Passive House + Living Building: Combining Rigorous Building Standards for Maximum Benefit

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

Ashley McGraw Architects and Binghamton University are currently collaborating to design and construct a 2800 square foot research station. The project is located proximate to campus on a 70+ acre nature preserve called Nuthatch Hollow, and is being designed to become certified as a Living Building by the International Living Futures Institute. The project team includes two Passive House Certified Consultants, who chose to overlay the Passive House Standard with the Living Building Challenge as a methodology to achieve rigorous energy use reductions in a high performance building.

As a requirement of the Living Building Challenge, the Nuthatch Hollow project must achieve net positive energy, which means 105% of the project's energy needs must be supplied by on-site renewable energy on a net annual basis, without the use of on-site combustion. Meeting the ambitious Passive House limits on heating and cooling loads, as well as source energy, will allow the Nuthatch project to easily meet the Living Building net positive energy requirements. This approach is more difficult than typical design strategies, but much more valuable in terms of investment and resilience. A PHIUS feasibility study has been initiated and will inform the ongoing design process.

Combining Passive House and Living Building presents some interesting challenges. The strict thermal requirements of Passive House and the material use limitations presented by the LBC "Red List", makes the selection of common building components, like windows, energy recovery ventilators, and insulation materials, into a very rigorous investigative process. The composting toilets used to achieve the water use limitations of LBC must be designed to ventilate through the building envelope in accordance with Passive House thermal and air tightness requirements. On-site energy storage required for LBC must be located strategically in order to eliminate any negative thermal impacts within the Passive House envelope. Reuse of the existing building foundation to meet site disturbance limitations within LBC requires specific attention to envelope details to achieve Passive House.

We are learning many valuable strategies through this challenging process. Collaboration is crucial to understand the building use and schedule in order to reduce loads as much as possible. Binghamton University faculty and students are engaged through integrated course curriculum in the vast amount of materials research required. In the face of all of the challenges, we will keep pushing the limits of what can be accomplished, to reach our climate goals for the future of people and planet.

Learning Objectives

At the end of the this course, participants will be able to:

1. Learn how the Passive House standard can facilitate the path to the Living Building Challenge Energy Petal.
2. Understand the compound challenges of meeting two very rigorous building programs: Passive House and Living Building Challenge, and some strategies for overcoming those challenges.
3. Understand documentation and research strategies to overcome the challenges of public bidding an ultra-high performance building.

AGENDA

- Place
- Project
- Living Building Challenge
- Design
- Combining Standards
- Challenges and Strategies

Nuthatch Hollow

Nuthatch Hollow

Nuthatch Hollow

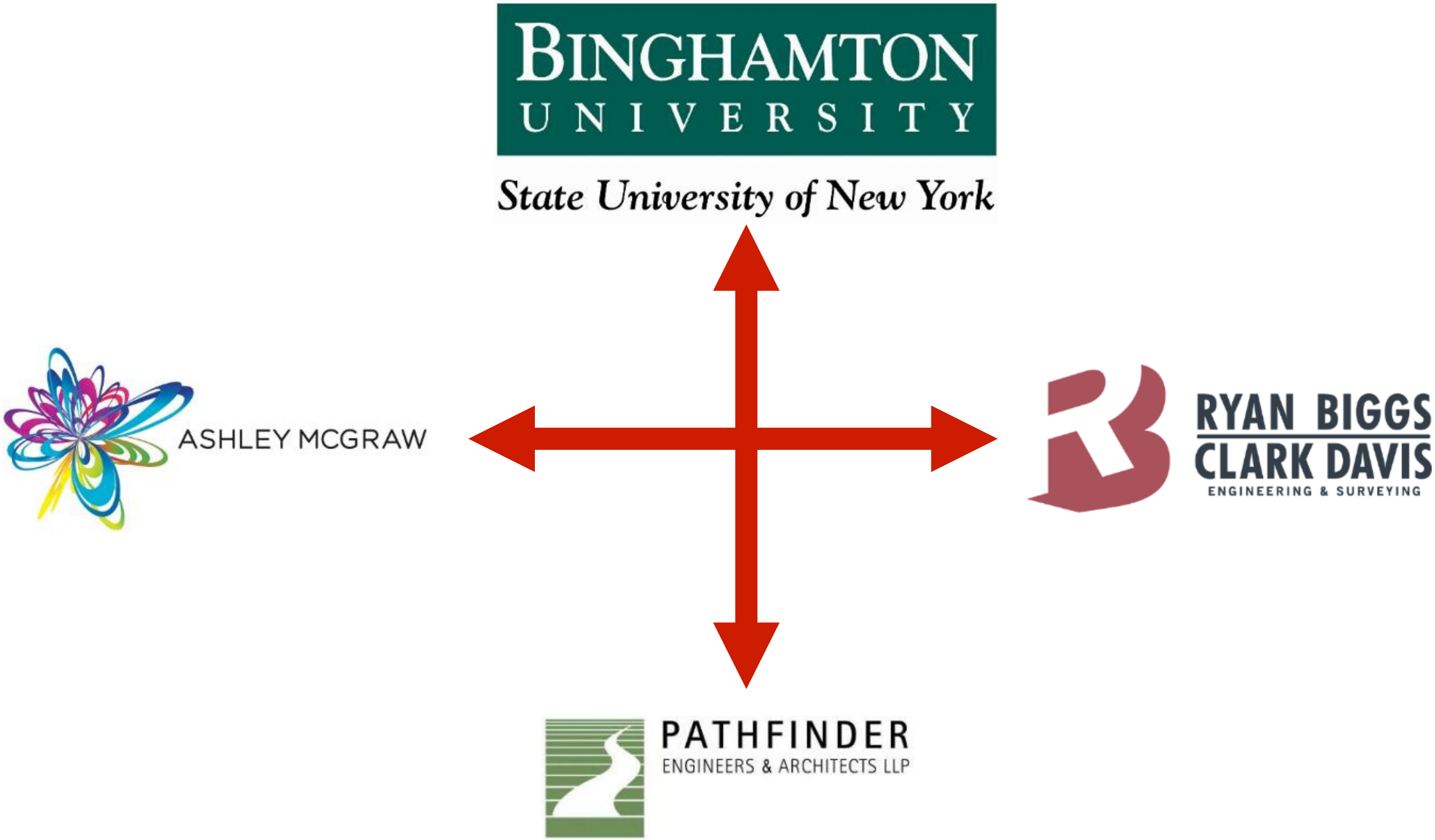
Nuthatch Hollow

Essence of Nuthatch Hollow

Discovery
Diversity
Variety
Layered
Movement
Rhythm
Balance
Resilient
Ancient
Complex
Rejuvenating
Happiness
Oasis

Sanctuary
Water
Nutrients
Changing
Evolving
Energy
Understanding
Intertwined
Sensory (all 5)
Random
Connection
Separation
Mystery

The Living Building at Nuthatch Hollow




WHO ARE YOU ?


The Living Building at Nuthatch Hollow
LAB


The Living Building at Nuthatch Hollow
MULTI-
PURPOSE
LAB

The Living Building at Nuthatch Hollow

GOALS

GOALS

- Place for environmental research

GOALS

- Place for environmental research
- Hub for interdisciplinary collaboration


GOALS
• Place for environmental research
• Hub for interdisciplinary collaboration
• Engage a wider audience

GOALS

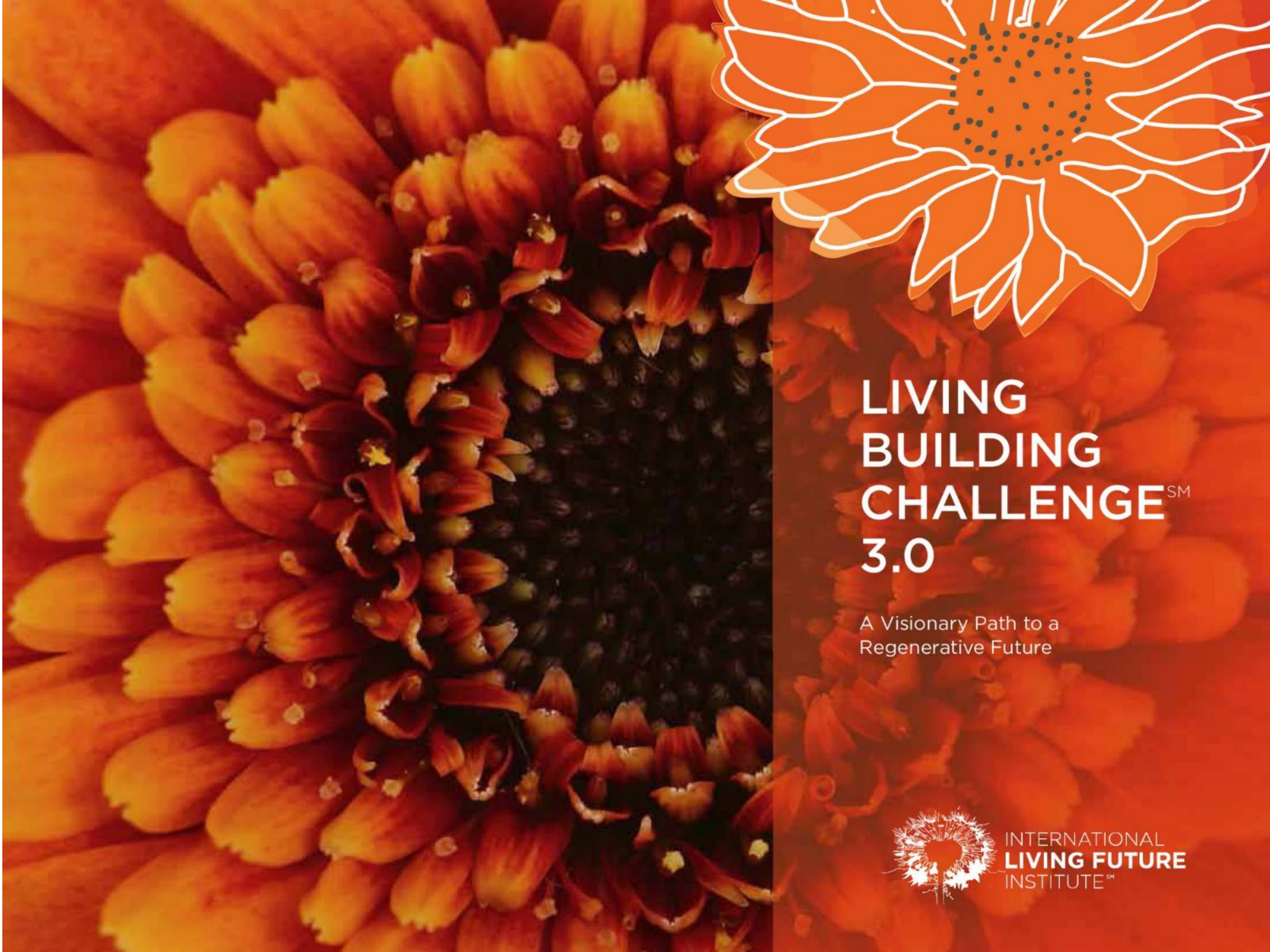
- Place for environmental research
- Hub for interdisciplinary collaboration
- Engage a wider audience
- Smart energy technology

GOALS

- Place for environmental research
- Hub for interdisciplinary collaboration
- Engage a wider audience
- Smart energy technology
- Replicable

GOALS

- Place for environmental research
- Hub for interdisciplinary collaboration
- Engage a wider audience
- Smart energy technology
- Replicable
- Living Building Certification



