master planning resilience and getting to net zero energy

spring 2023 iccfo conference
case study - net zero energy (designed) agriculture complex

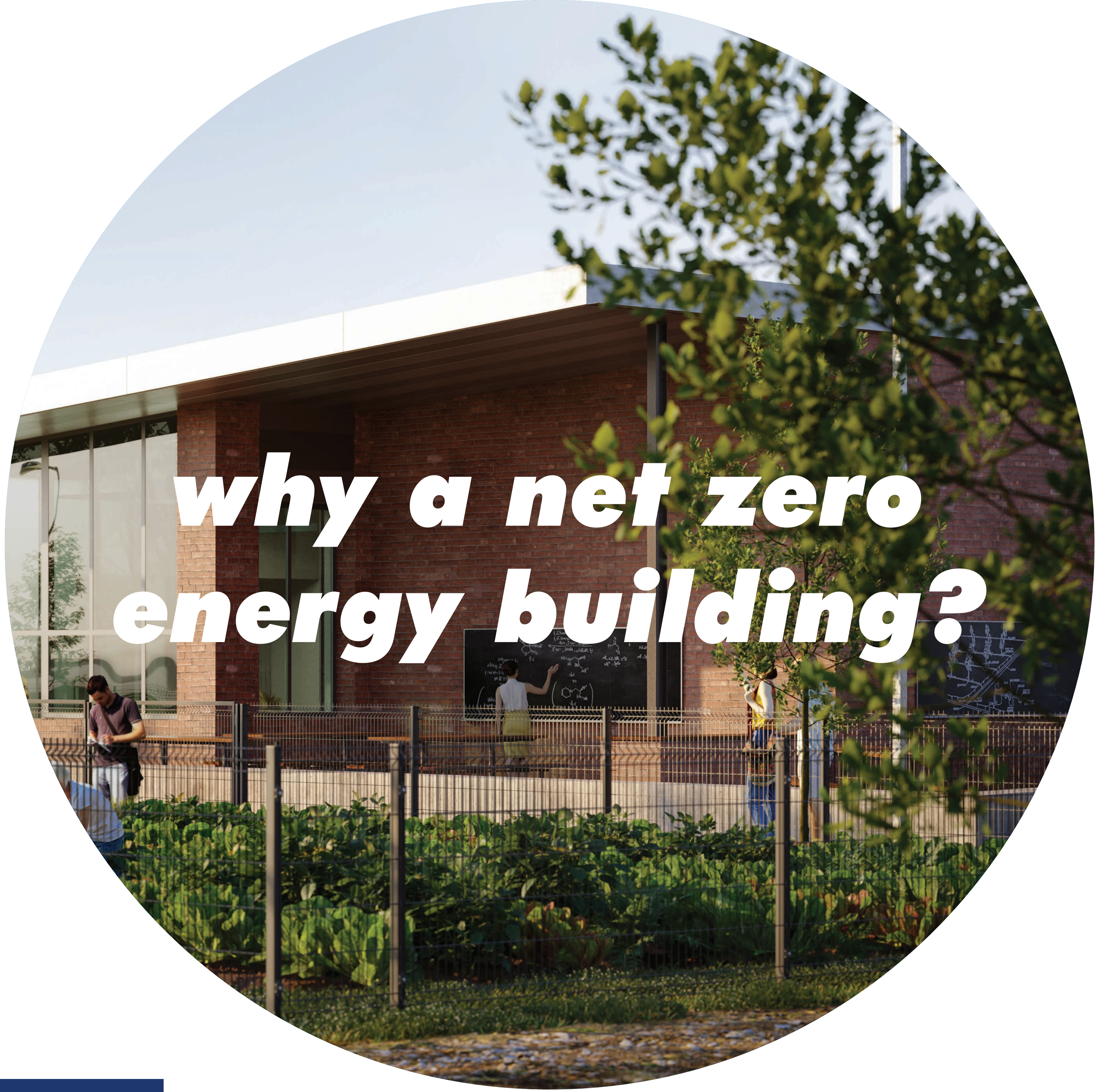
presenters

letisha trepac
- heartland community college
- vice president, finance and administration

michael lundeen
- legat architects
- principal
- director of higher education

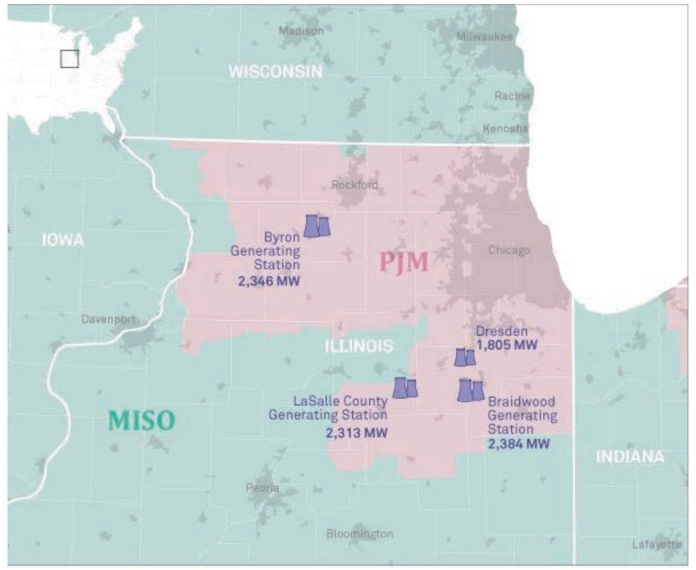
loren johnson
- legat architects
- senior architect
- sustainability lead

why a net zero energy building?



state of illinois: goal of 100% clean energy by 2050 and ending carbon-emitting power by 2030

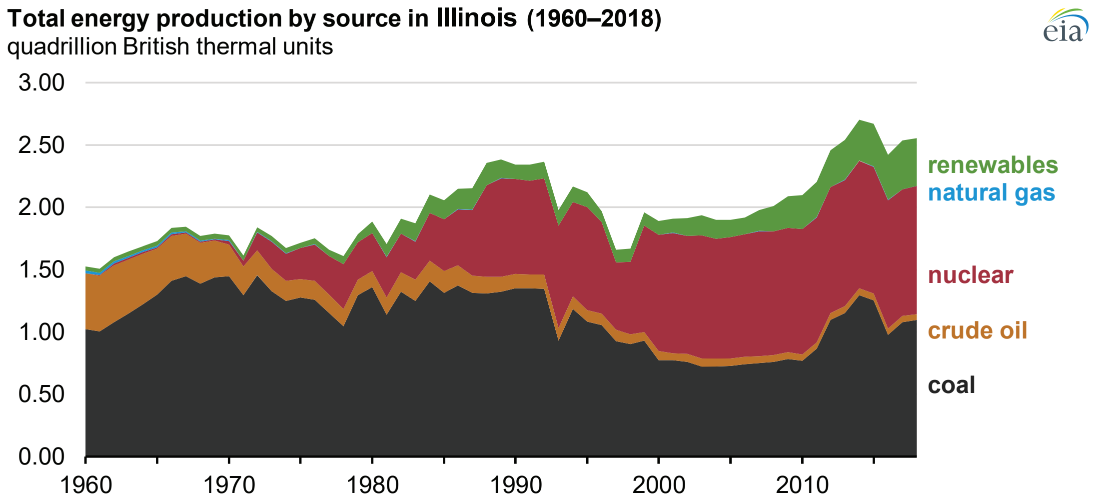
climate and equitable jobs act, september 2021



ending carbon emitting power

one: slow the growth in energy grid demand (low draw new construction, renovations)

two: replacing current carbon sources with non-carbon sources (nuclear, wind, solar)

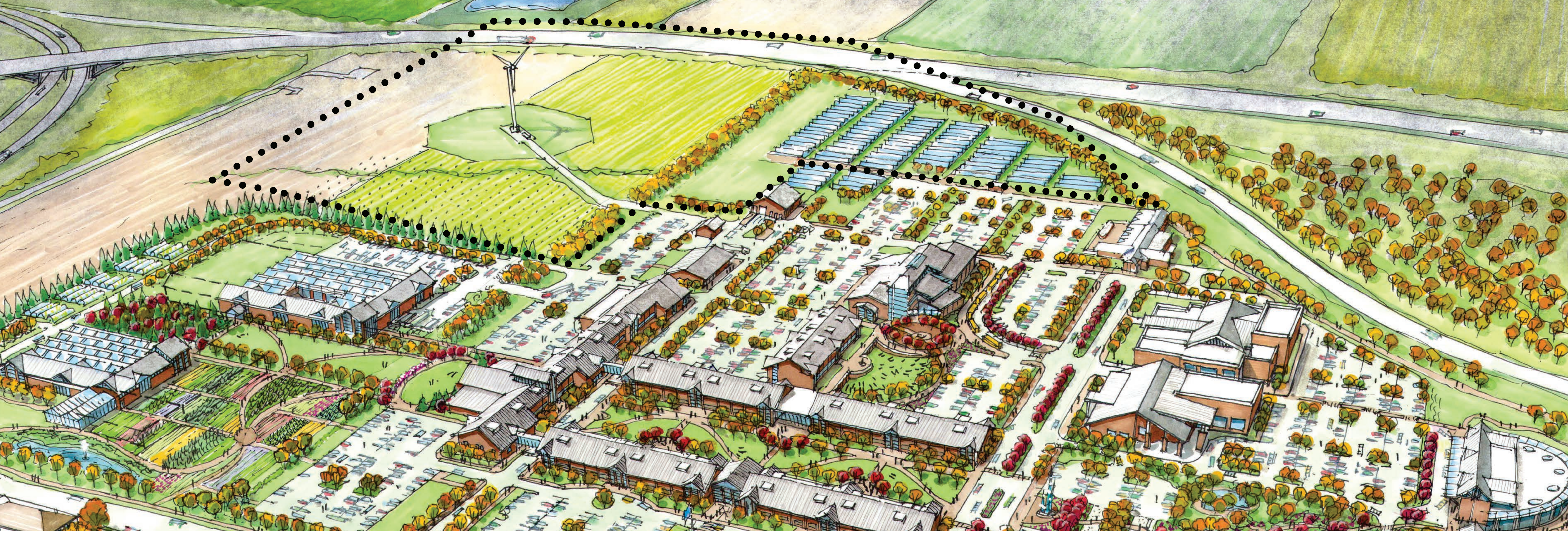


IL in 2022:

