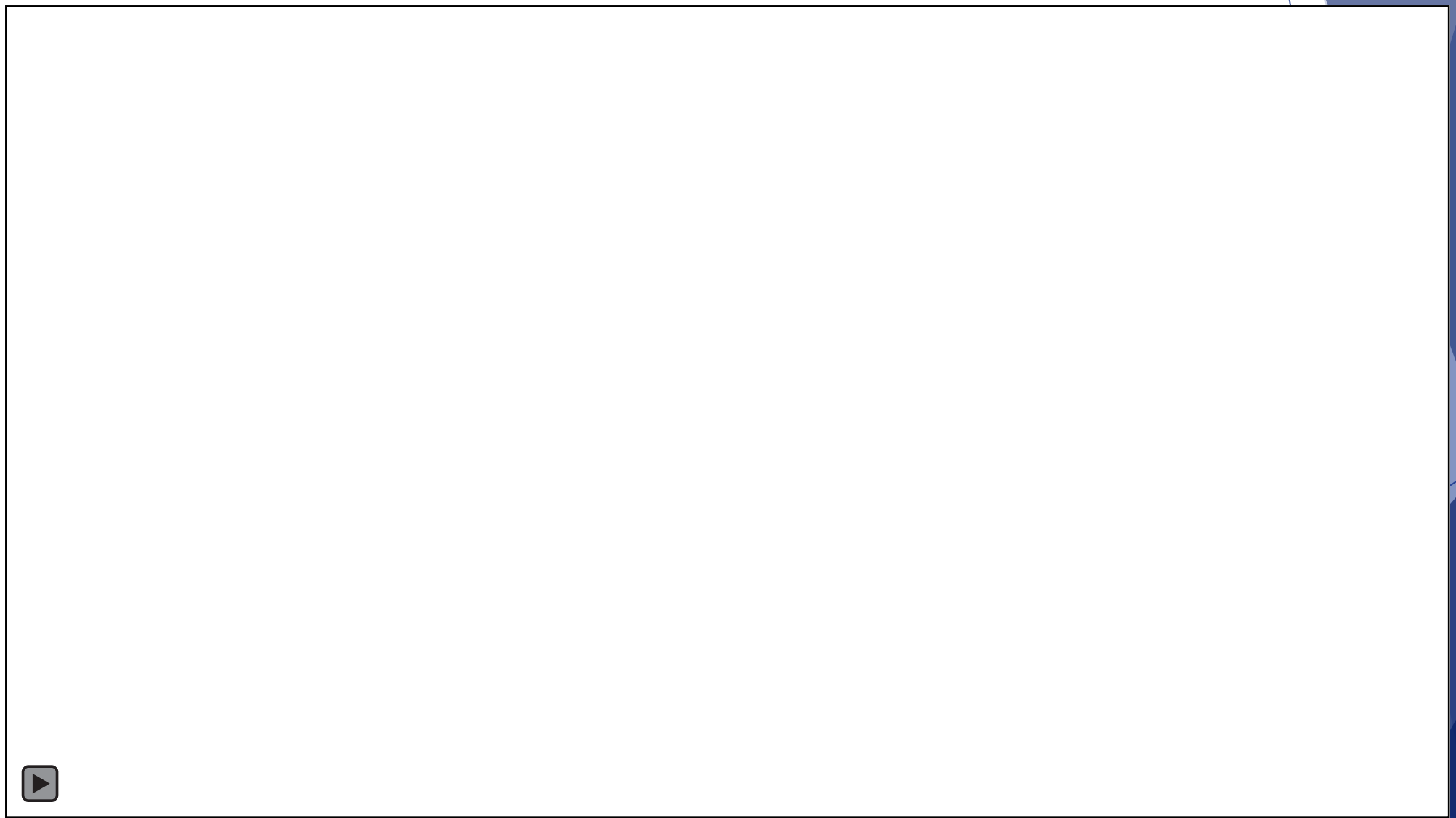
# WALL PERFORMANCE




## Air Infiltration Mitigation

- Building Pressurization Test
  - Reduction from Code Minimum to 0.15cfm/sf = 12% Energy Reduction