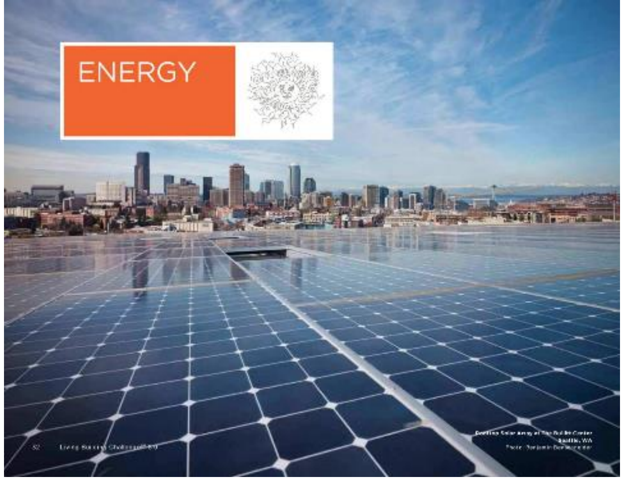
LIVING BUILDING CHALLENGE℠ 3.0

A Visionary Path to a Regenerative Future

INTERNATIONAL
LIVING FUTURE
INSTITUTE℠


PLACE

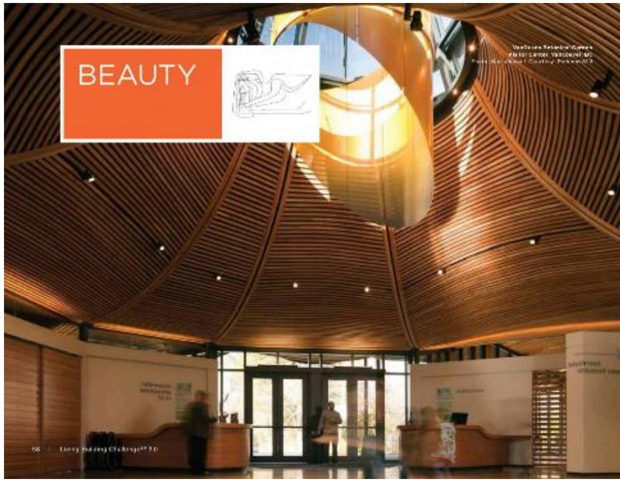

WATER


ENERGY


HEALTH &
HAPPINESS


MATERIALS


EQUITY


BEAUTY

PLACE

WATER

ENERGY

Rooftop Solar Array at The Bullitt Center
Seattle, WA
Photo: Benjamin Benschneider

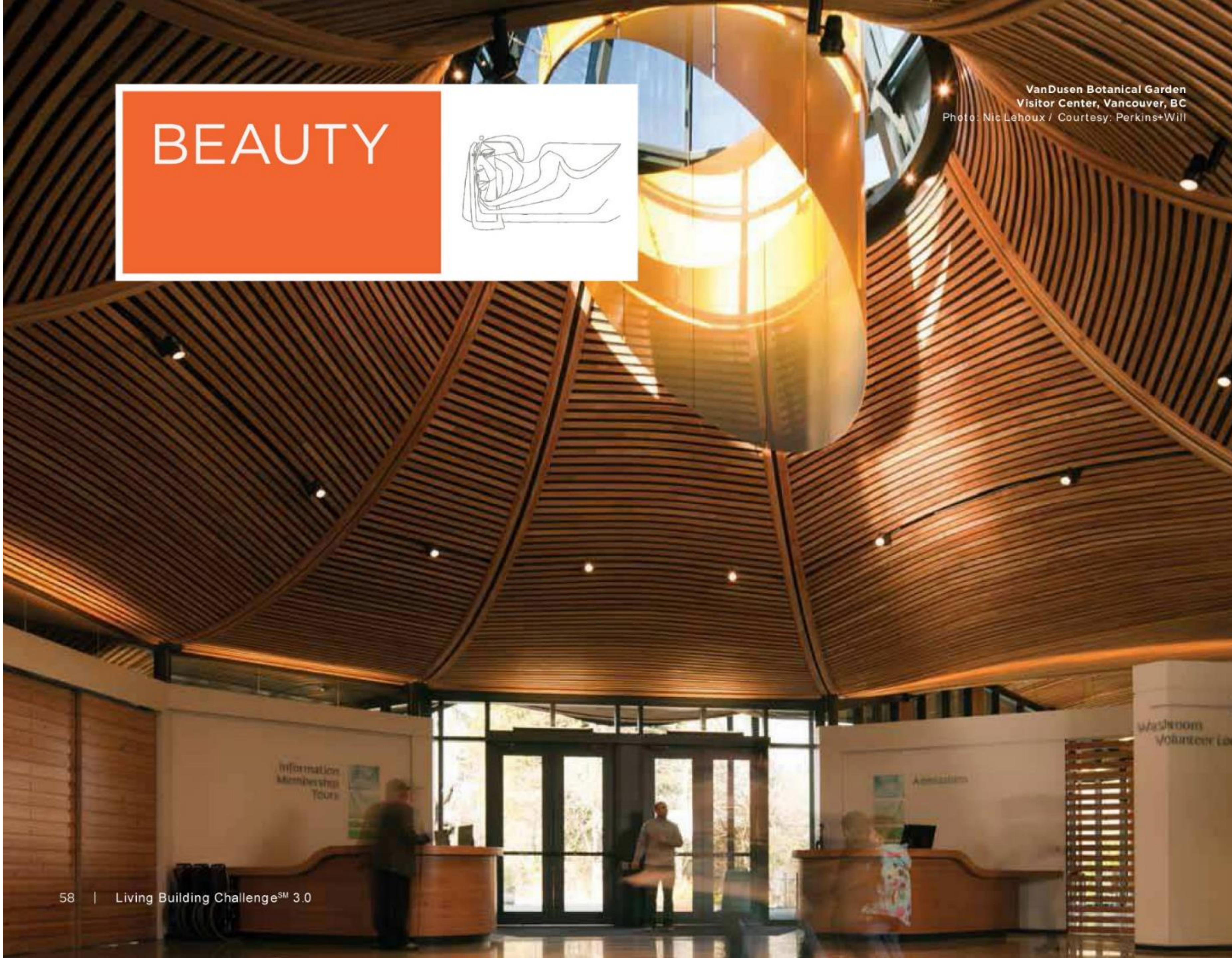
HEALTH & HAPPINESS

MATERIALS

UniverCity Childcare Centre
Burnaby, BC
Courtesy: space2place

EQUITY

The Bullitt Center, Seattle, WA
Photo: Benjamin Benschneider



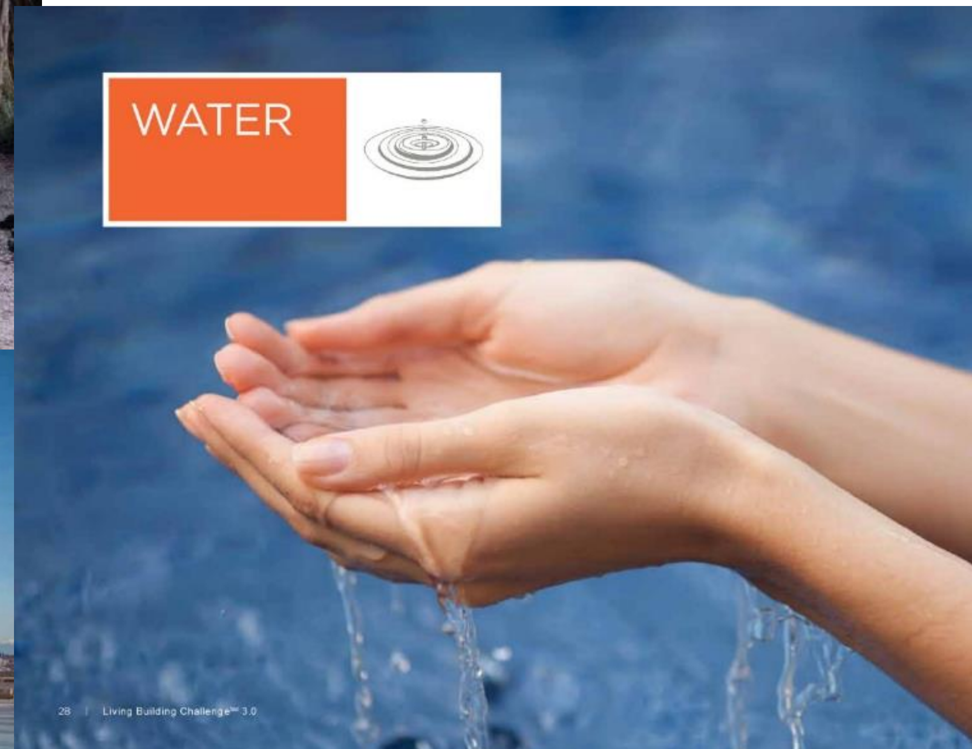
BEAUTY

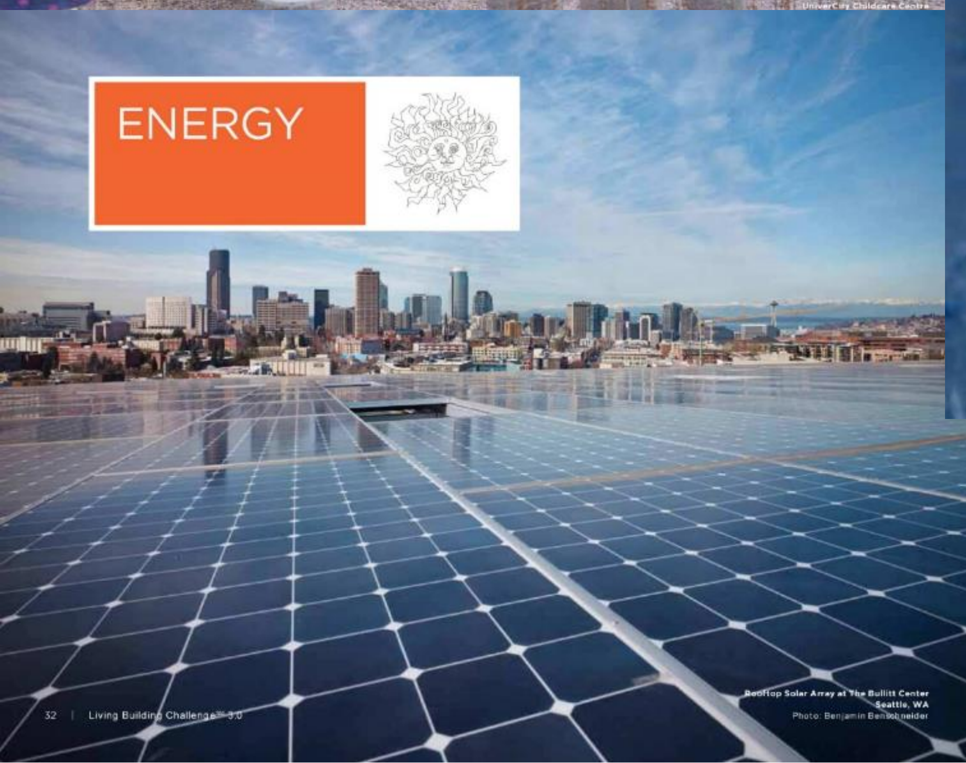
VanDusen Botanical Garden Visitor Center, Vancouver, BC
Photo: Nic Lehoux / Courtesy: Perkins+Will