66.2% non-carbon sources

33.8% carbon sources


STEVE BLYE · LEGAT



FACILITIES MASTER PLAN OBJECTIVES:

Academic Support Cluster

- Classroom Improvements
- Library Improvements

STEM Cluster

- Health Sciences
- Science
- Agricultural Program Complex

Career and Technical Cluster

- Career and Technical Education

Student Success Services Cluster Enrollment and Student Services

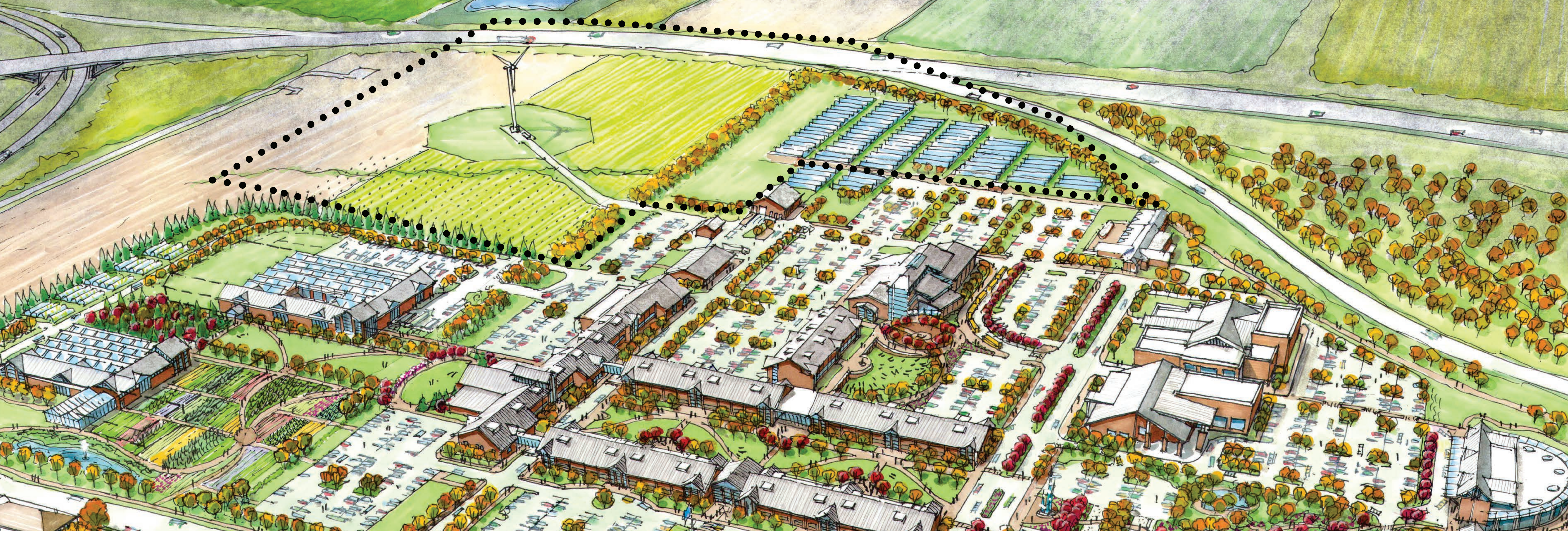
- Fitness and Recreation
- Student Life Improvements
- Centralize Student Services and One-Stop Enrollment Center - Credit and Non-Credit

Community Engagement Cluster

- Child Development Lab
- Challenger Learning Center
- Event Space Improvements
- Performing Arts

Strategic Institutional Enhancements Cluster

- Building Maintenance and Interior Improvements
- Information Technology
- Landscape and Outdoor Improvements
- Public Safety
- Signage and Wayfinding
- Sustainability, Energy and Power (Infrastructure)



FACILITIES MASTER PLAN OBJECTIVES:

Academic Support Cluster
- Classroom Improvements
- Library Improvements

STEM Cluster
- Health Sciences
- Science
- Agricultural Program Complex

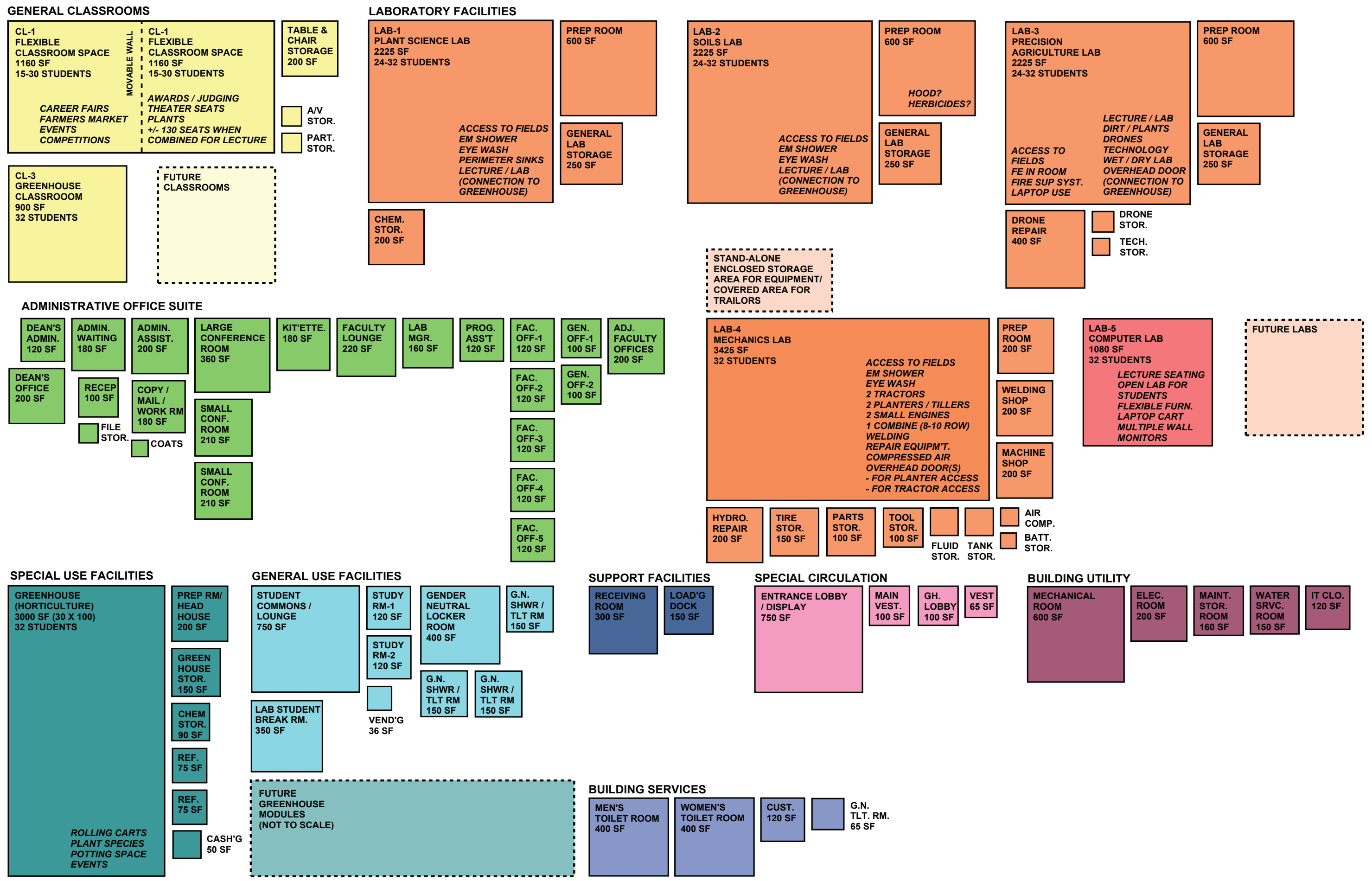
Career and Technical Cluster
- Career and Technical Education