# WALL ASSEMBLY

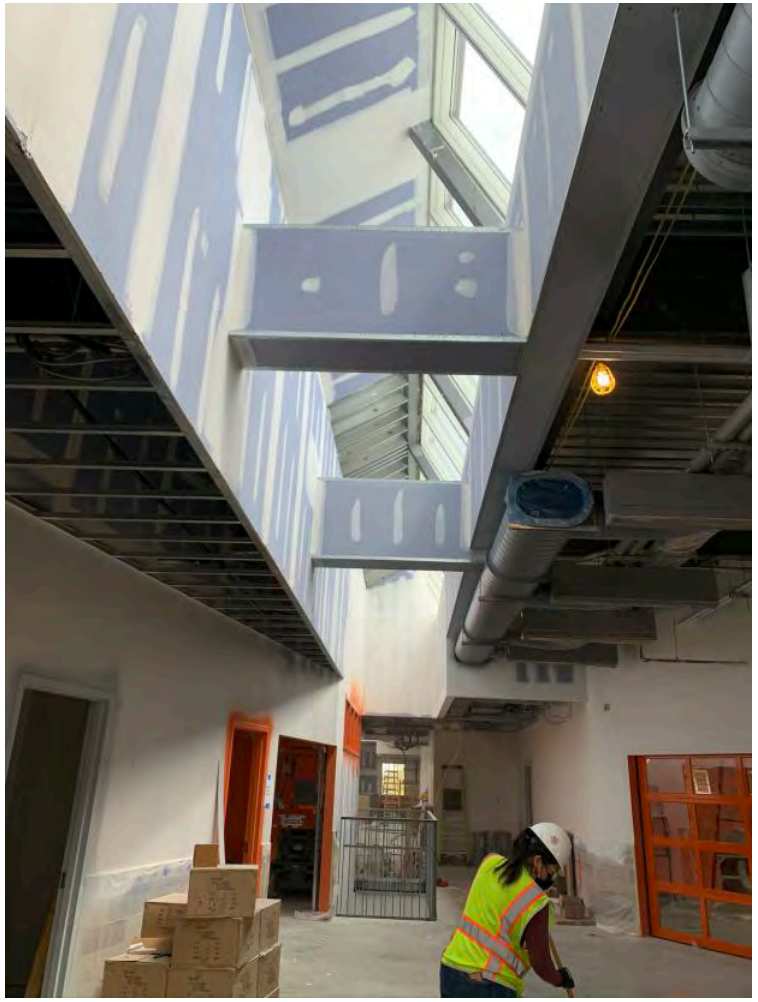


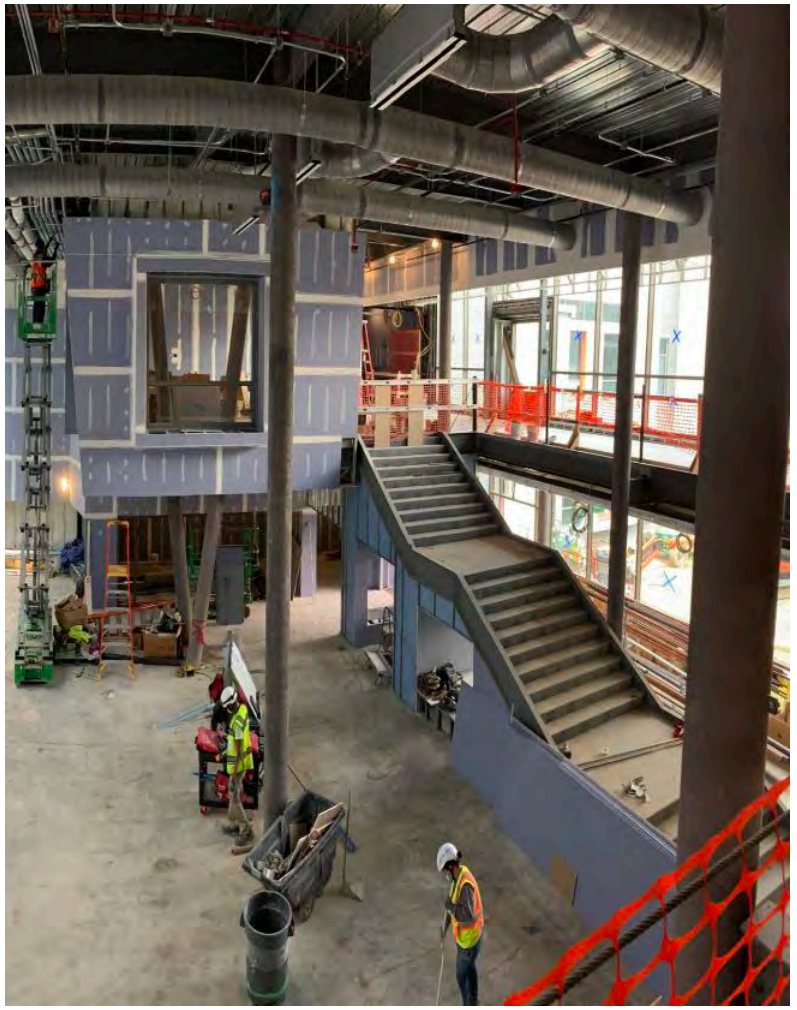