Nuthatch Hallow

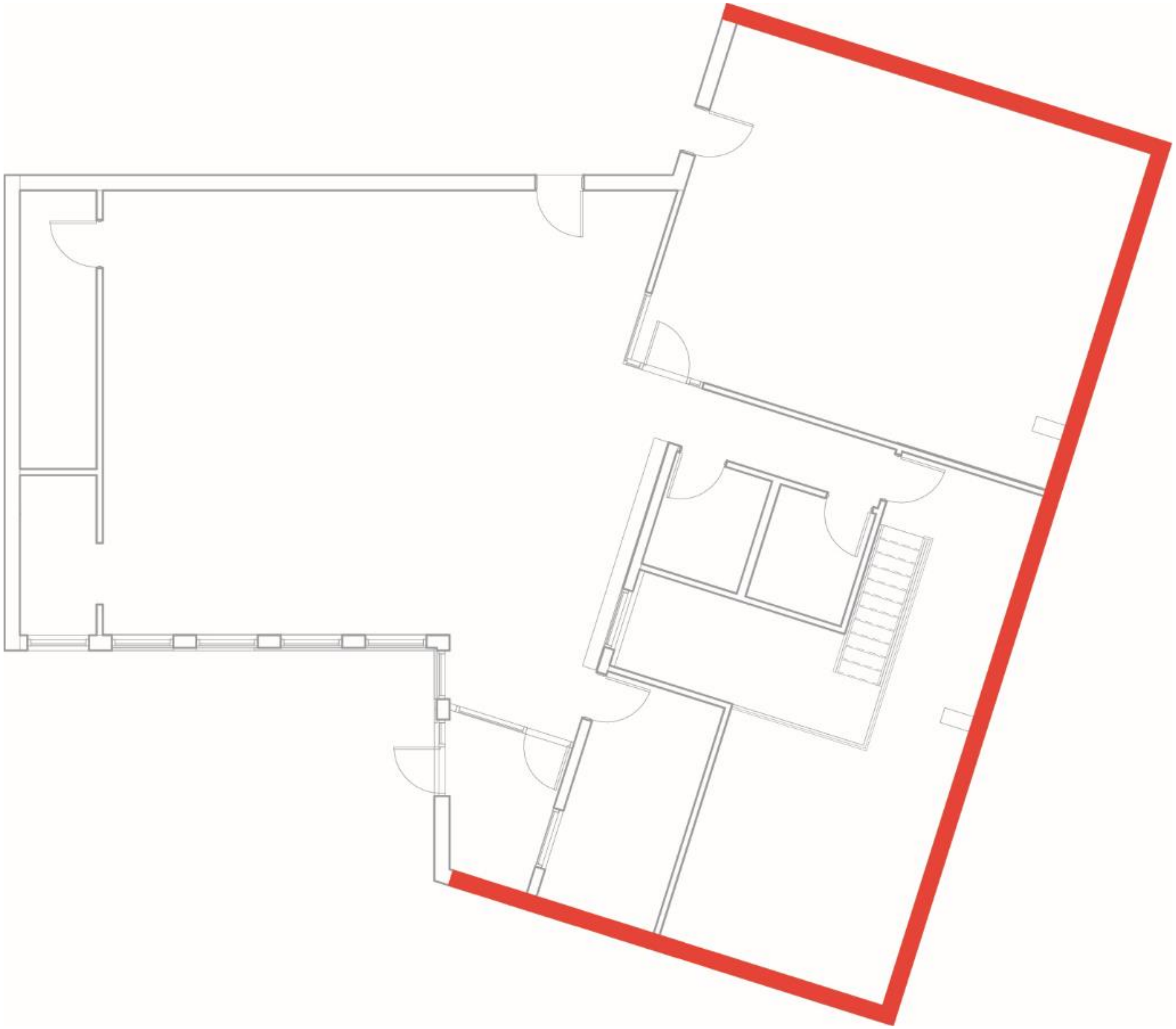
July 17, 2017


MATERIALS
UniverCity Childcare Centre

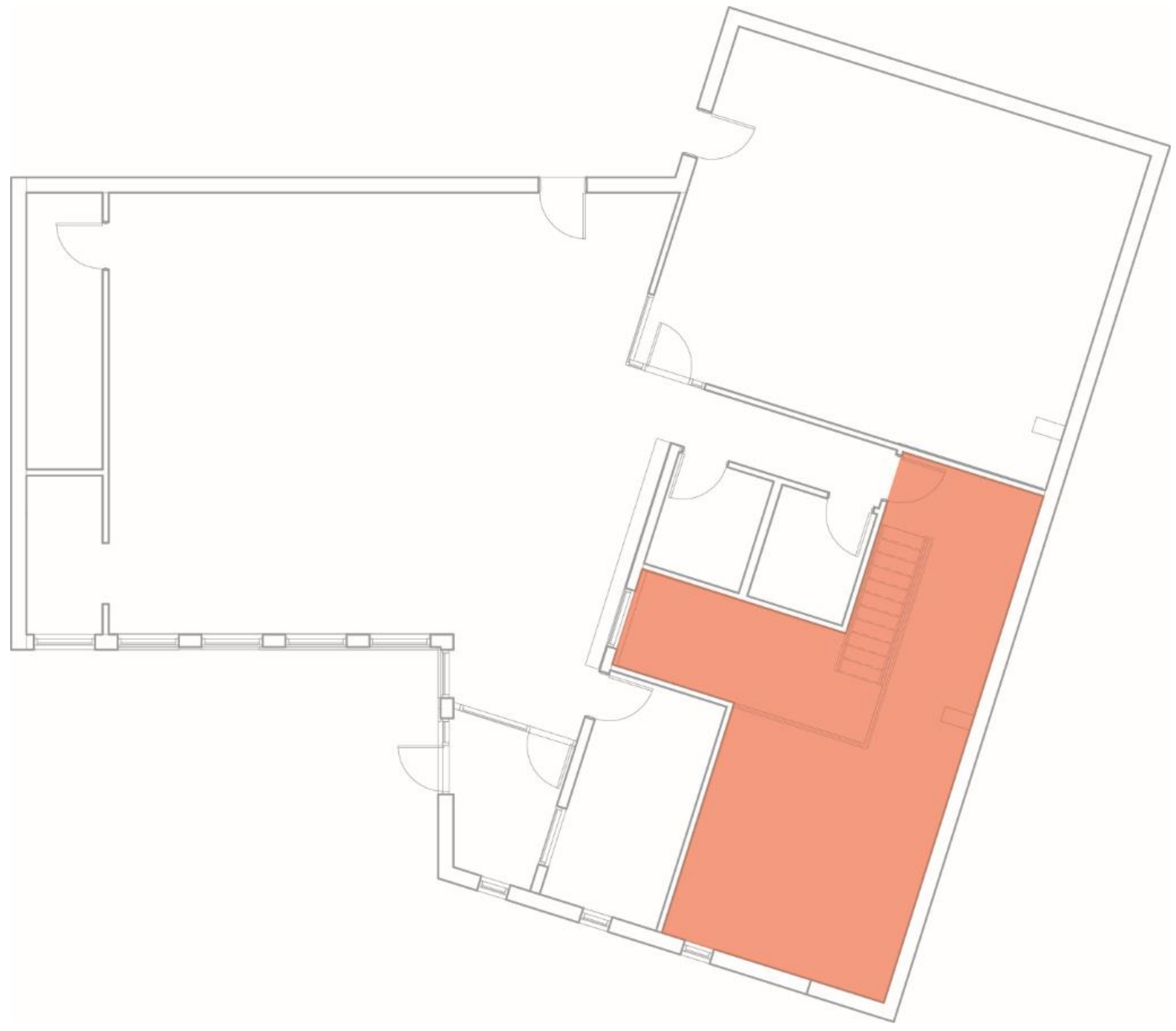

WATER
28 | Living Building Challenge℠ 3.0


ENERGY
Rooftop Solar Array at The Bullitt Center
Seattle, WA
Photo: Benjamin Benschneider
32 | Living Building Challenge℠ 3.0

