BUILDINGENERGY BOSTON

Cutting Ties: Designing to Reduce Reliance on Existing Utility Plants

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Curated by Kurt Roth

Northeast Sustainable Energy Association (NESEA) | March 23, 2026

Presenters

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Learning Objectives*

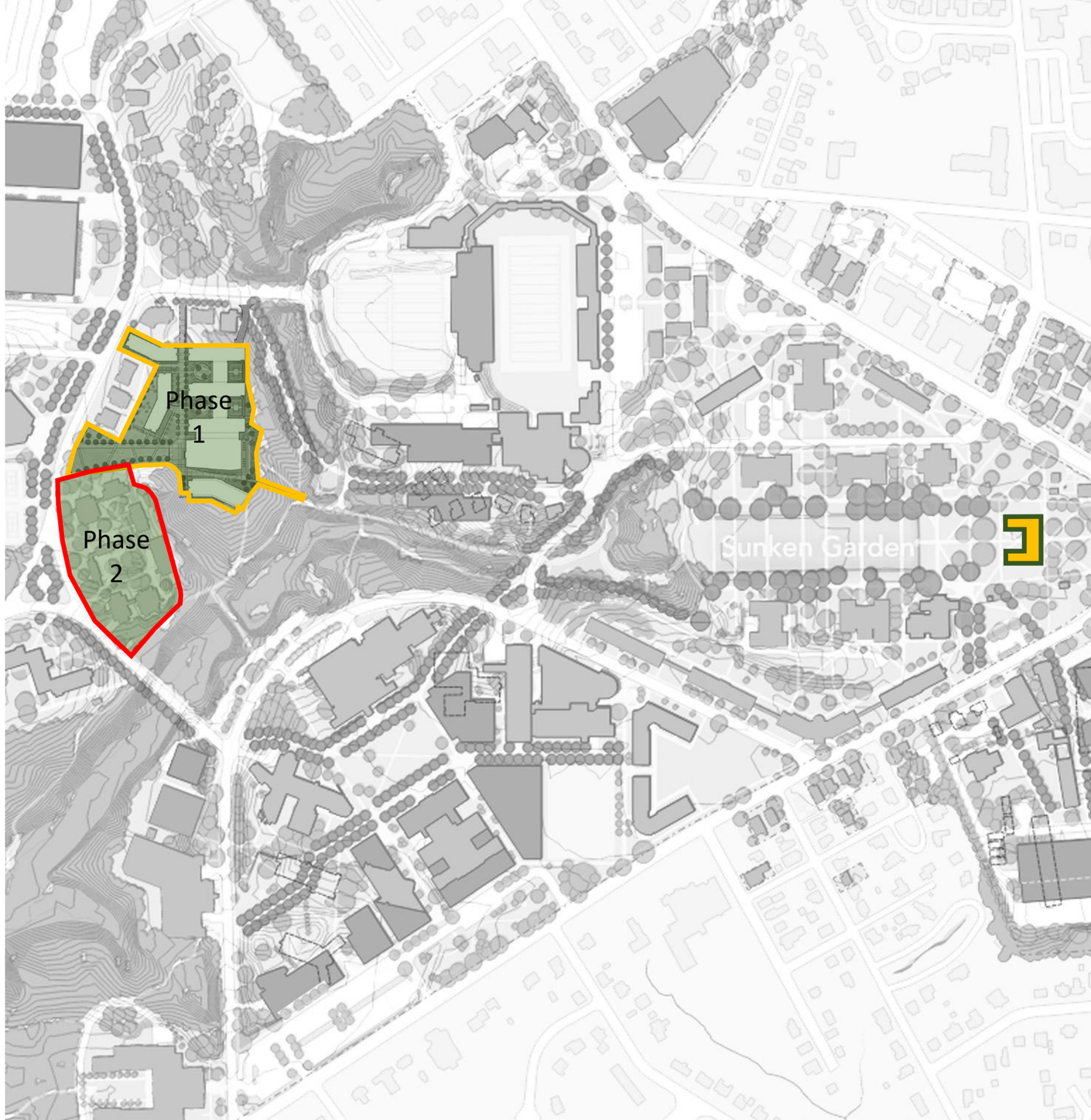
- Describe how a site-specific geothermal well field can support multiple independent buildings with different load requirements.
- Explore how different façade strategies can reduce overall cooling/heating loads of buildings.
- Communicate system strategies and pros/cons with Owners and other stakeholder groups.
- Calculate a simple payback period and LCCA for implemented mechanical system.

*This session is pre-approved for 1 credit hour toward AIA (LU|HSW), LEED (BD+C, O+M), MA CSL, and NARI certification. Those who attend a full day of the conference are additionally eligible for credit toward Phius and RESNET certification.

Don’t Stop **(Us)** Now!