# CONSTRUCTION SCHEDULE UPDATE

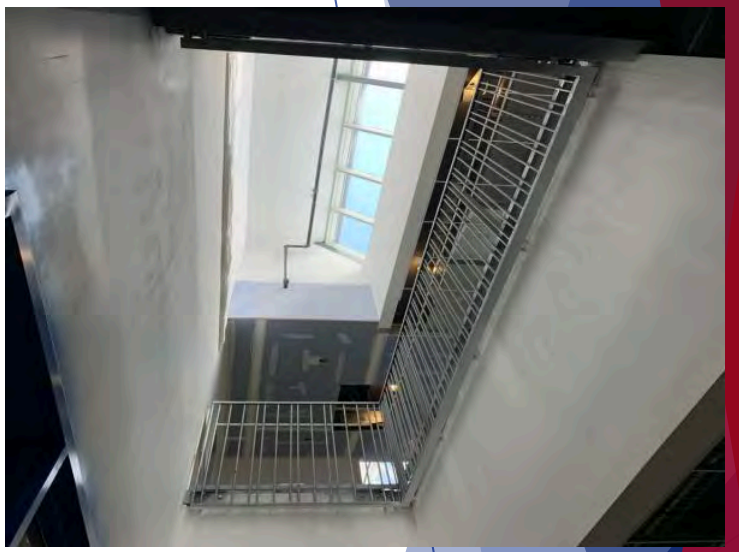
WEST ES:  SUBSTANTIAL COMPLETION~ 1 MONTH