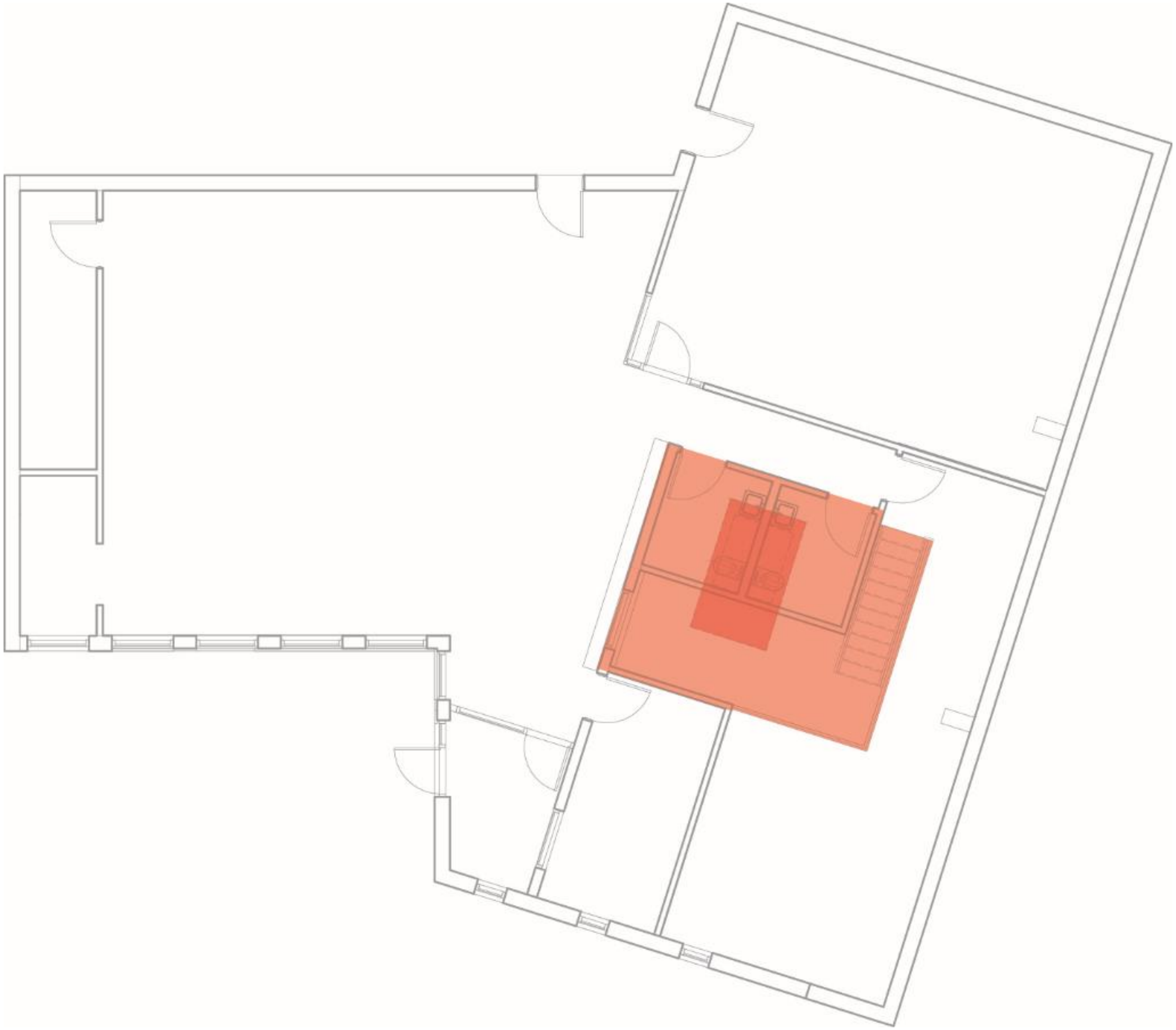
REVEAL



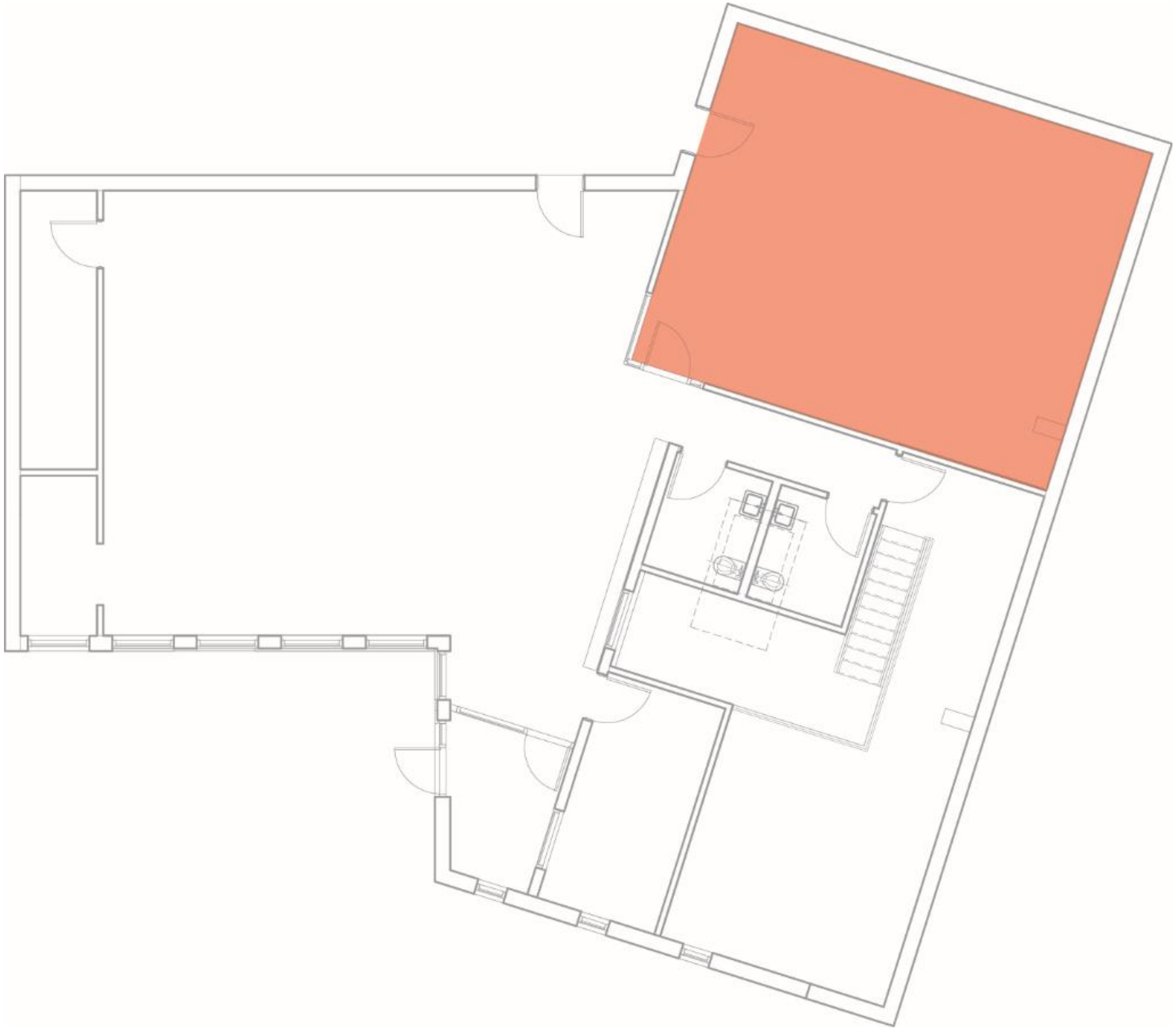
Foundation Walls



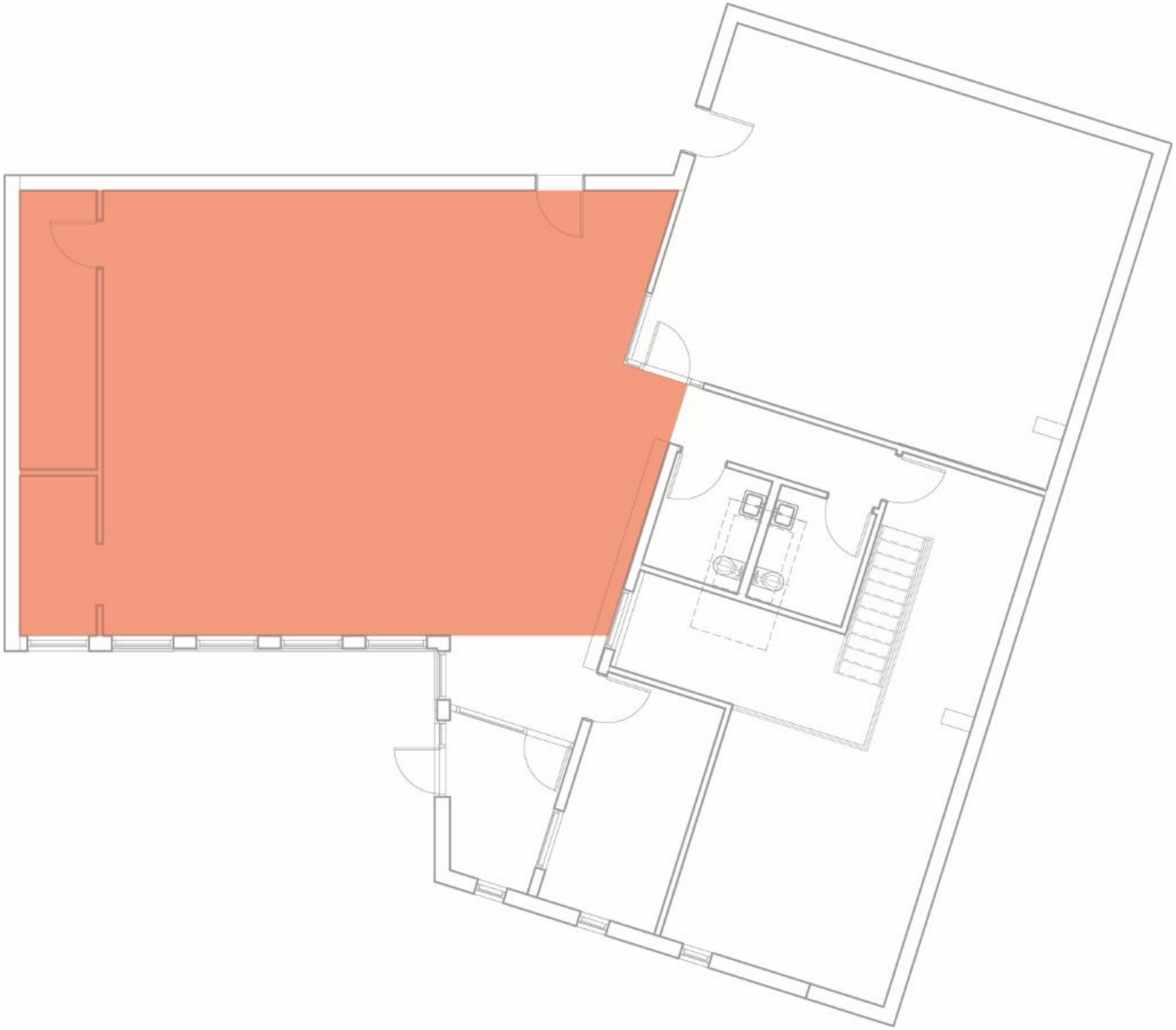
Mechanical Room



Composter

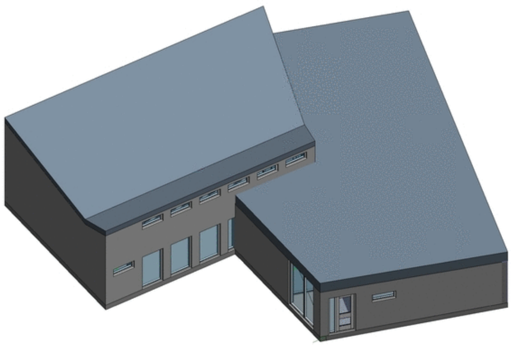


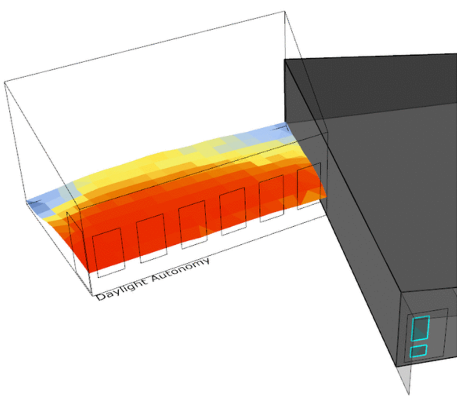
Lab



Multipurpose Room

1 PLACEMENT

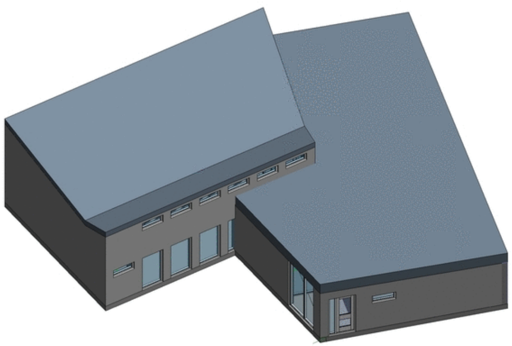


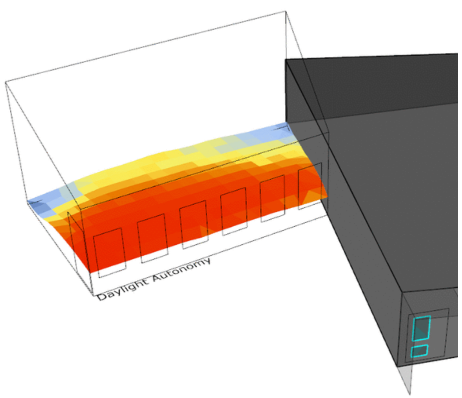


sDA: 74.86 | Adaptive comfort: 20.46%

Too hot: 30.45% | Too cold: 49.1%

1 PLACEMENT





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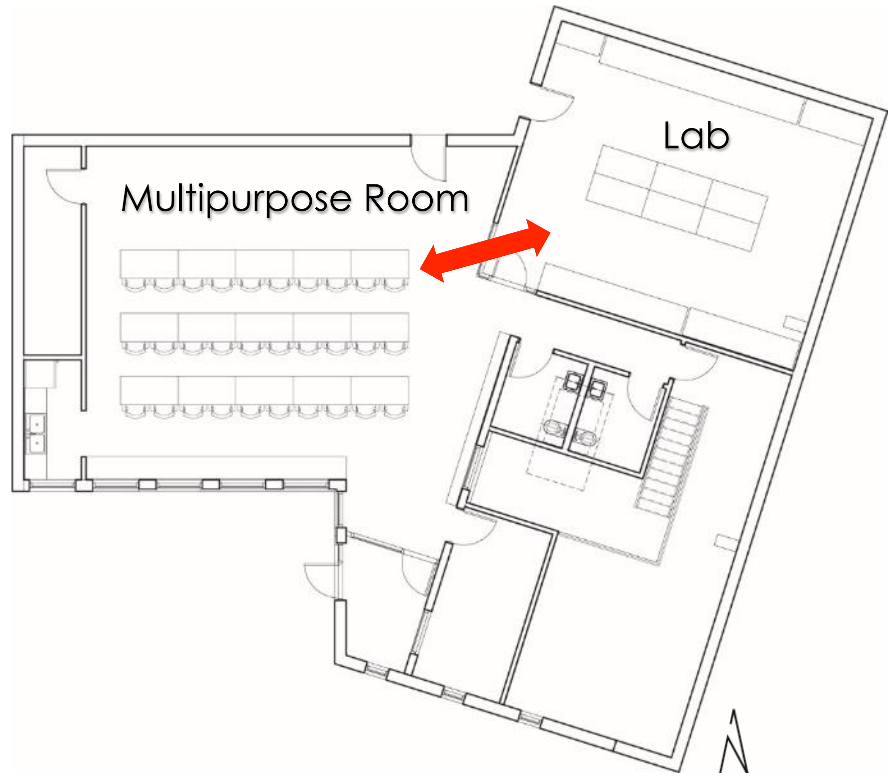
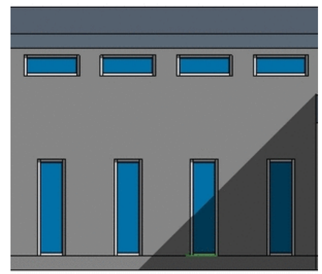
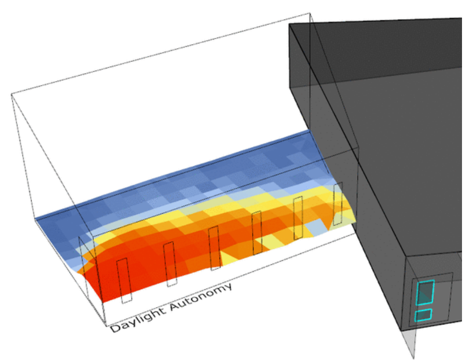