(But a lot Tried to Stop us)

- **Project scale**
  - First comprehensive housing-dining masterplan in the 328-year history of the institution, aiming to renovate and/or replace 80% of the existing housing-dining building portfolio
  - West Woods project includes ~430,000 GSF of new construction w/ 1,400 beds across two phases



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- **New (and maybe scary) systems**
  - Geothermal hadn’t been used on this size of project at W&M
  - User expectations of controllability and comfort
  - Anxiety about maintainability on behalf of facilities management

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- **Volatile political and economic factors**
  - Uncertainty of funding availability
  - Unexpected tariffs on raw materials, equipment, and country of origin

Project Introduction

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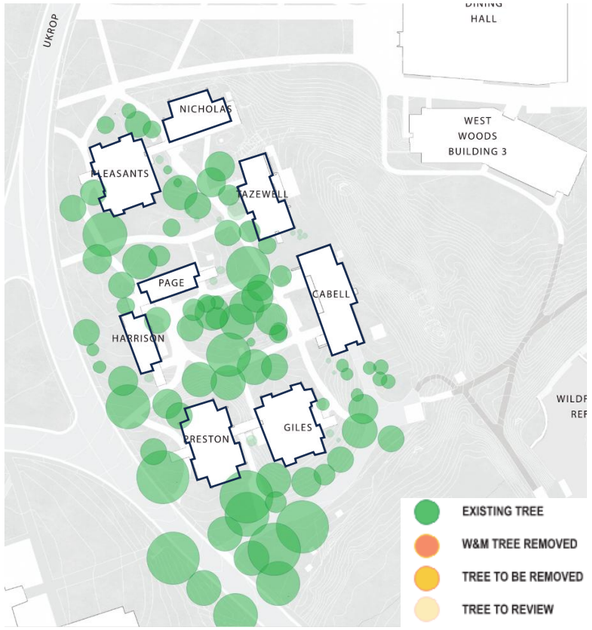
- Second phase of West Woods student residential development at William & Mary
- Demo of existing buildings, construction of 133,000 GSF w/ 455 beds
- $86.2M budget
- Design schedule: fall ‘24 – fall ’25
- Anticipated opening fall ‘28

Project Introduction

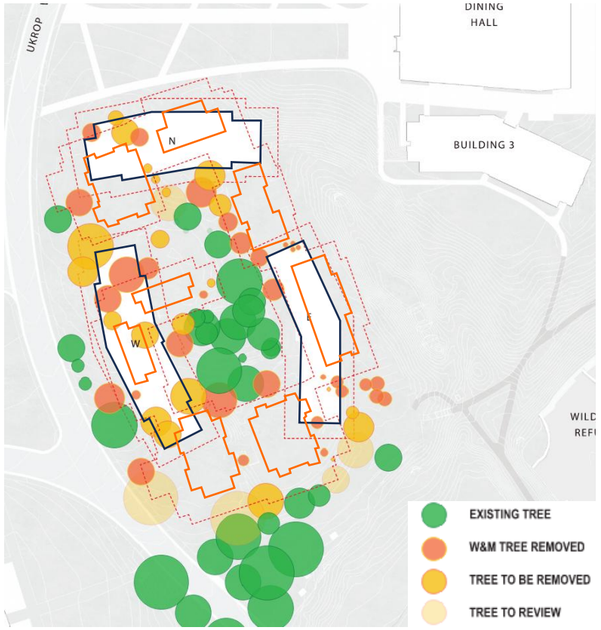
- Project RFP described a "LEED-Silver minimum" project
- W&M’s goal of carbon neutrality by 2030
- Early goal-setting session with all stakeholders was key (and regular check ins during design)
- Let's go beyond the RFP...

Project Introduction

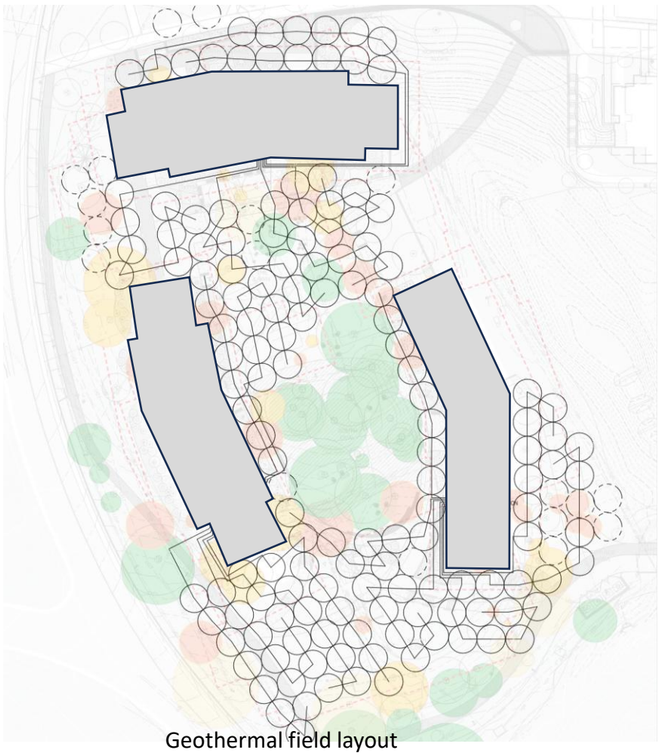
- Tree preservation drove site strategy
- New buildings within footprints of demolished
- Careful tree survey
- Right-sizing of geothermal wellfield