# CONSTRUCTION SCHEDULE UPDATE

BANNEKER HS:  SUBSTANTIAL COMPLETION~ 1 MONTH

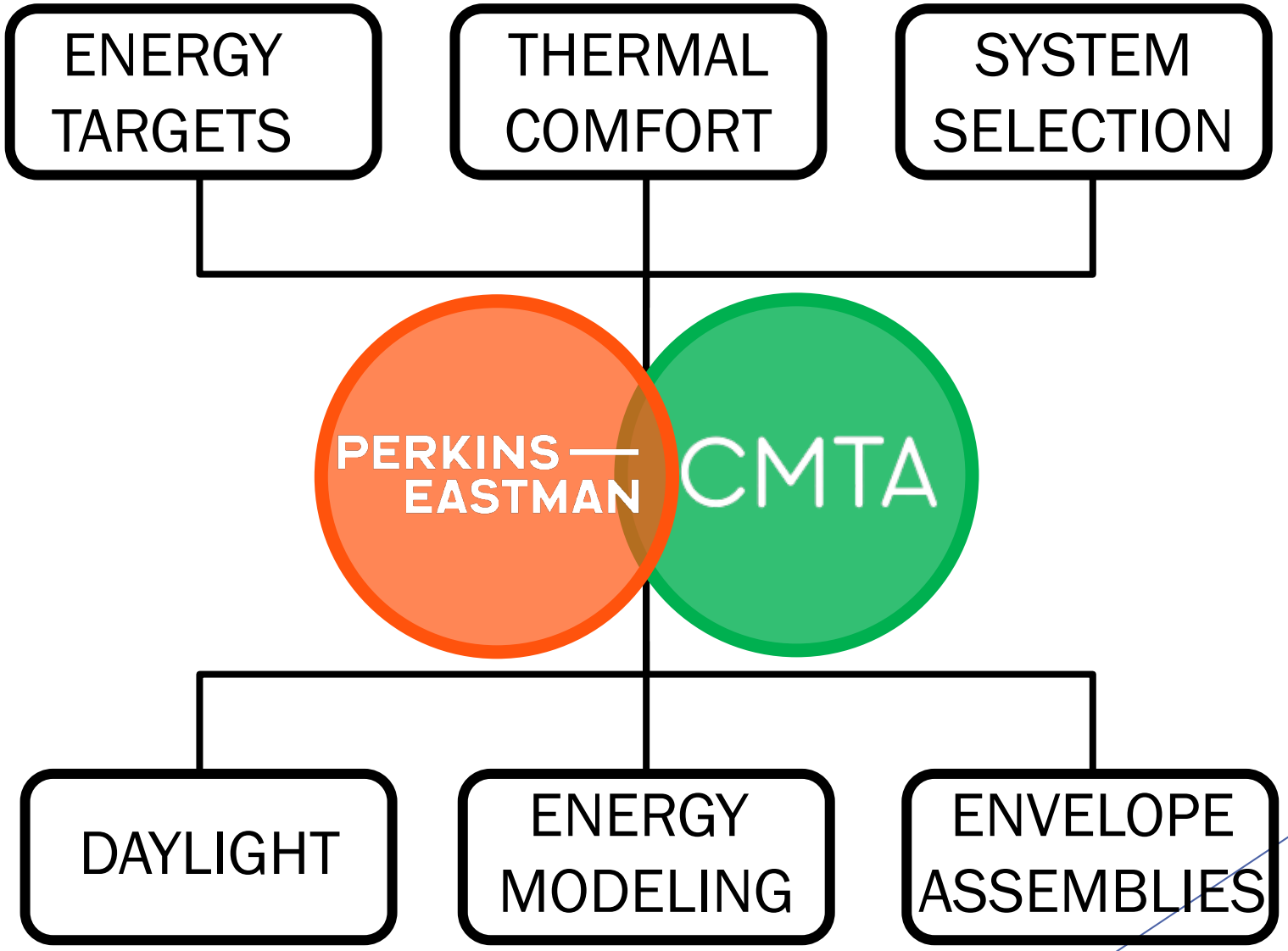




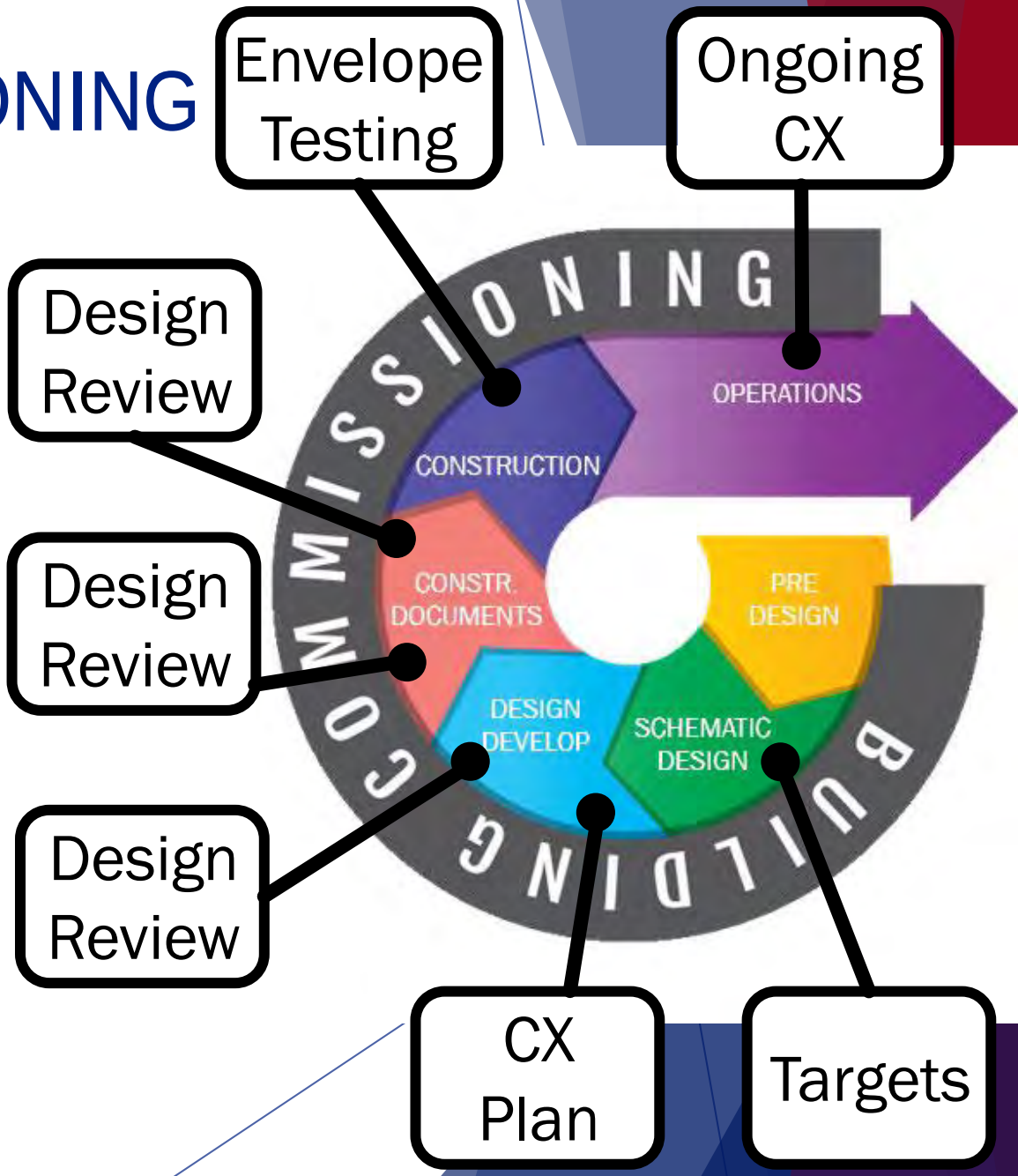



# LESSONS LEARNED

# JOINT EFFORT BETWEEN MEP+ARCHITECT

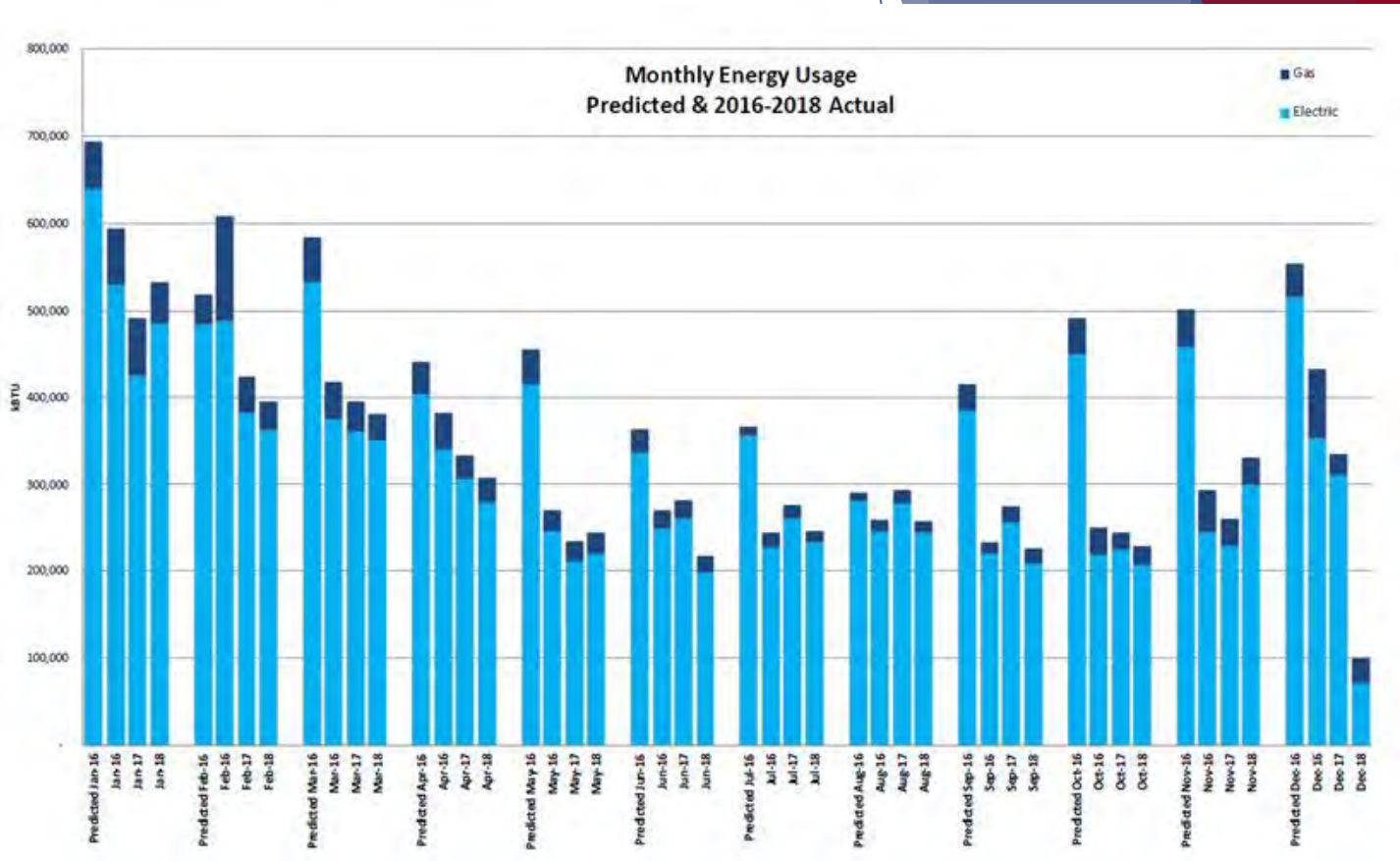