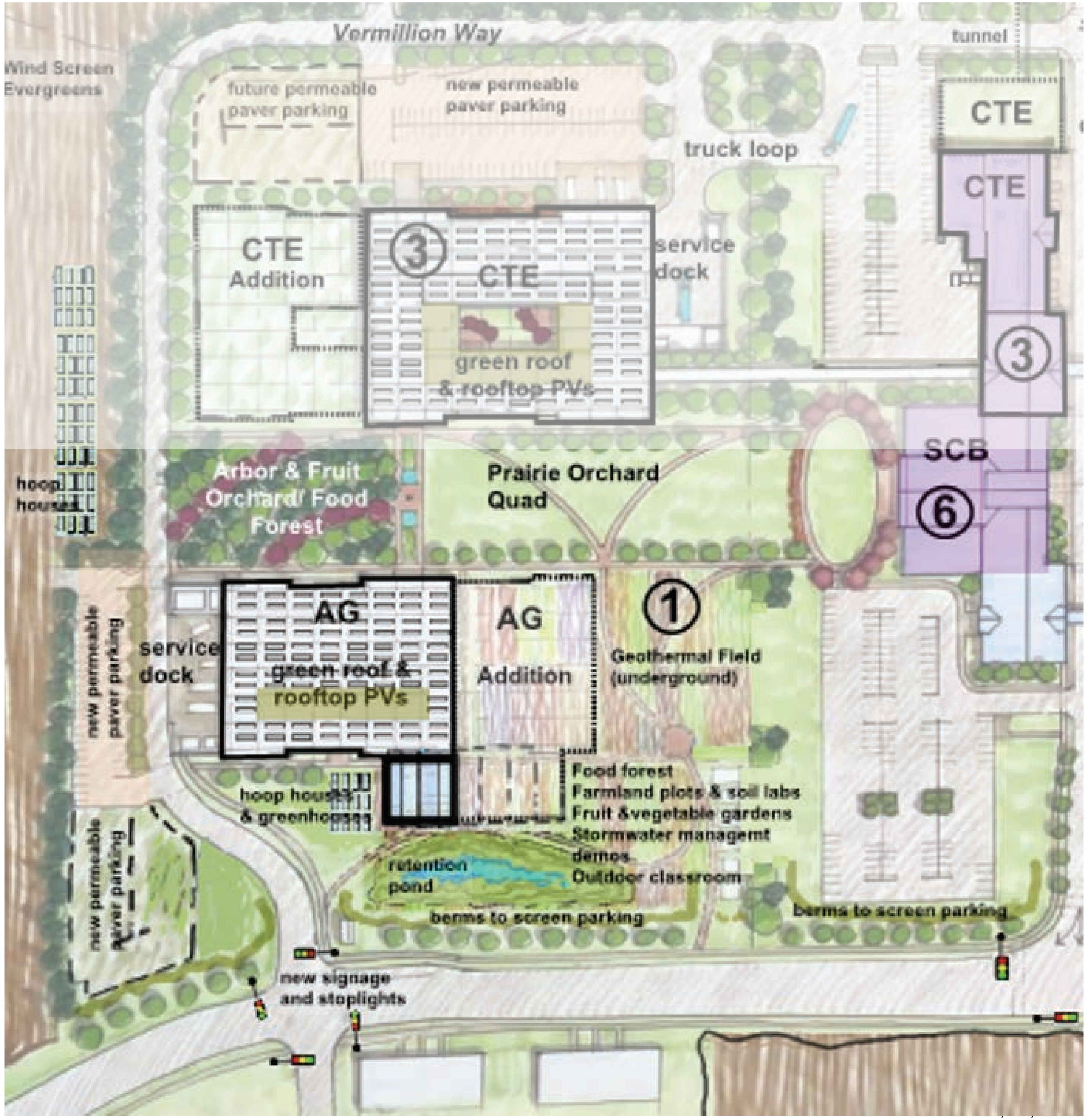
Student Success Services Cluster Enrollment and Student Services
- Fitness and Recreation
- Student Life Improvements
- Centralize Student Services and One-Stop Enrollment Center - Credit and Non-Credit

Community Engagement Cluster
- Child Development Lab
- Challenger Learning Center
- Event Space Improvements
- Performing Arts

Strategic Institutional Enhancements Cluster
- Building Maintenance and Interior Improvements
- Information Technology
- Landscape and Outdoor Improvements
- Public Safety
- Signage and Wayfinding
- Sustainability, Energy and Power (Infrastructure)

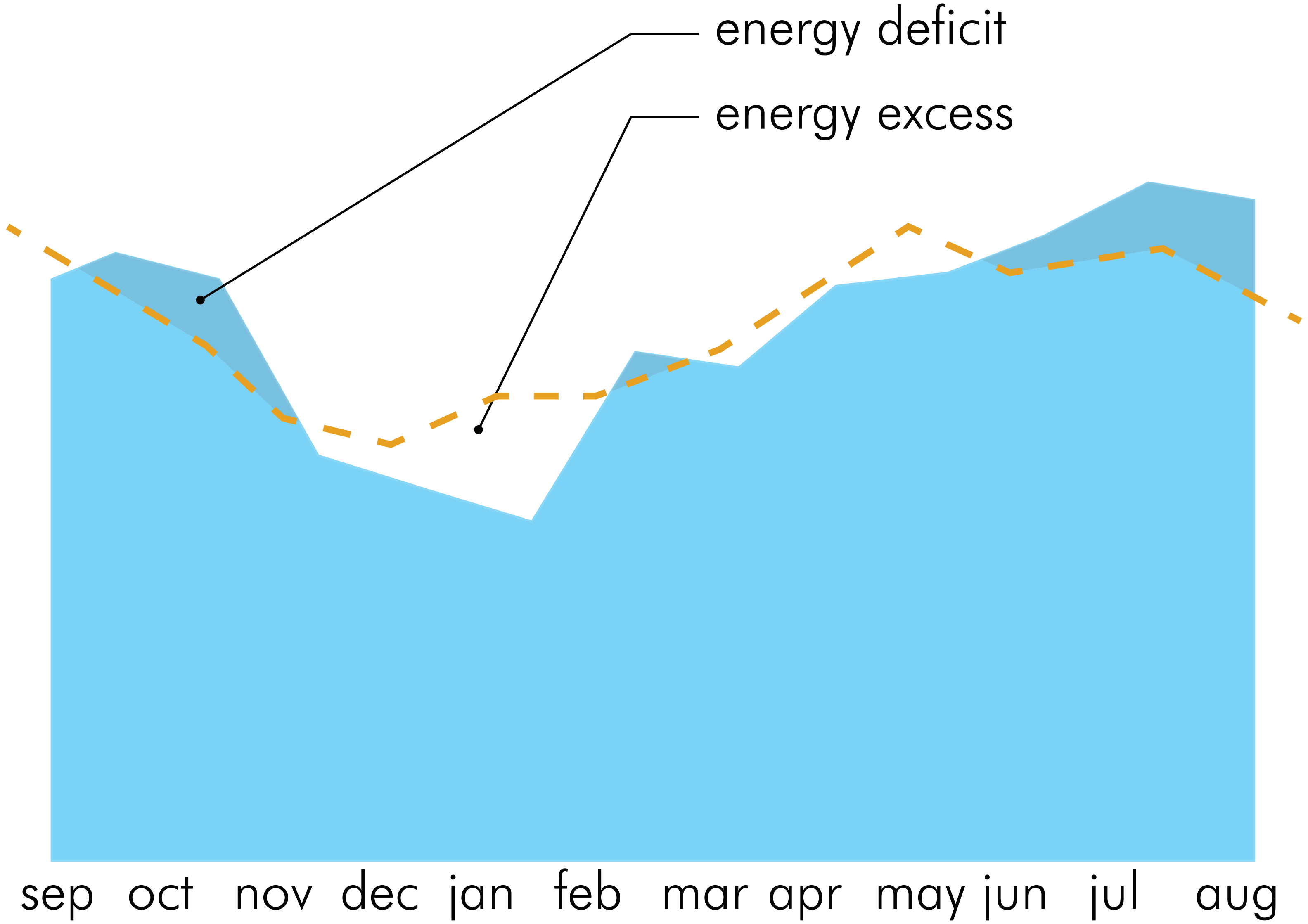
Agriculture Complex Program Space Diagram






what is net zero energy?
net zero carbon?
campus decarbonization?

what is building net zero energy?



the goal of net zero energy is to produce as much or more energy as a building uses in a year.

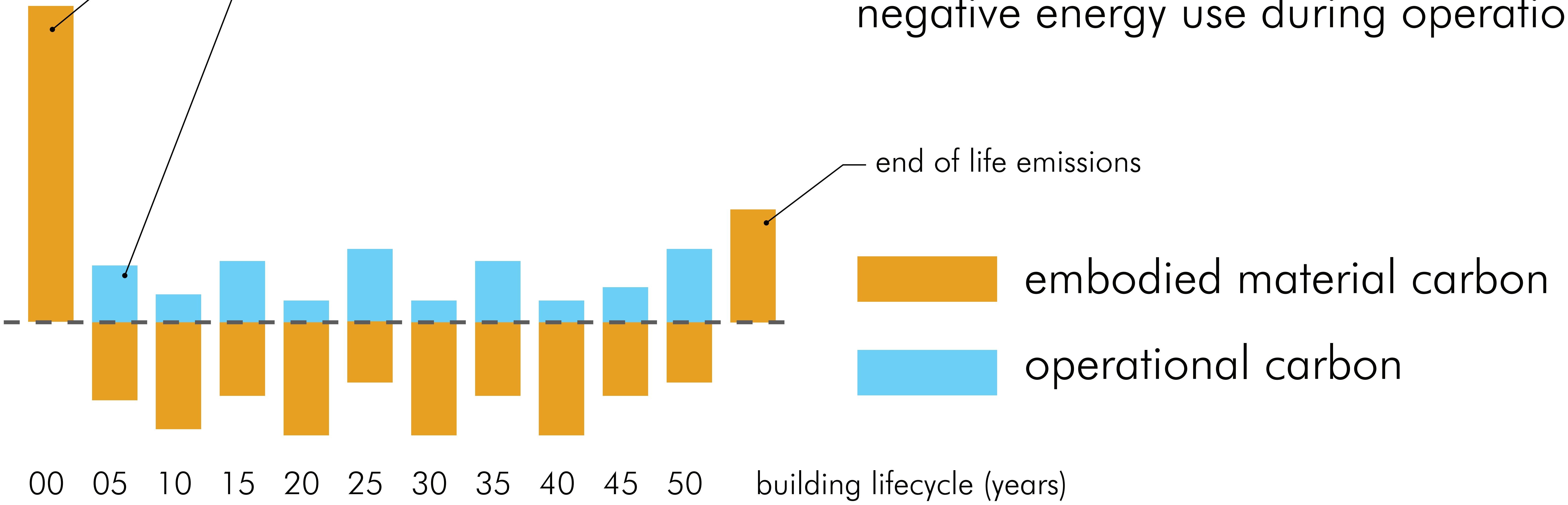
after a year of use, the excesses of energy produced should be equal to or greater than the energy deficits.