existing site- buildings & trees



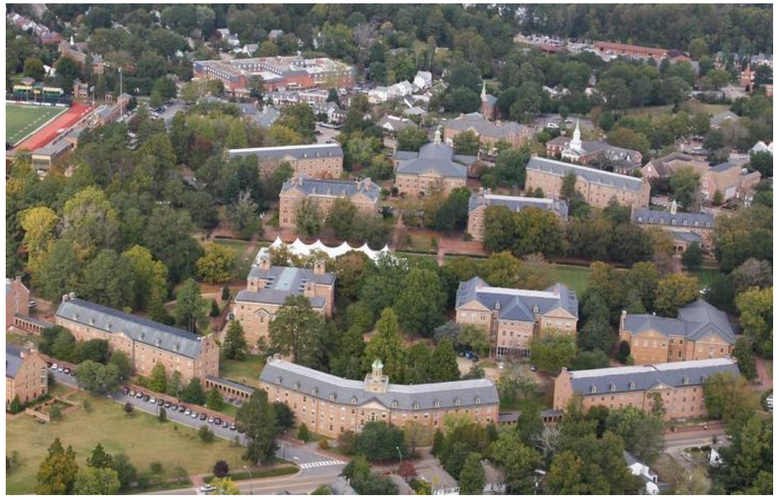
building-tree coordination

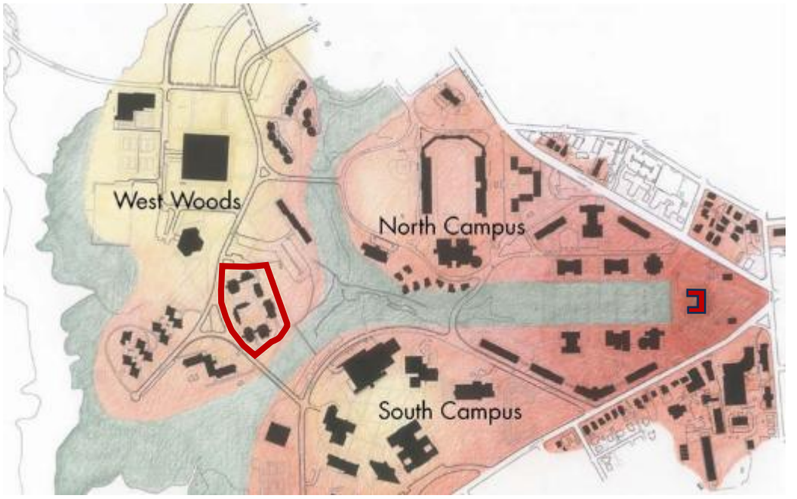


Geothermal field layout

Project Introduction

- Architectural massing and cladding strategies must adhere to strict design guidelines and face review by multiple state and local agencies
- Free to interpret Neo-Georgian ideals, but there were guiderails
- Limit to passive strategies we could integrate
- Roof-integral PV was not an option
- Operable windows were non-negotiable