1 PLACEMENT

2 GLAZING-WALL RATIO



sDA: 75.96 | Adaptive comfort



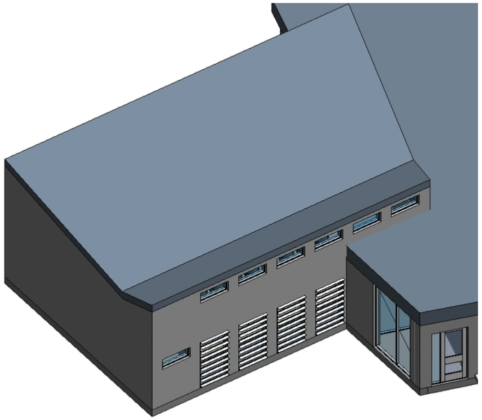
sDA: 37.16 | Adaptive comfort: 21.18%

Too hot: 25.59% | Too cold: 53.23%

1 PLACEMENT

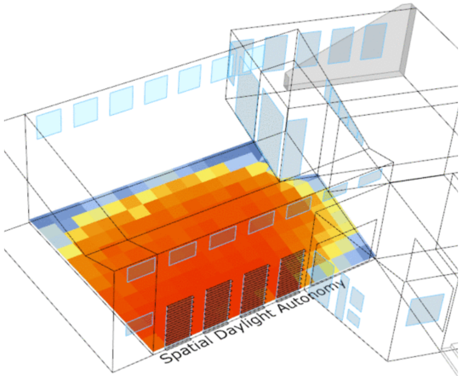
2 GLAZING-WALL RATIO

3 SHADING DEVICE

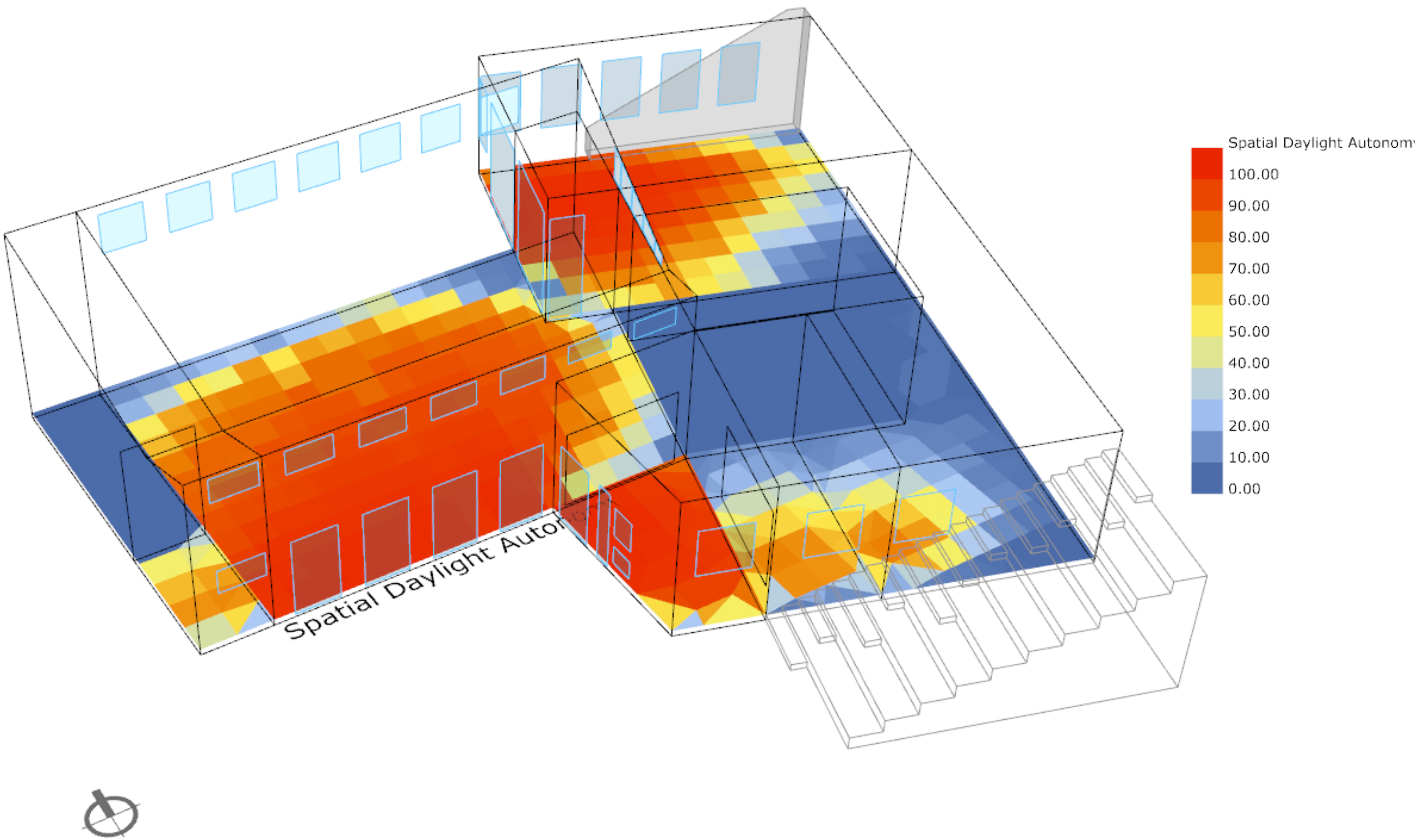


sDA: 75.96 | Adaptive comfort

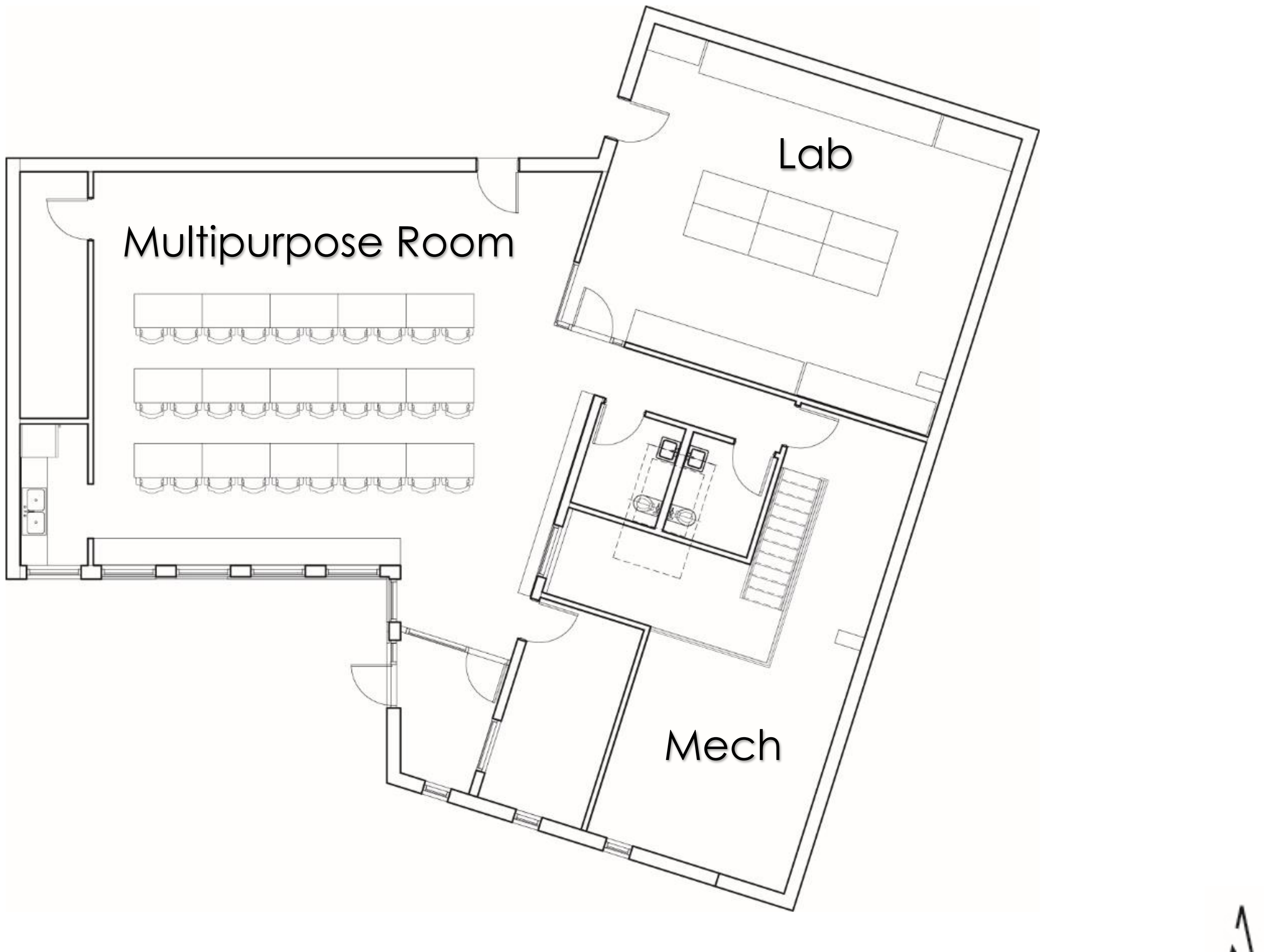
sDA: 75.96 | Adaptive comfort: 20.4%



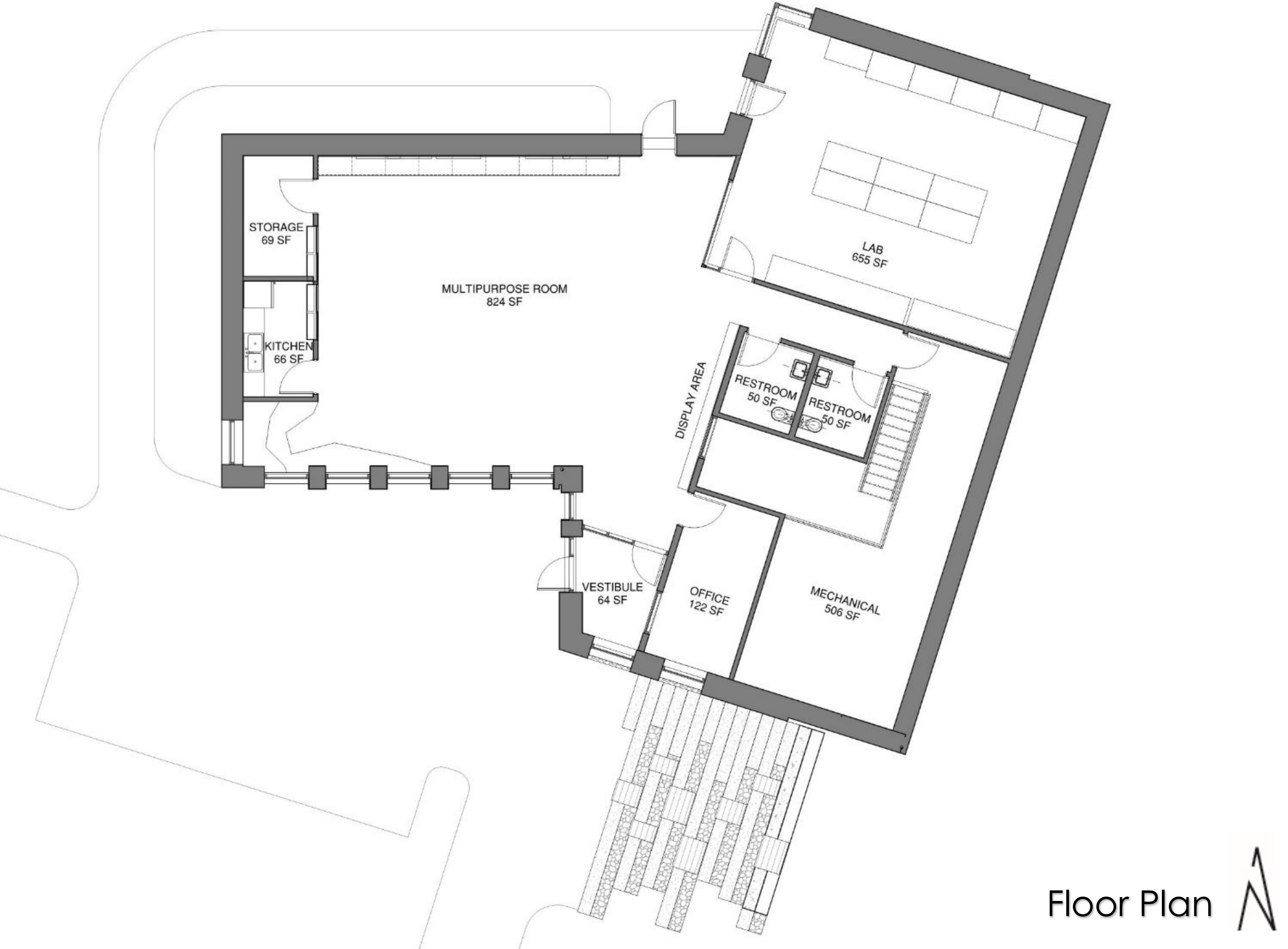
sDA: 75.24%



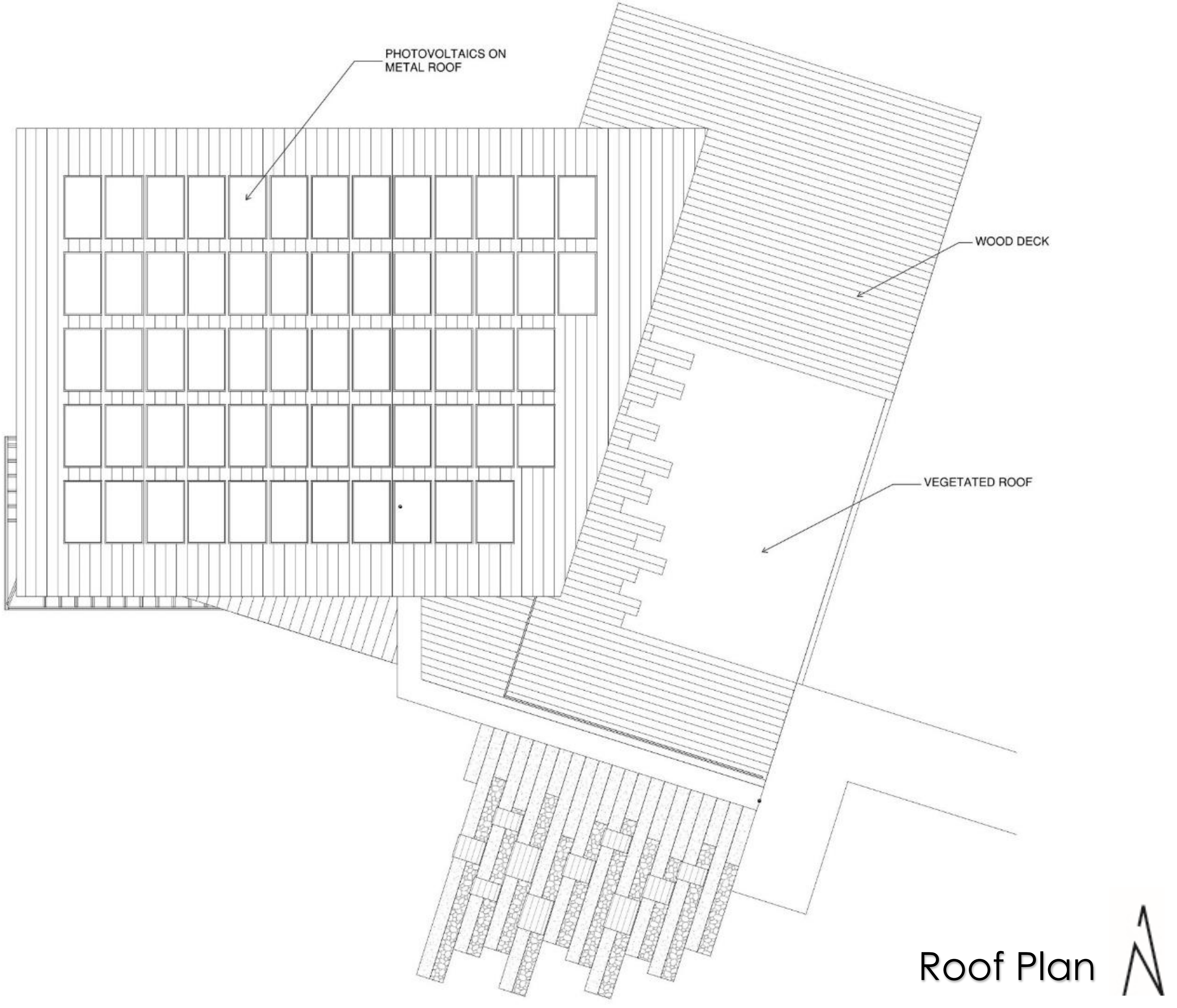