- - - - - monthly solar energy production

monthly energy use

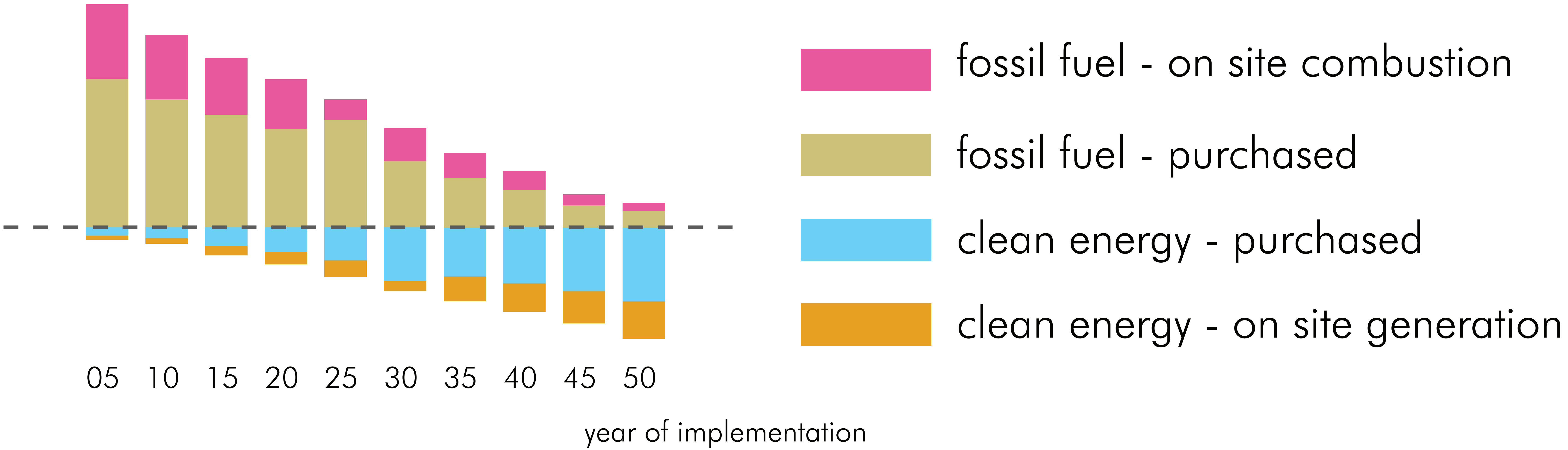
what is building net zero carbon?

the goal of net zero carbon is to offset the embodied carbon of building construction, maintenance, and end of life through negative energy use during operations.

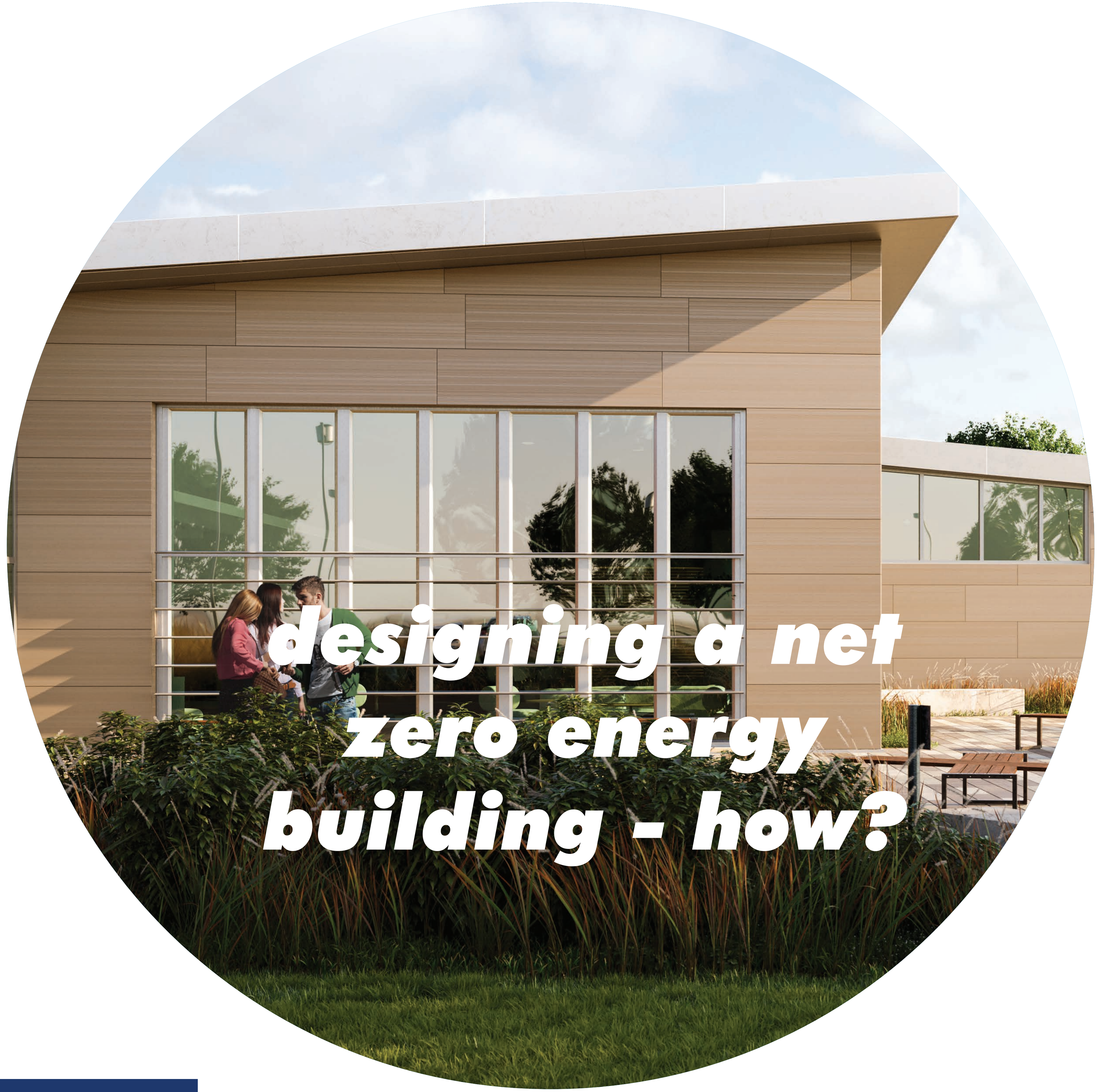


what is campus decarbonization?

the goal of “campus decarbonization” is to strategically convert existing fossil fuel energy sources to non-fossil fuel sources over time.



designing a net zero energy building - how?



building location

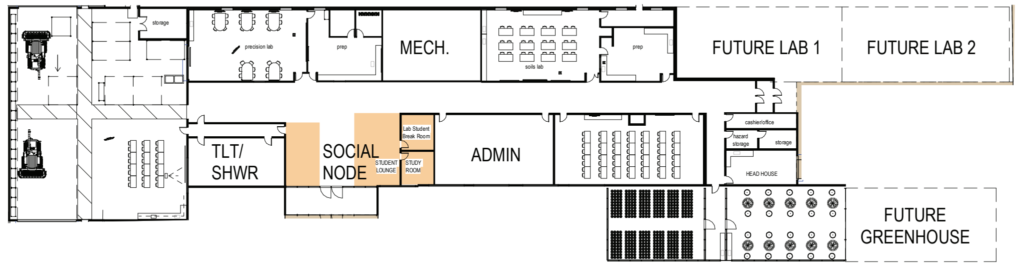
ACRE QUANTITY

FARMLAND	95 ACRES
LANDSCAPE/POND/RETENTION	38.6 ACRES
PARKING LOTS/ROADS/OTHER	23.6 ACRES
BUILDINGS/CAMPUS/GROUNDS	38.3 ACRES
OTHER/UNASSIGNED	63 ACRES
TOTAL SITE	258 ACRES