An Iterative Design Process

Discover → **Develop** → **Decide**

Schematic Design

Baseline and High-Performance envelope analysis

Passive House feasibility study

Early LEED energy analysis

Life Cycle cost analysis
3 mechanical system configurations

Design Development

Strategic glazing percentage reduced

Mechanical system determined

Building envelope optimized

Advanced glazing performance analysis

Construction Drawings

Revised Passive House feasibility

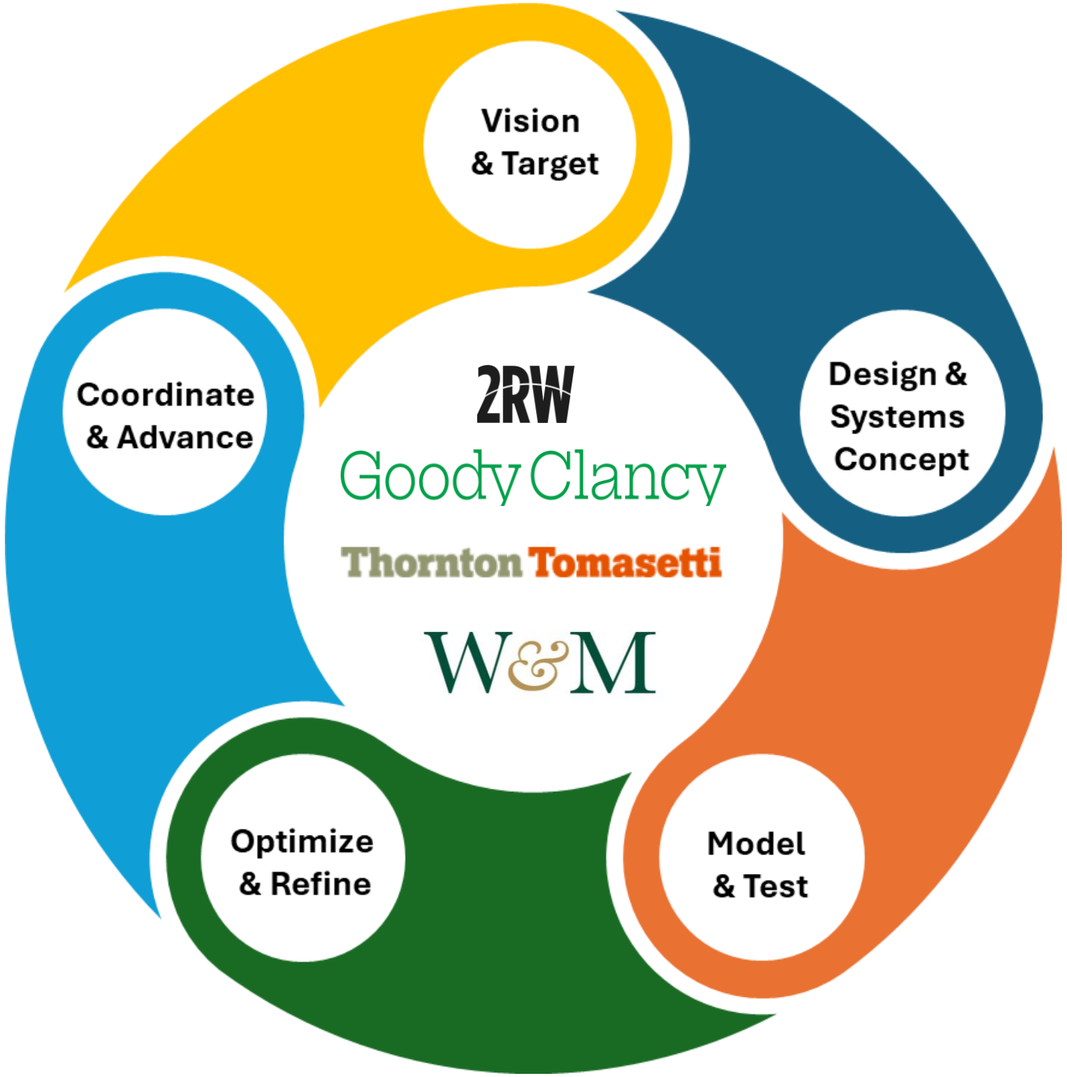
Updated LEED energy analysis

Revised system load calculations

ALL ELECTRIC THERMAL INDEPENDENCE – ACHIEVED!

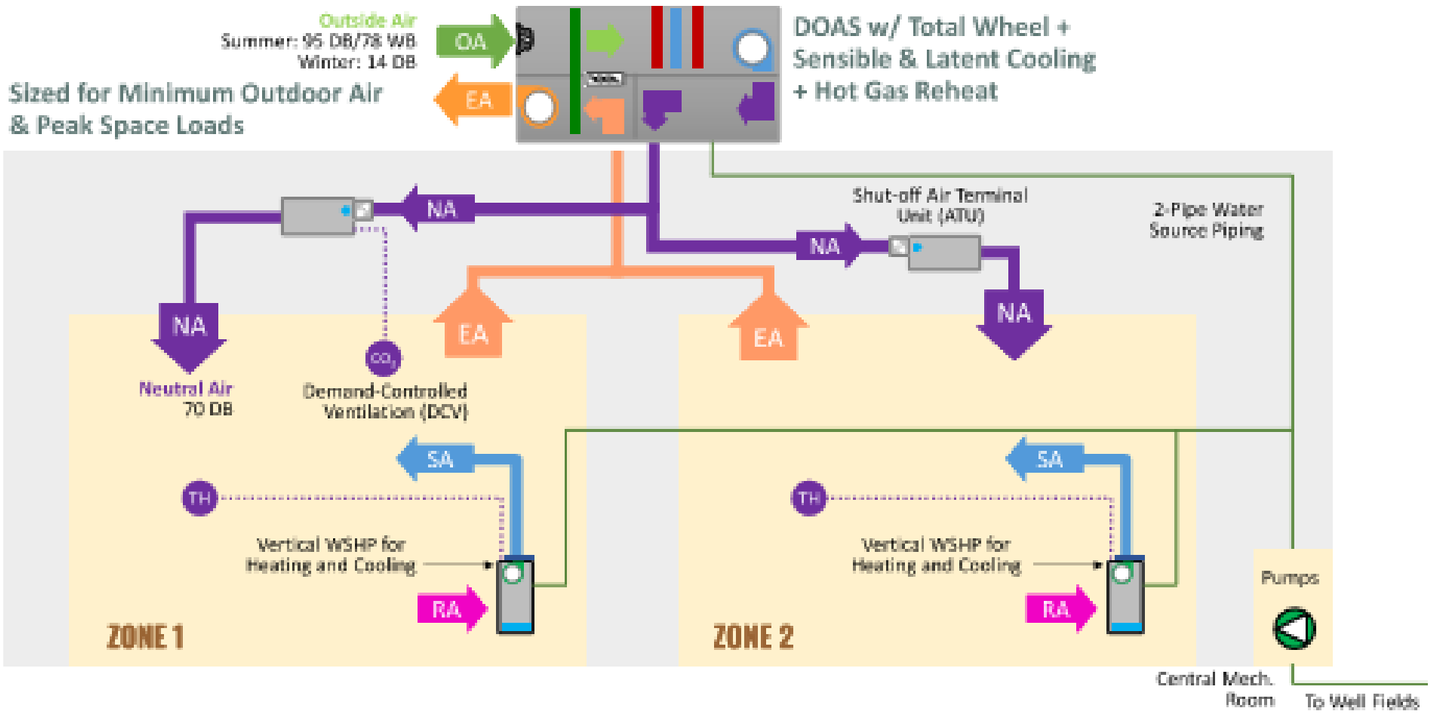
The Success of an Iterative Design Process