# CONSTRUCTION + COMMISSIONING

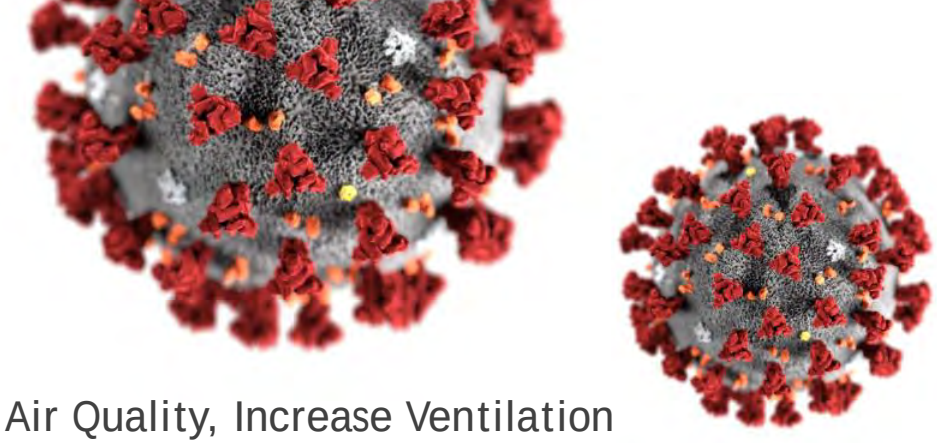


# POST-OCCUPANCY

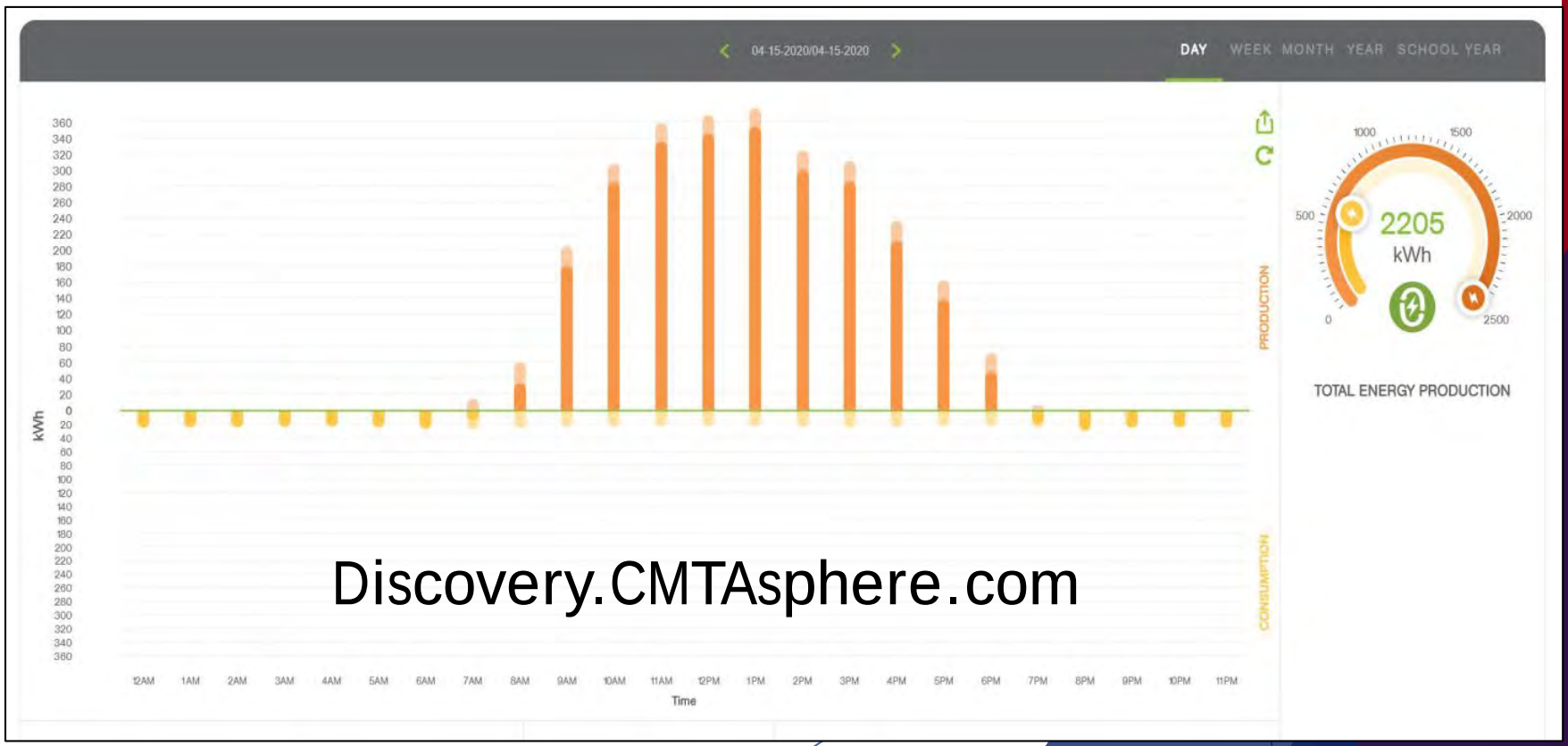
- On-going commissioning
- Post-Occupancy Evaluation




# TODAY'S NEW NORMAL



- Designing for Health and Wellness
  - WELL: Increased cleaning of High-touch surfaces, Improved Indoor Air Quality, Increase Ventilation 30%, Increased Daylight (UV light)
- Air Quality
  - 30%+ increase in OA
  - Increased Filtration
  - UV-C Lighting
  - Operable Windows
- High Performance Buildings
  - Improved flexibility / Unoccupied Shutdown
  - Days w/ 5x Production 2,779 kWH produced 594kWH consumed



# CURRICULUM INTEGRATION

# THE NEXT GENERATION