KEY

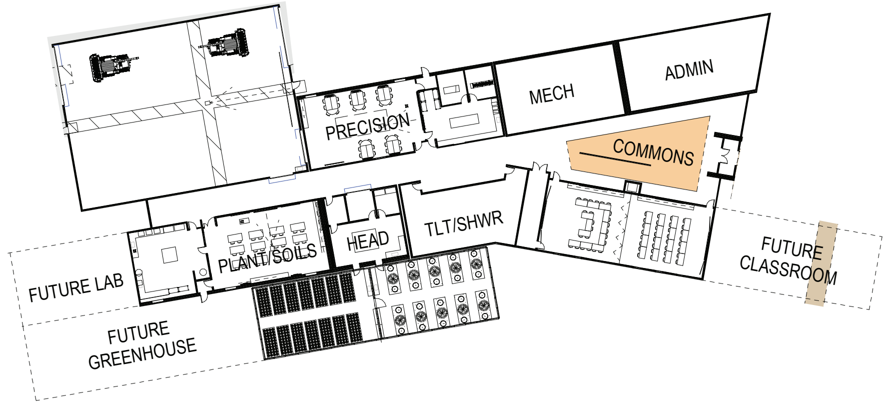
1 HOMESTEAD
2 NATIONAL GUARD
3 SPORTS FACILITIES
4 FARMLAND
5 MAIN CAMPUS
PROPERTY LINE
BODY OF WATER
GRASS/GREEN SPACE
PRAIRIE/WETLAND

schematic design - process



Option 1 - "Stem"
- most energy efficient, EUI 30 (+10-15%%)
- event space visible from Raab
- most feasible construction
- most feasible additions

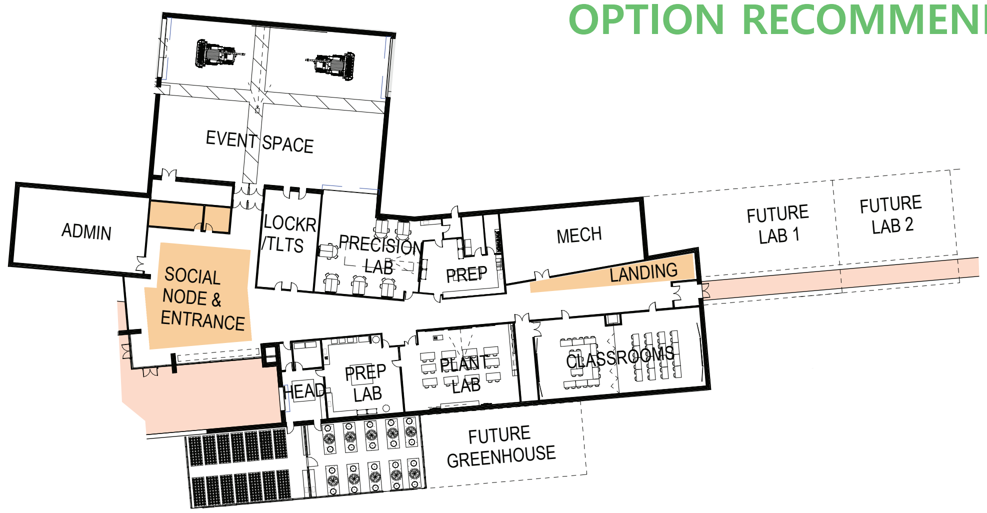
pEUI: 30 kbtu/sf/yr



Option 2 - "Petal"
- least energy efficient, EUI 38
- greatest connection to existing campus
- event space least connected to entrance
- shower/tlt not connected to lab space

pEUI: 38 kbtu/sf/yr

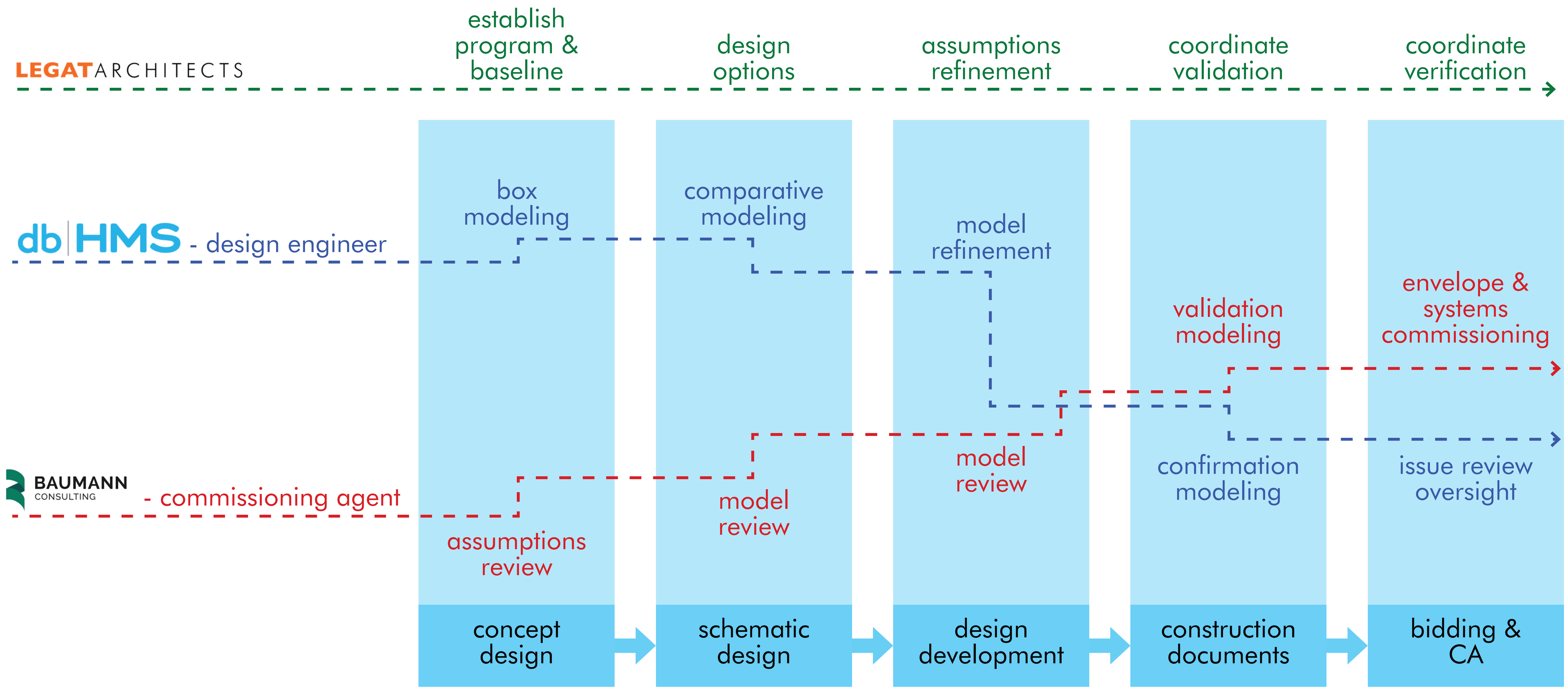
OPTION RECOMMENDED BY STEERING COMMITTEE



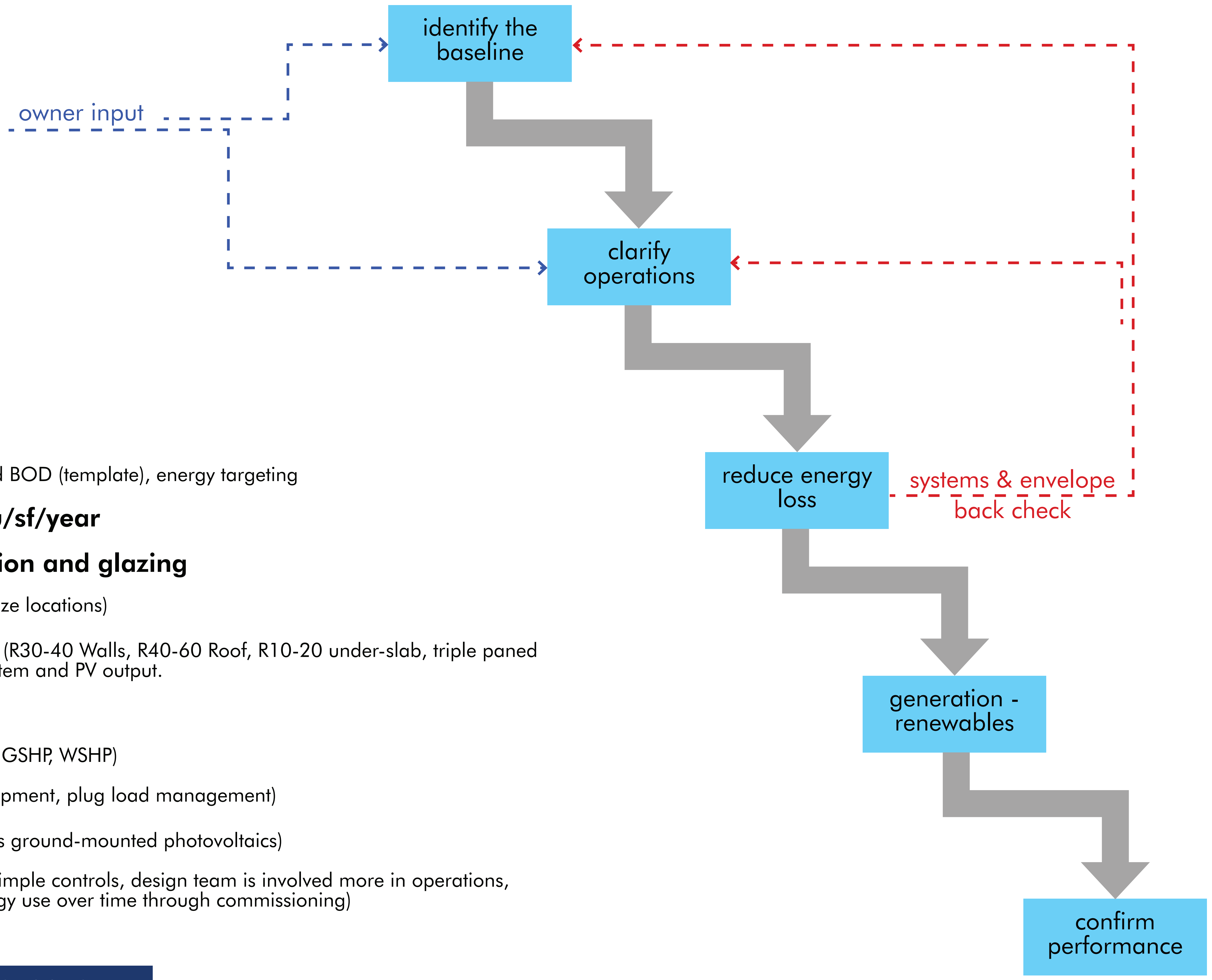
Option 3 - "Root"
- middle energy efficiency, EUI 36
- greatest interaction between social areas and greenhouse
- greatest interaction between social areas and event space
- greatest connection between labs