- **System priorities**
  - Geothermal
  - Controllability and comfort
  - Maintainability
- **Iterative design process**
  - Site constraints: limited wells
  - Backup plan: chilled water injection loop
  - Energy model analysis
  - Envelope improvements = reduction in cooling needs

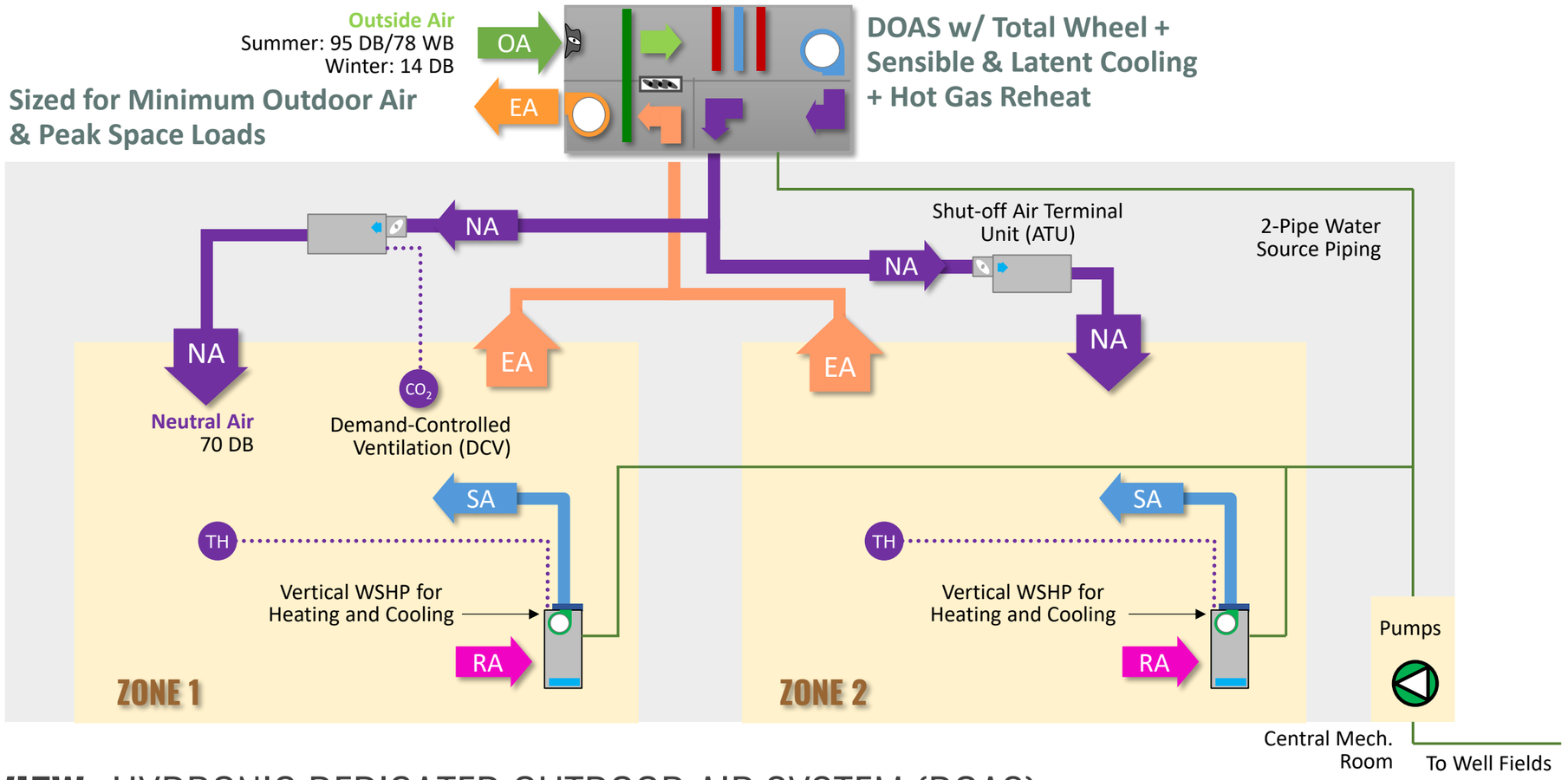


Systems Selection

- **Water Source Heat Pump w/ DOAS**
- **Fancoil w/ DOAS**
- **Heat Recover Chiller w/ Geothermal & DOAS**