Spatial Daylight Autonomy
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00



Schematic Floor Plan


STORAGE
69 SF
MULTIPURPOSE ROOM
824 SF
KITCHEN
66 SF
LAB
655 SF
DISPLAY AREA
RESTROOM
50 SF
RESTROOM
50 SF
VESTIBULE
64 SF
OFFICE
122 SF
MECHANICAL
506 SF

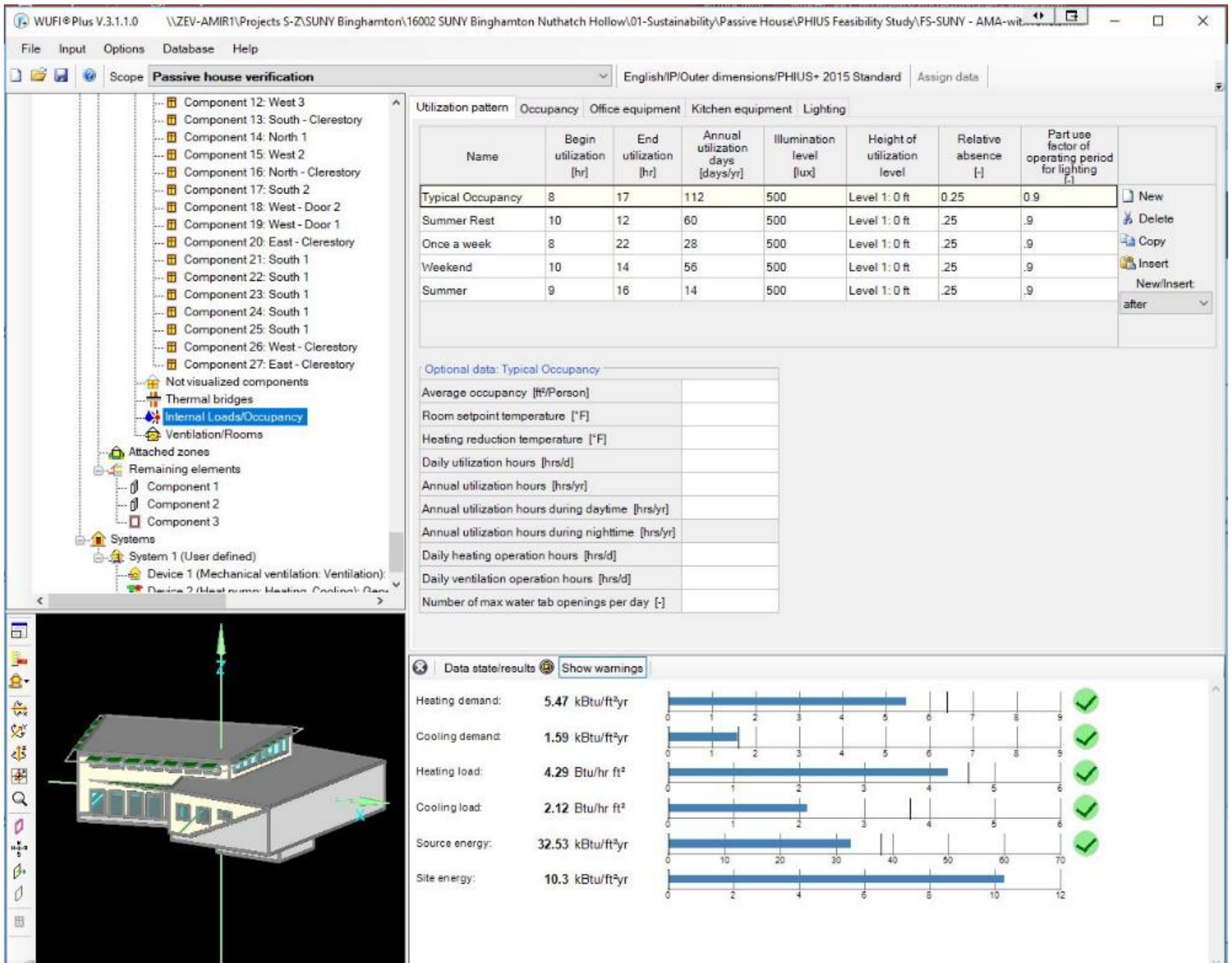
Floor Plan

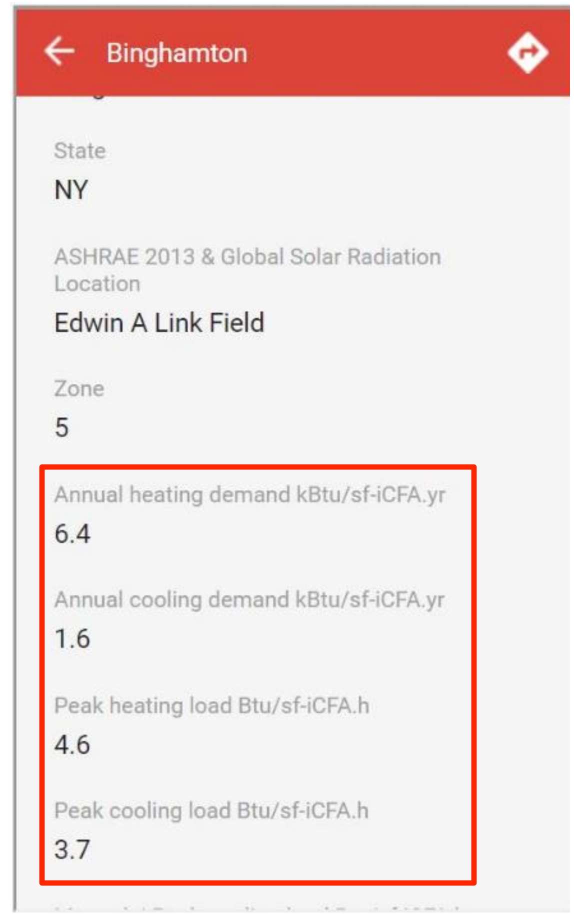


Roof Plan

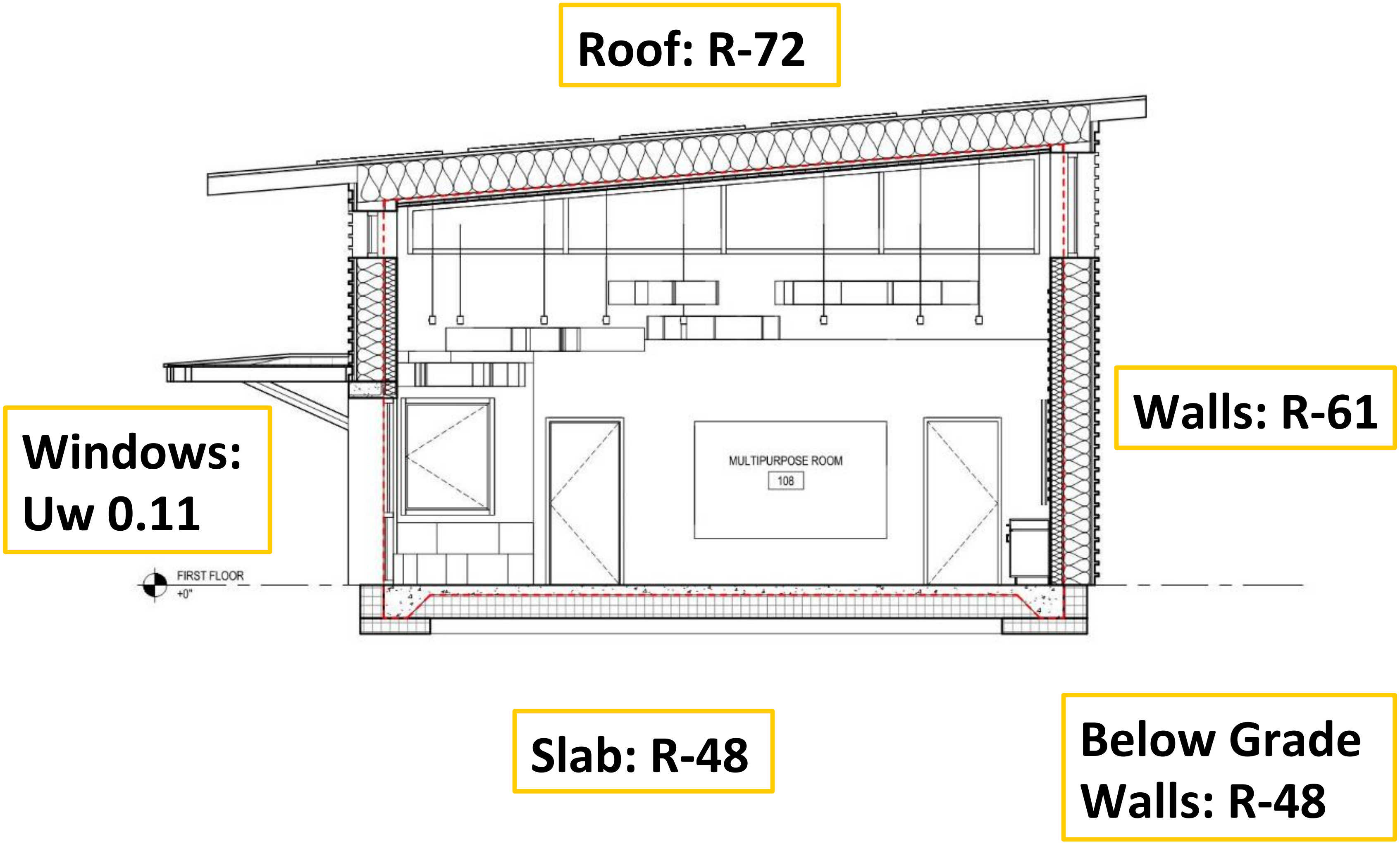
Current Status

Source Energy:
38 KBTU/sf*yr or 11.1kWh/sf
Site Energy:
12.025 KBTU/sf*yr or
3.513kWh/sf*yr
@2909 sf =
10,218.32kWh/yr