pEUI: 36 kbtu/sf/yr

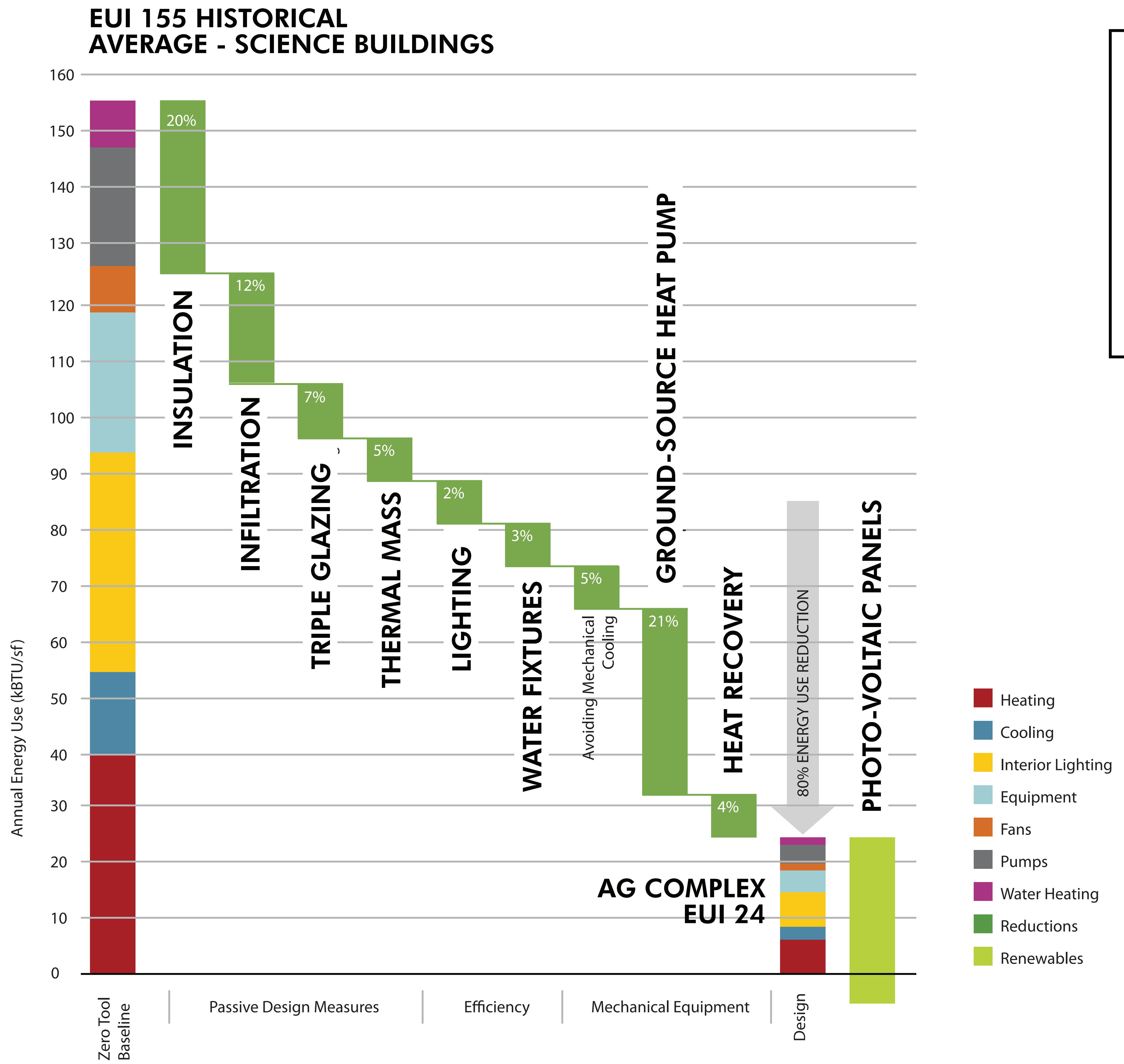
defining the energy team - roles & responsibilities

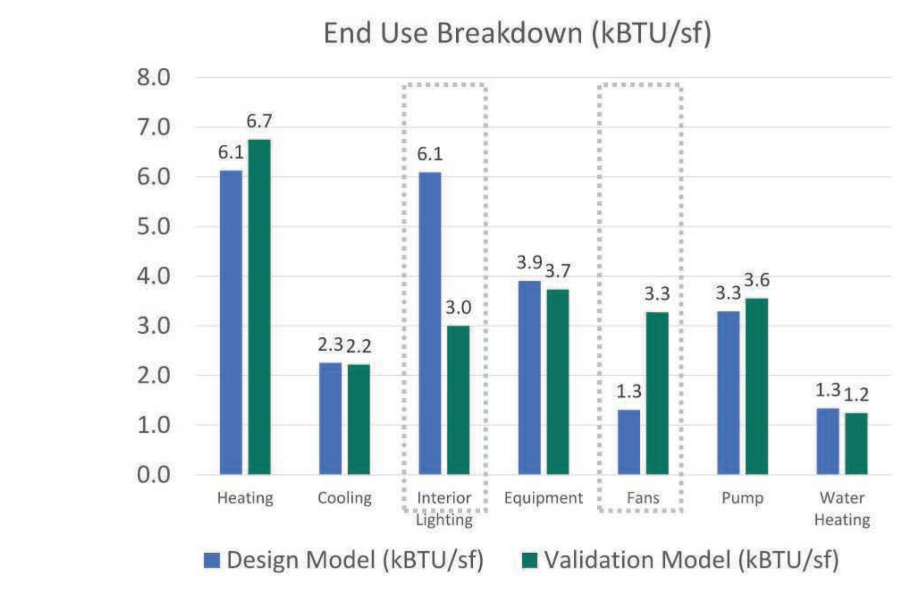


getting to zero

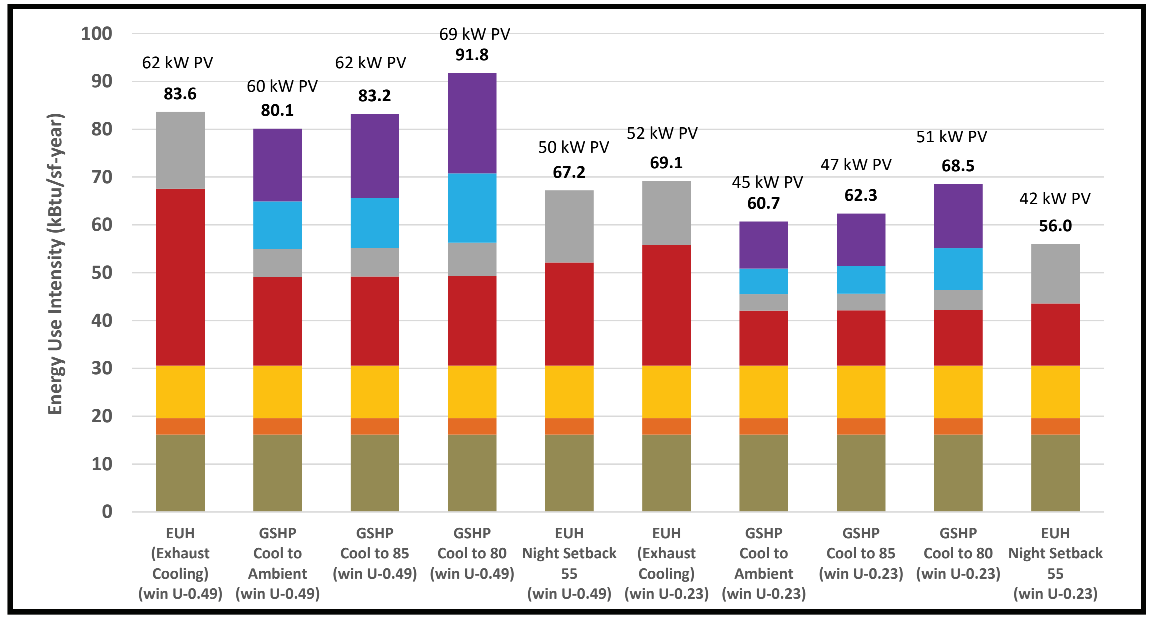


1. Integrative Process (box modeling, OPR and BOD (template), energy targeting
2. **EUI Target: approx. 15-25 kbtu/sf/year**
3. **Passive Solar Design - orientation and glazing**
4. Solid to Glazing Ratio (approx. 30%, optimize locations)
5. **Continuous Envelope R Values** (R30-40 Walls, R40-60 Roof, R10-20 under-slab, triple paned windows) - balance against mechanical system and PV output.
6. Light Use Density Reductions
7. **Mechanical Systems** (compare VRF, GSHP, WSHP)
8. Equipment Energy (energy efficient lab equipment, plug load management)
9. **Renewable Energy** (roof-mounted vs ground-mounted photovoltaics)
10. Maintenance and Operations. (design for simple controls, design team is involved more in operations, design team needs to be able to track energy use over time through commissioning)