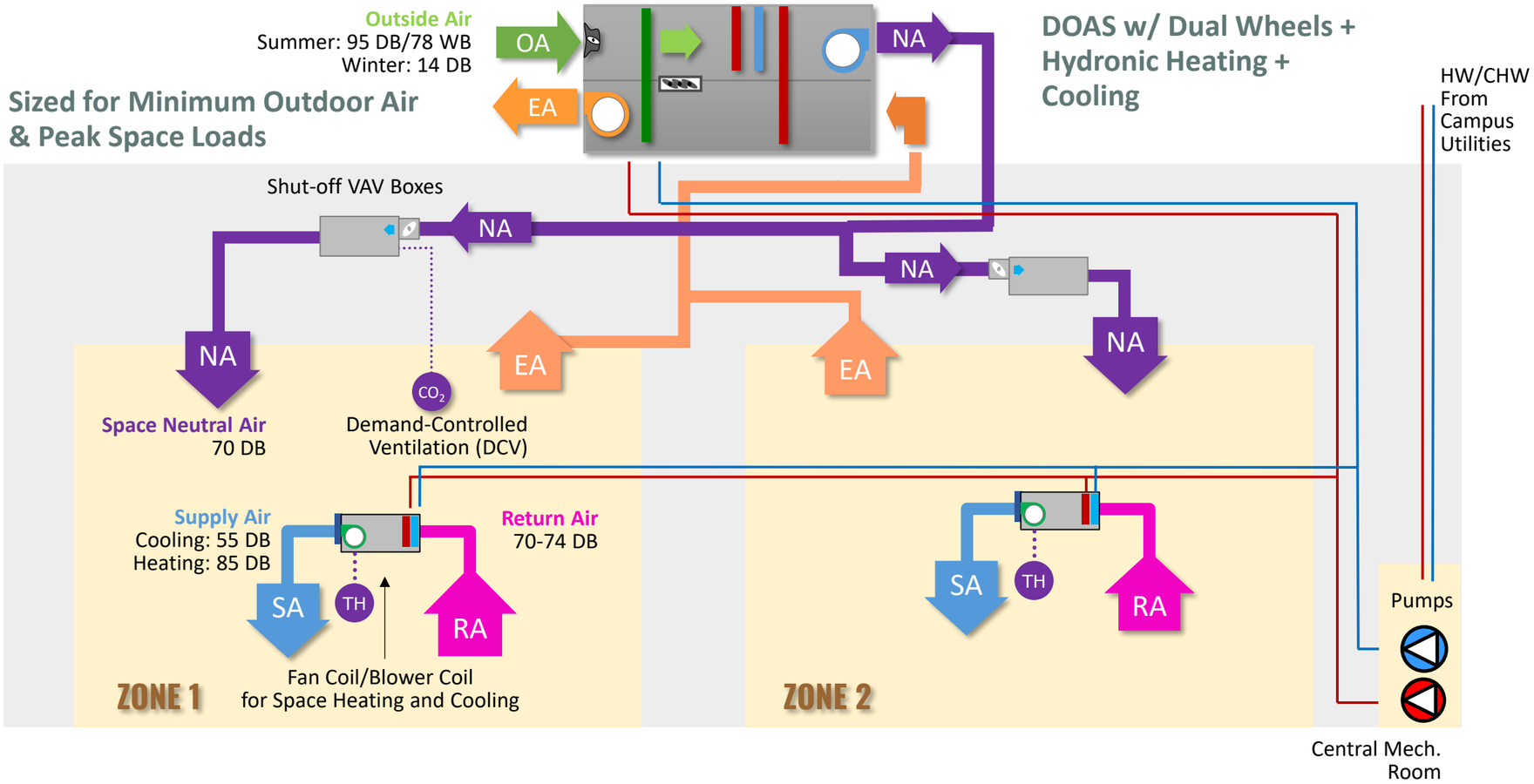


Systems Selection



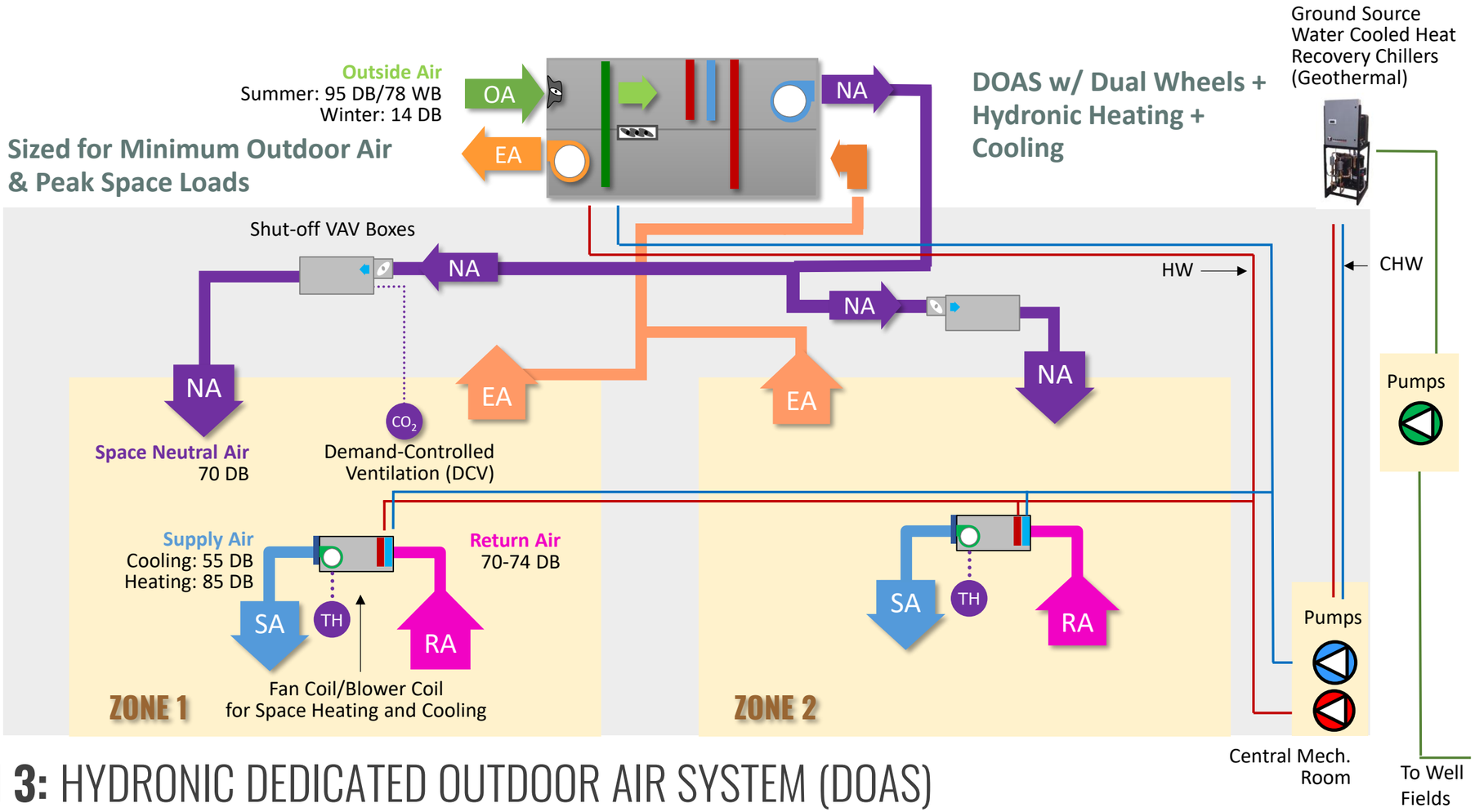
SYSTEM OVERVIEW: HYDRONIC DEDICATED OUTDOOR AIR SYSTEM (DOAS) W/ WATER SOURCE HEAT PUMP (WSHP) (GEOTHERMAL)