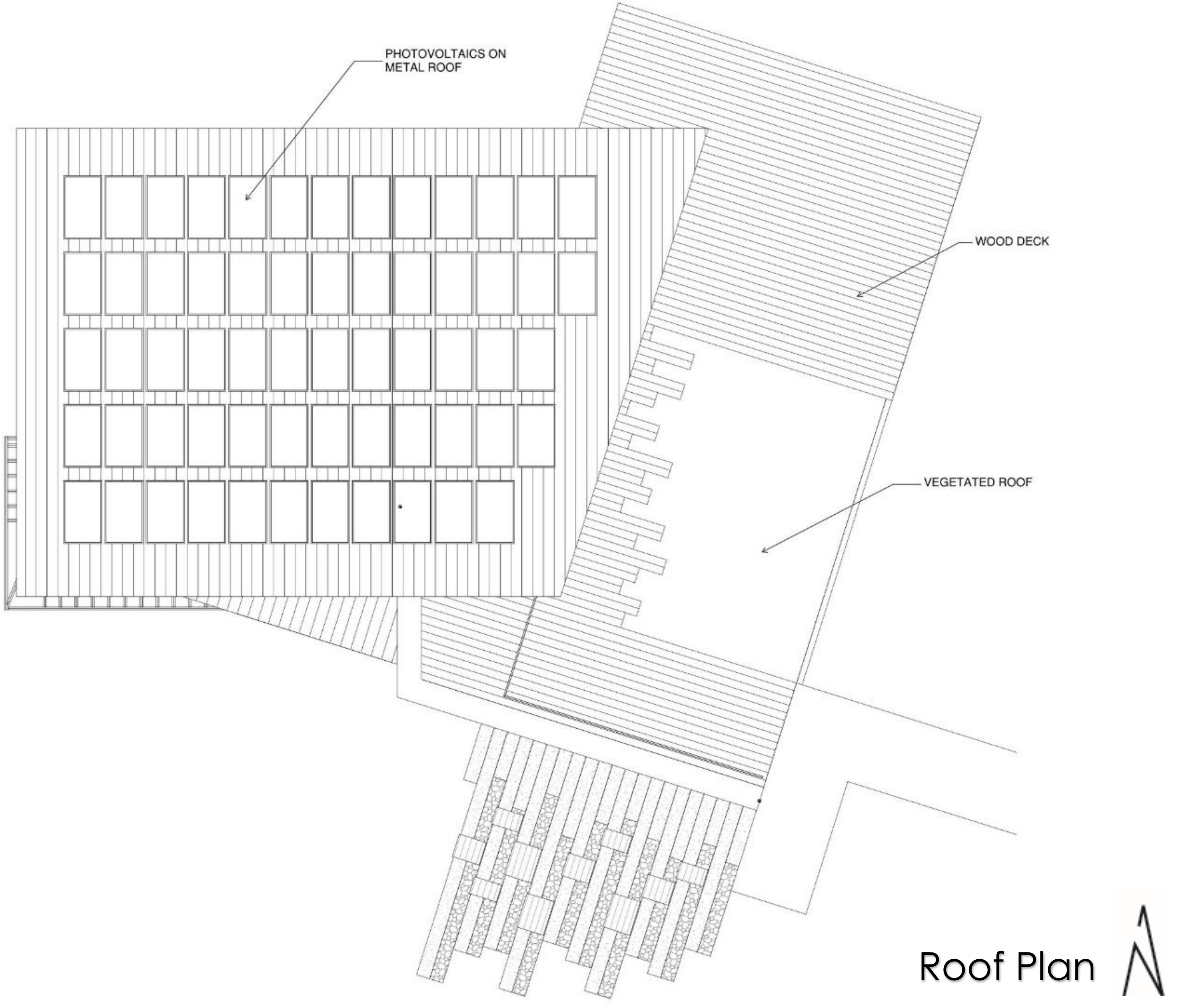




Name	Begin utilization [hr]	End utilization [hr]	Annual utilization days [days/yr]	Occupant quantity
Typical Occupancy	8	17	112	45
Summer Typical	10	12	60	5
Once a week	8	22	28	60
Weekend	10	14	56	5
Summer Camp	9	16	14	45


Roof: R-72
Windows: Uw 0.11
Walls: R-61
MULTIPURPOSE ROOM
108
FIRST FLOOR
+0"
Slab: R-48
Below Grade Walls: R-48


FOAM SALES 8330 1188



Roof Plan

At each hourly time step

$$\begin{aligned}&\text{if } \left[SOC \le 0 \text{ or } SOC \ge BC\right] \text{ then}\\ &\qquad B = 0\\ &\text{else}\\ &\qquad B = B'\\ &\text{end if}\end{aligned}$$

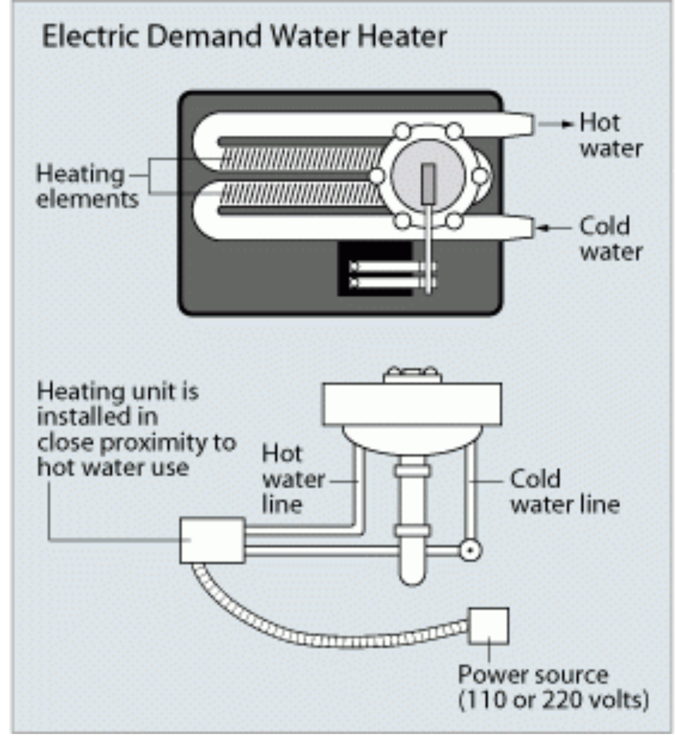
$$C_{RE,batt} = \frac{\sum_{hour} \max\left(0, B_{hour} + \min\left(LE_{hour}, RE_{hour}\right)\right)}{\sum_{hour} RE_{hour}}$$

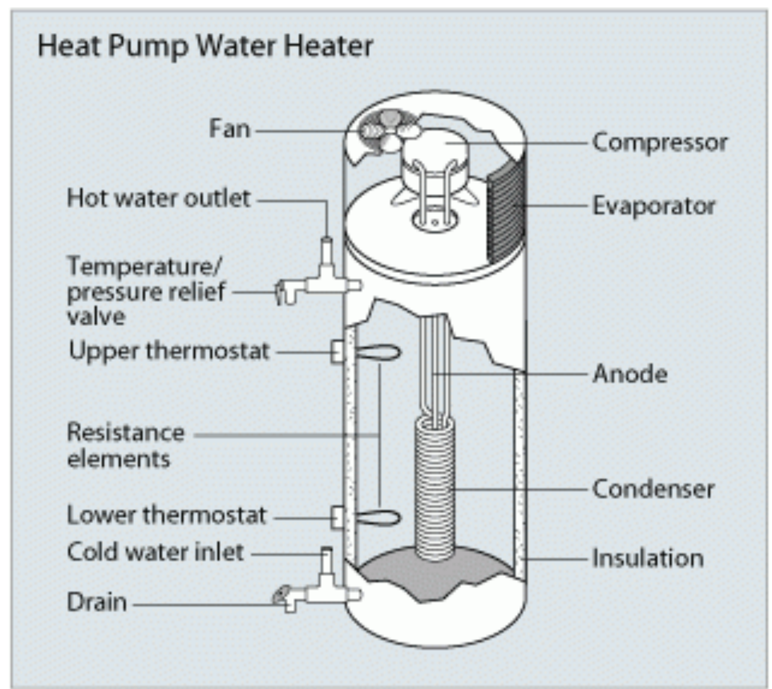
Where is the battery state-of-charge, is the battery capacity, and

$$B' = LE - RE$$

The battery state of charge at each step is calculated as

$$SOC_{hour} = \min\left(BC, \max\left(0, SOC_{hour-1} - B'_{hour} \cdot \left(1 + k_{LOSS} \operatorname{sign} B'_{hour}\right)\right)\right)$$

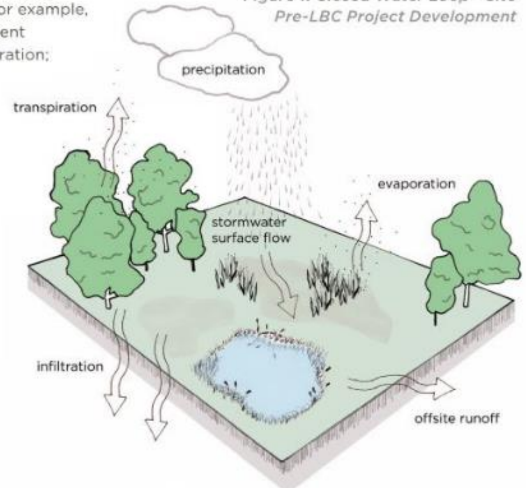

Electric Demand Water Heater
Heating elements
Hot water
Cold water
Heating unit is installed in close proximity to hot water use
Hot water line
Cold water line
Power source (110 or 220 volts)


Heat Pump Water Heater
Fan
Compressor
Hot water outlet
Evaporator
Temperature/ pressure relief valve
Upper thermostat
Anode
Resistance elements
Condenser
Lower thermostat
Cold water inlet
Insulation
Drain

Carrying Capacity

Project water needs must be met within the carrying capacity of the site's natural water systems. For example, if the supply is rainwater, there must be sufficient opportunities for evapotranspiration and infiltration; if the supply is groundwater, there must be sufficient opportunities to recharge the aquifer. Where water is returned to the aquifer after use, it must be reintroduced so that it does not compromise natural systems (e.g., appropriately treated and reintroduced at an undamaging temperature, etc.).