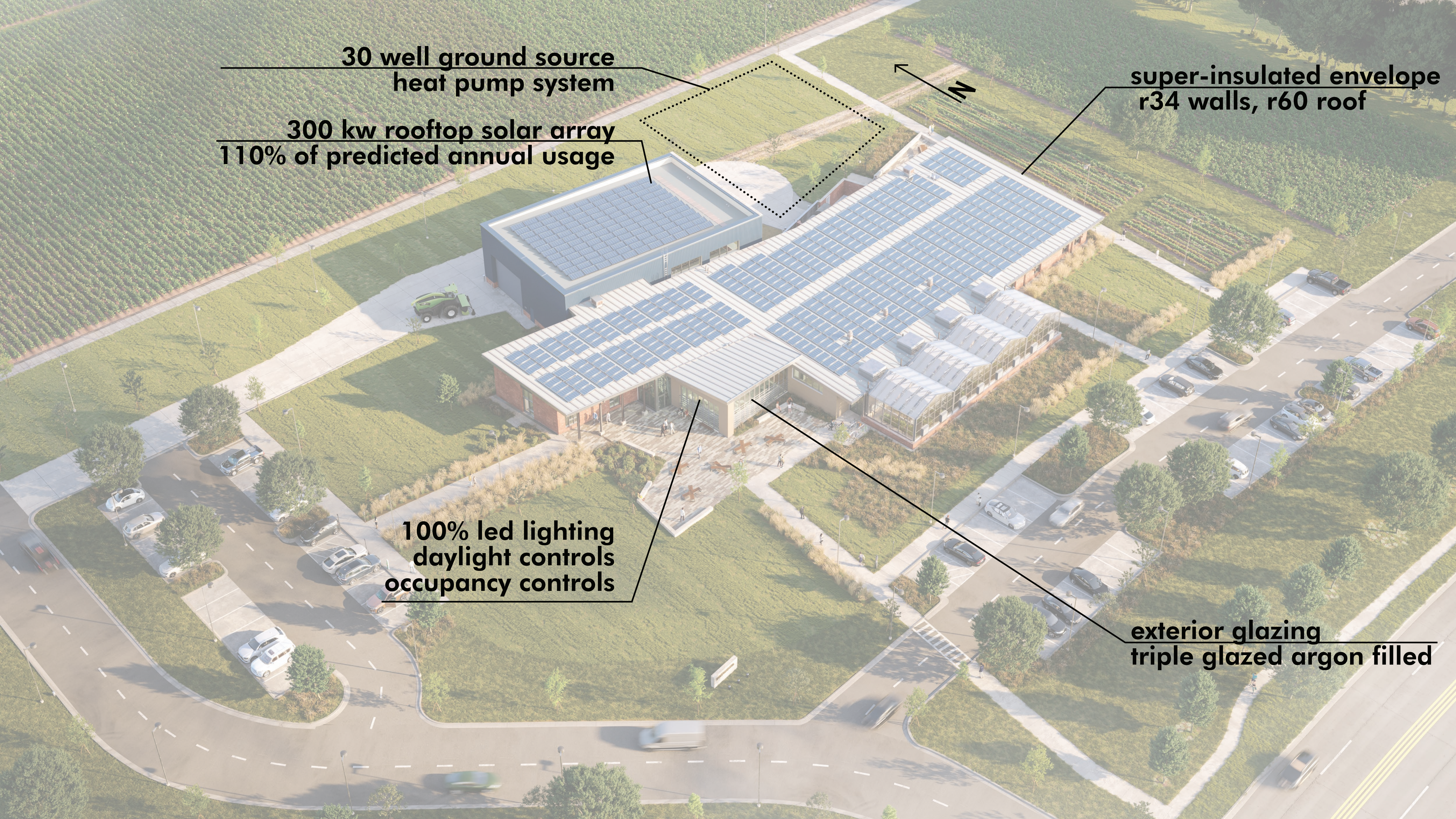
	Design Model (kBTU/sf)	Validation Model (kBTU/sf)
Heating	6.1	6.7
Cooling	2.3	2.2
Interior Lighting	**6.1**	**3.0**
Equipment	3.9	3.7
Fans	**1.3**	**3.3**
Pump	3.3	3.6
Water Heating	1.3	1.2
TOTAL	**24.3**	**23.8**



energy modeling - real-time feedback on decision making

04/21/2023


WORKING FARM
FLEX SPACE
TEST PLOTS
STUDENT GARDEN
OFFICES
GREENHOUSES


30 well ground source
heat pump system
300 kw rooftop solar array
110% of predicted annual usage
N
super-insulated envelope
r34 walls, r60 roof
100% led lighting
daylight controls
occupancy controls
exterior glazing
triple glazed argon filled


superinsulated rainscreen system
horizontal exterior shades


native landscape plantings
student garden / test plots
outdoor classroom


FOOD FOR FUTURE
SUMMIT & EXPO
exposed heavy
timber deck
(carbon negative)
100% LED lighting
concrete floors - thermal mass

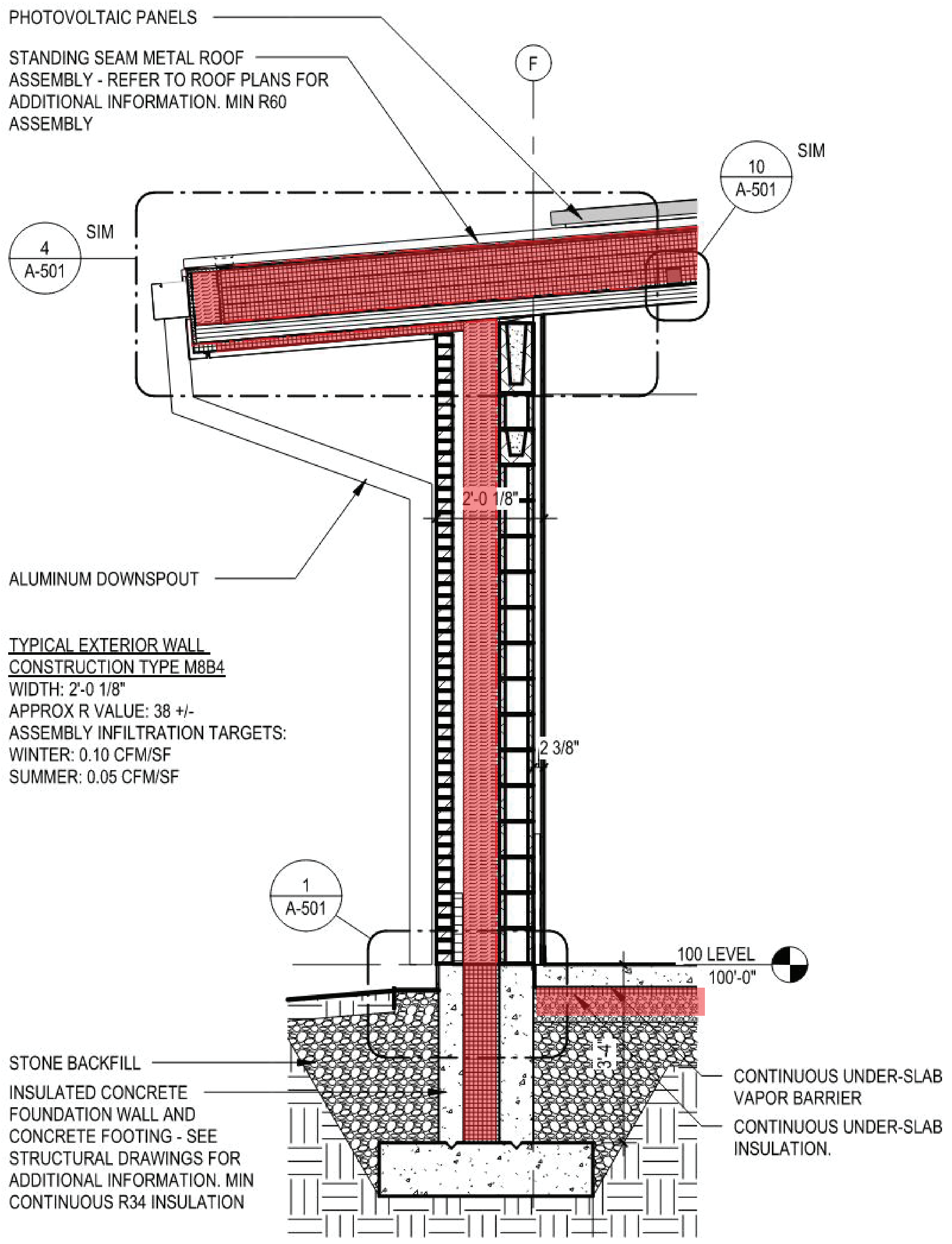
building envelope strategy - superinsulation