Systems Selection



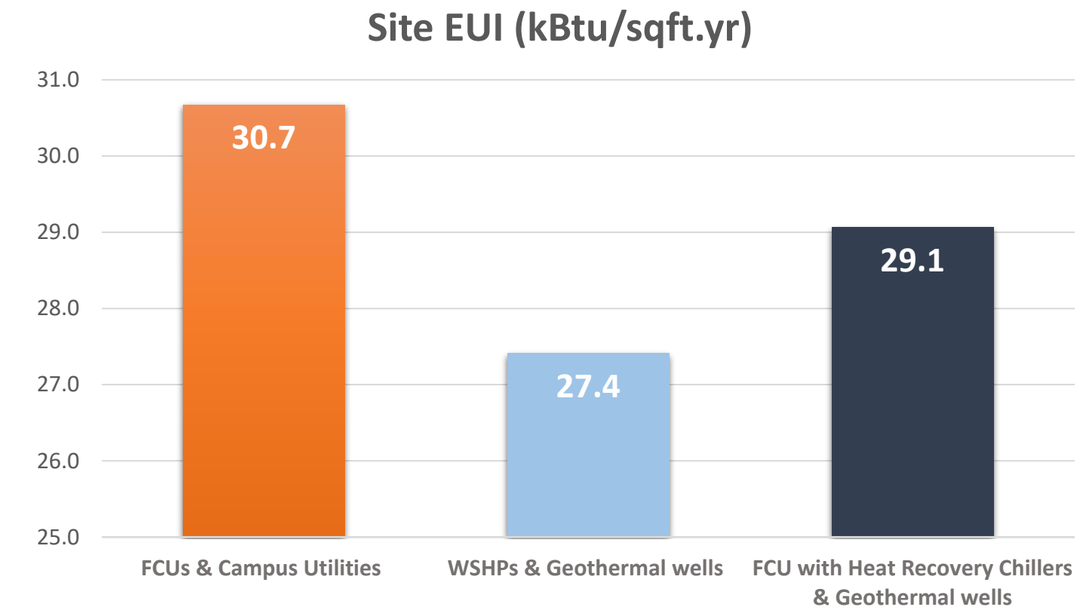
DESIGN OPTION 2: HYDRONIC DEDICATED OUTDOOR AIR SYSTEM (DOAS) W/ FAN COIL/BLOWER COIL FROM CAMPUS UTILITIES.