Figure 1. Closed Water Loop - Site Pre-LBC Project Development



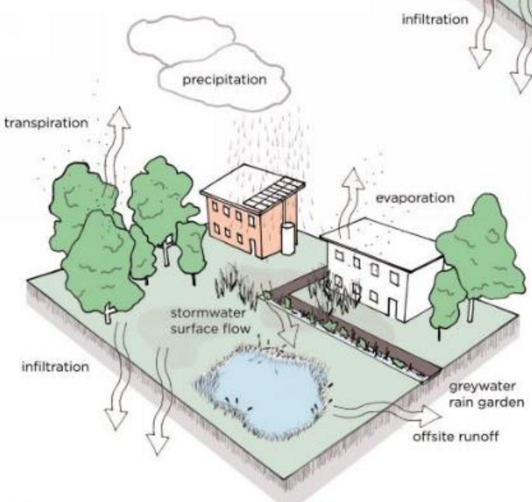


Figure 2. Closed Water Loop - Site Post-LBC Project Development

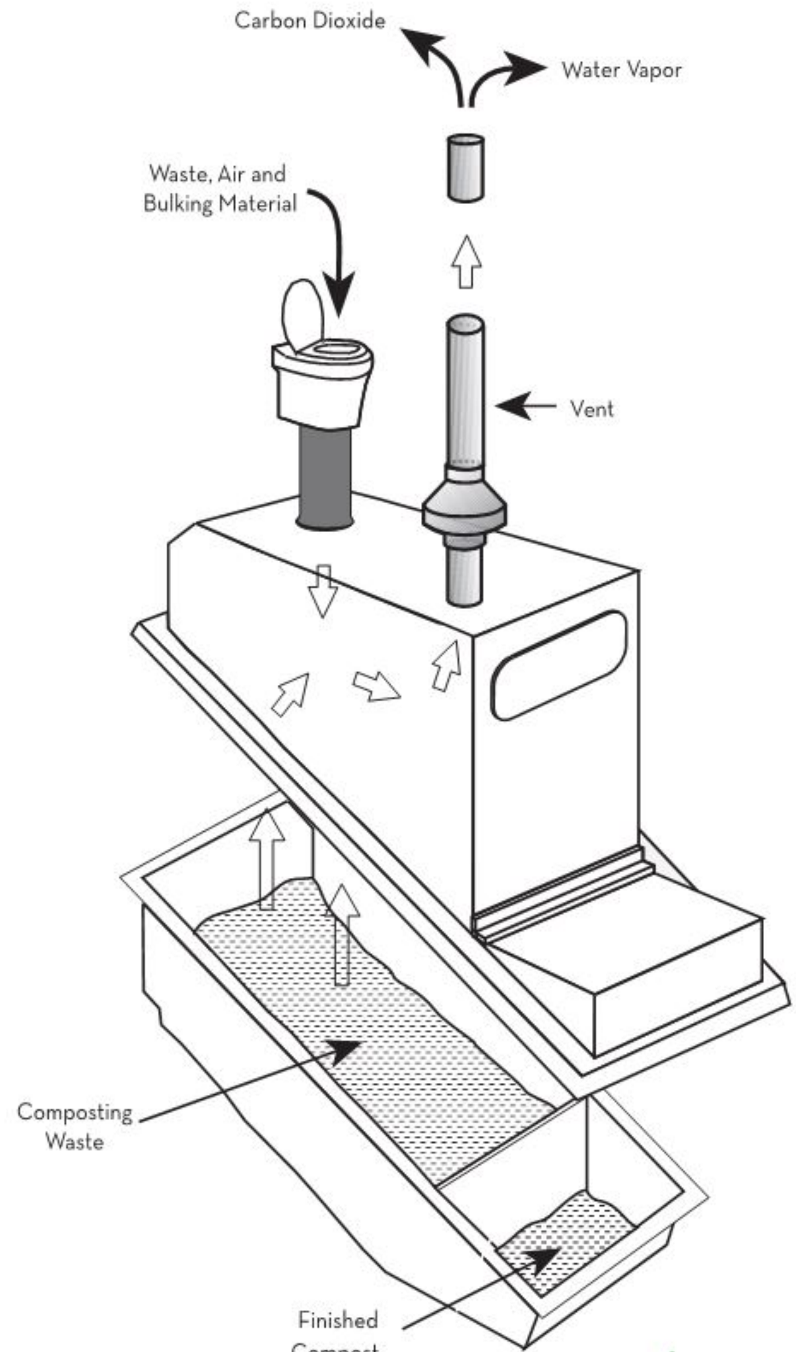


Figure 1. | Composting Process

Carrying Capacity
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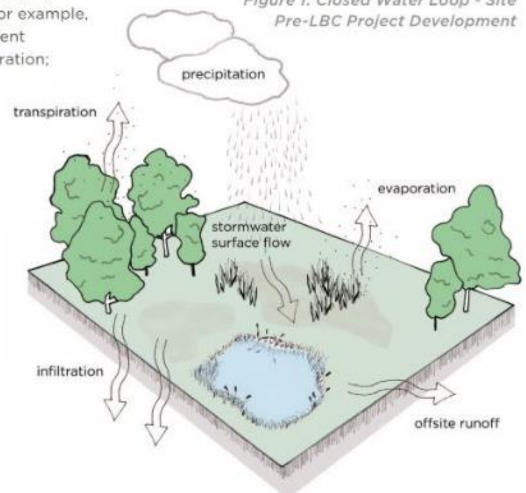

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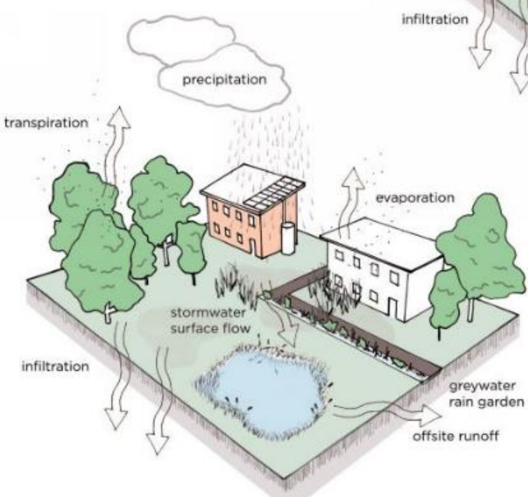

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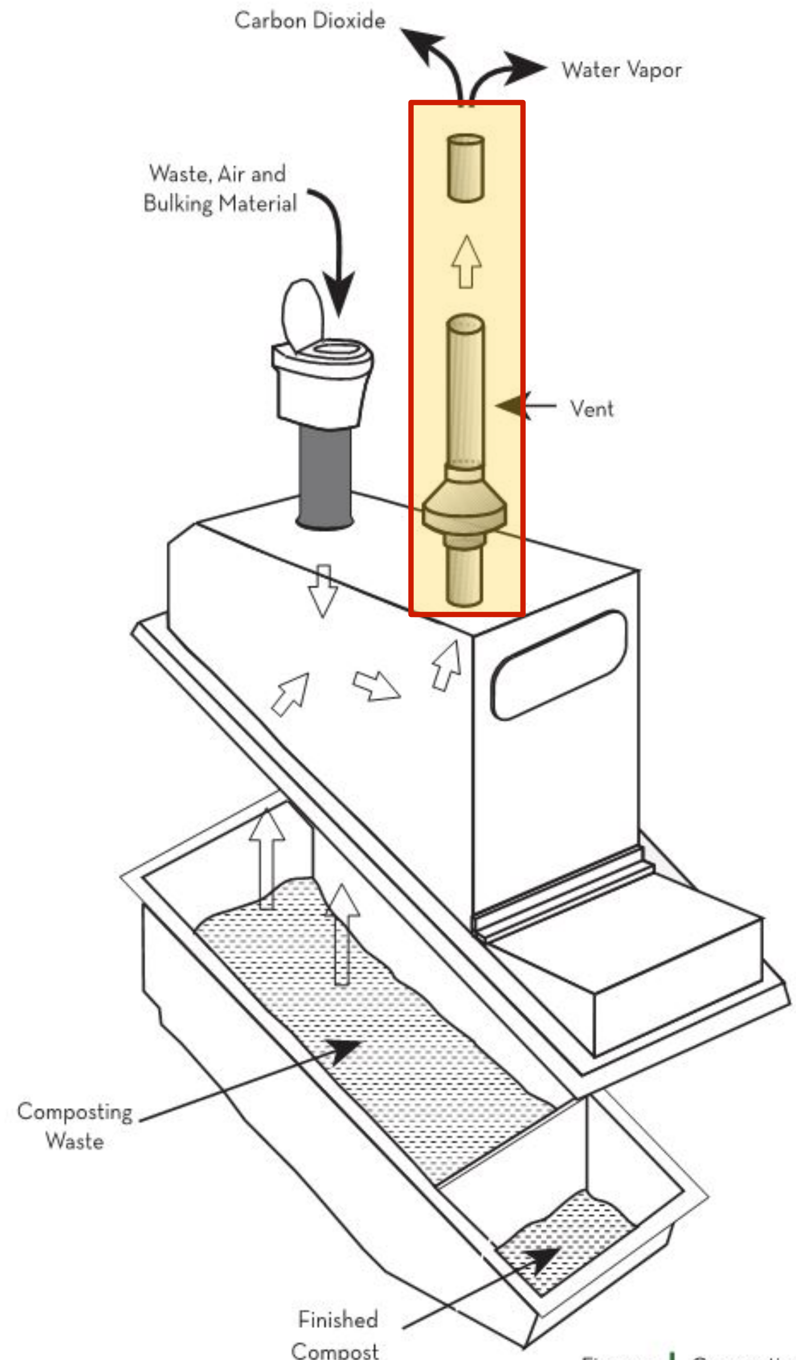

Figure 1. | Composting Process

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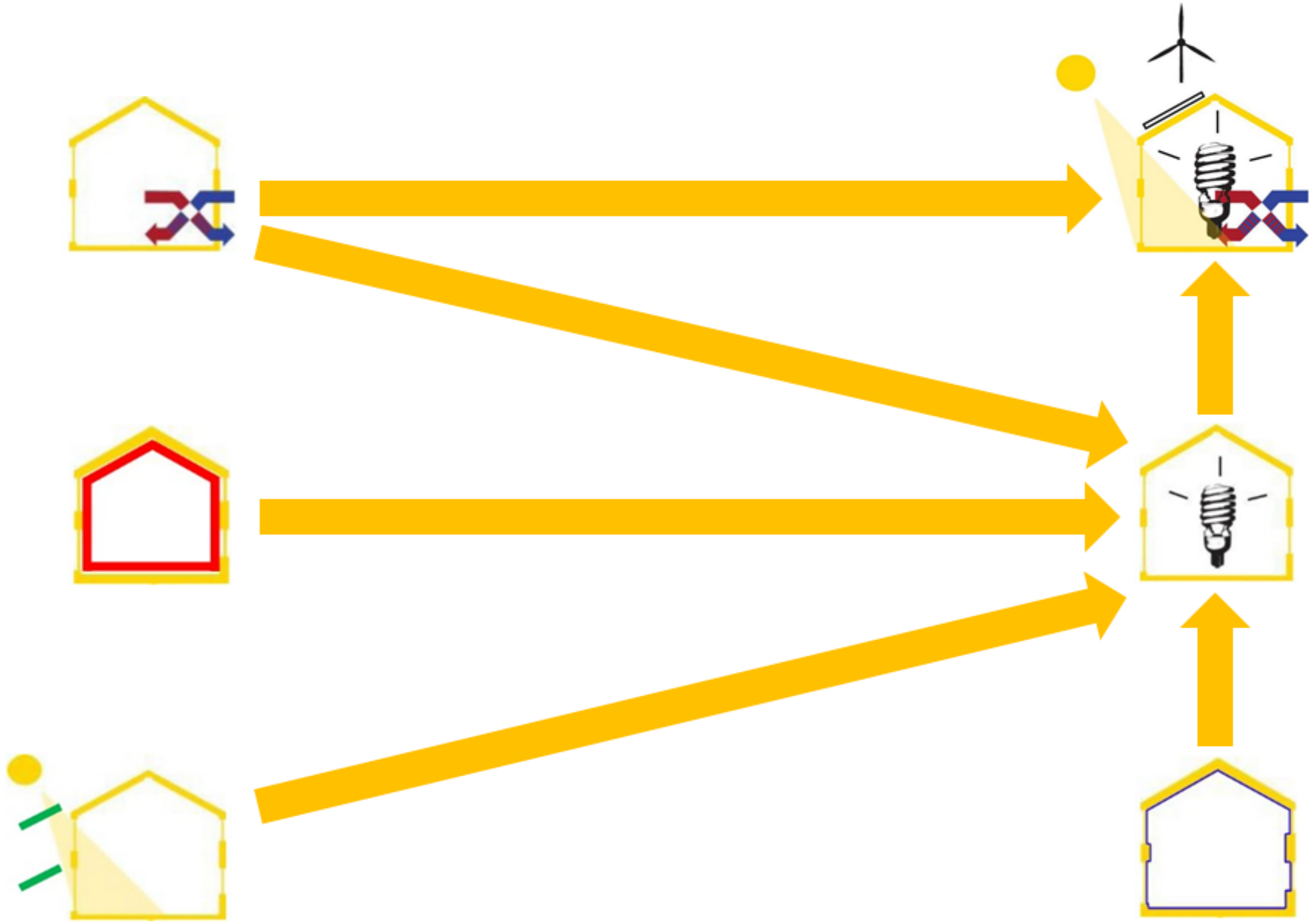
Passive House?



Conclusion

Blog: http://envi.Binghamton.edu


QUESTIONS ?

This concludes The American Institute of Architects Continuing Education Systems Course