roof: 11″ roofing insulation, R60
  code minimum: 6″, R30

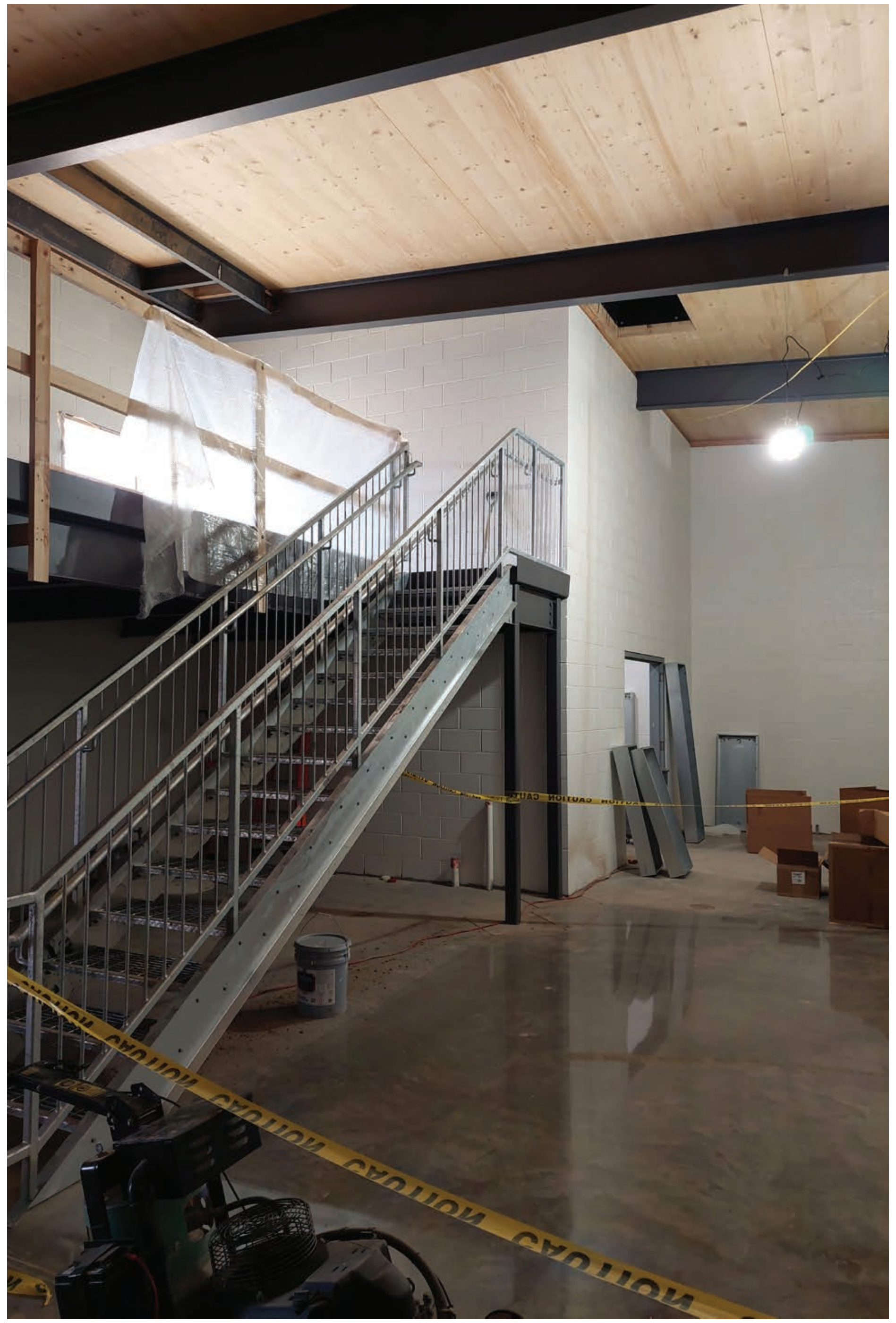
walls: 8″ R34 mineral wool
  code minimum: 2.5″ xps, r9

underslab: R10 xps
  code minimum: perimeter only

windows: triple glazed cw, R5
  code minimum: R3

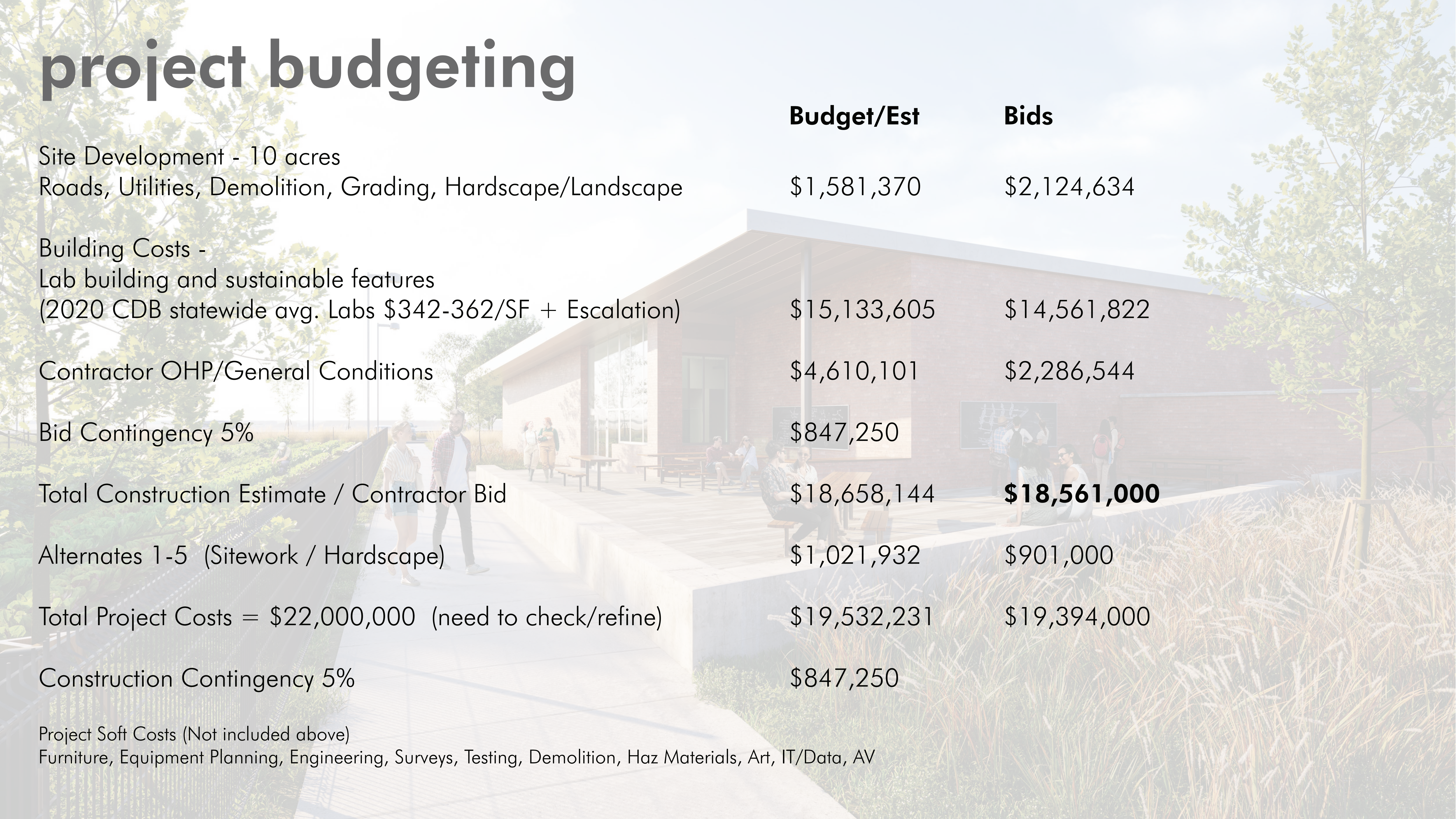


construction photos



budgeting and available grants

project budgeting



	Budget/Est	Bids
Site Development - 10 acres Roads, Utilities, Demolition, Grading, Hardscape/Landscape	$1,581,370	$2,124,634
Building Costs - Lab building and sustainable features (2020 CDB statewide avg. Labs $342-362/SF + Escalation)	$15,133,605	$14,561,822
Contractor OHP/General Conditions	$4,610,101	$2,286,544
Bid Contingency 5%	$847,250	
Total Construction Estimate / Contractor Bid	$18,658,144	**$18,561,000**
Alternates 1-5 (Sitework / Hardscape)	$1,021,932	$901,000
Total Project Costs = $22,000,000 (need to check/refine)	$19,532,231	$19,394,000
Construction Contingency 5%	$847,250	

Project Soft Costs (Not included above)
Furniture, Equipment Planning, Engineering, Surveys, Testing, Demolition, Haz Materials, Art, IT/Data, AV

project budgeting - net zero

Building envelope insulation	$592,396
Triple glazed window walls, thermally broken doors	$124,120
Roof overhang / solar shading	$540,576
Mechanical system effeciency improvements	$902,426
Electrical / pvs	$644,651
Soft costs (engineering, commissioning, design, energy modeling, grant submissions)	$470,033
Total ze hard & soft costs	$3,274,202
ICECF grant	$2,000,000

estimate of additional costs (before grant)

raw costs for net zero: $3,274,202 (19% inc.)

pre-grant add per square foot for net zero: $111/sf

estimate of additional costs (after grant)

addt'l costs for net zero: $1,274,202 (6.9% inc.)

post-grant to-owner cost for net zero: $43/sf

average electricity rate: 0.091 $/kWh

baseline
average annual predicted energy use: 1,215,081 kWh
average annual predicted energy use: $110,573

design - usage
average annual predicted energy use: 241,000 kWh
average annual predicted energy use: $21,931

design - generation
average annual pv generation: 279,649 kWh

average annual pv generation: $25,337

return on investment (with ICECF grant):

add investment after grant: 1.27 million

annual savings: $113,979

roi achieved: in year 11 of operation

building lifespan: 30-50 years

thank you!