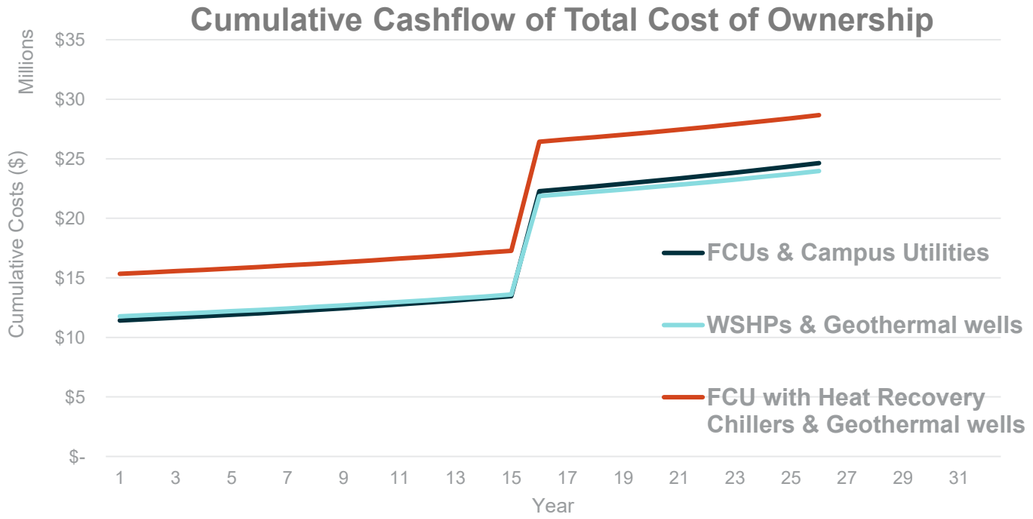
Systems Selection

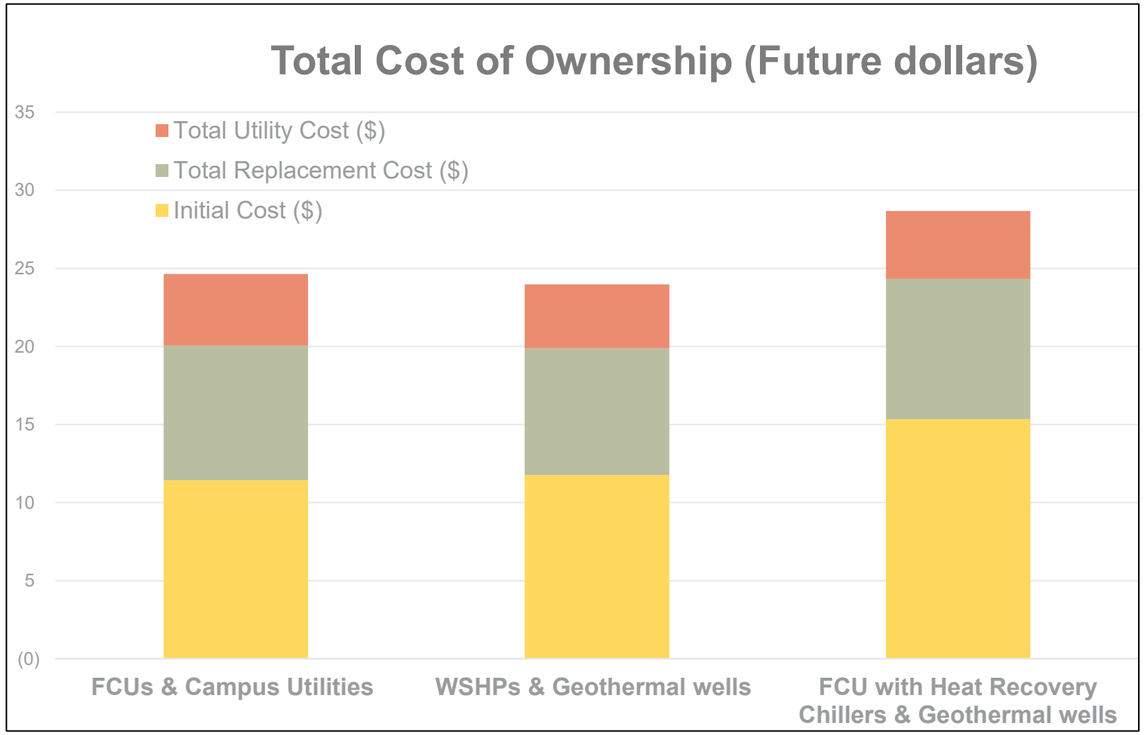


DESIGN OPTION 3: HYDRONIC DEDICATED OUTDOOR AIR SYSTEM (DOAS) W/ FAN COIL/BLOWER COIL & HEAT RECOVERY CHILLERS (GEOTHERMAL)

Systems Life Cycle Cost Analysis







	Total Cost Of Ownership ($)
FCUs & Campus Utilities	24,638,179
WSHPs & Geothermal wells	23,973,104
FCU with Heat Recovery Chillers & Geothermal wells	28,670,059

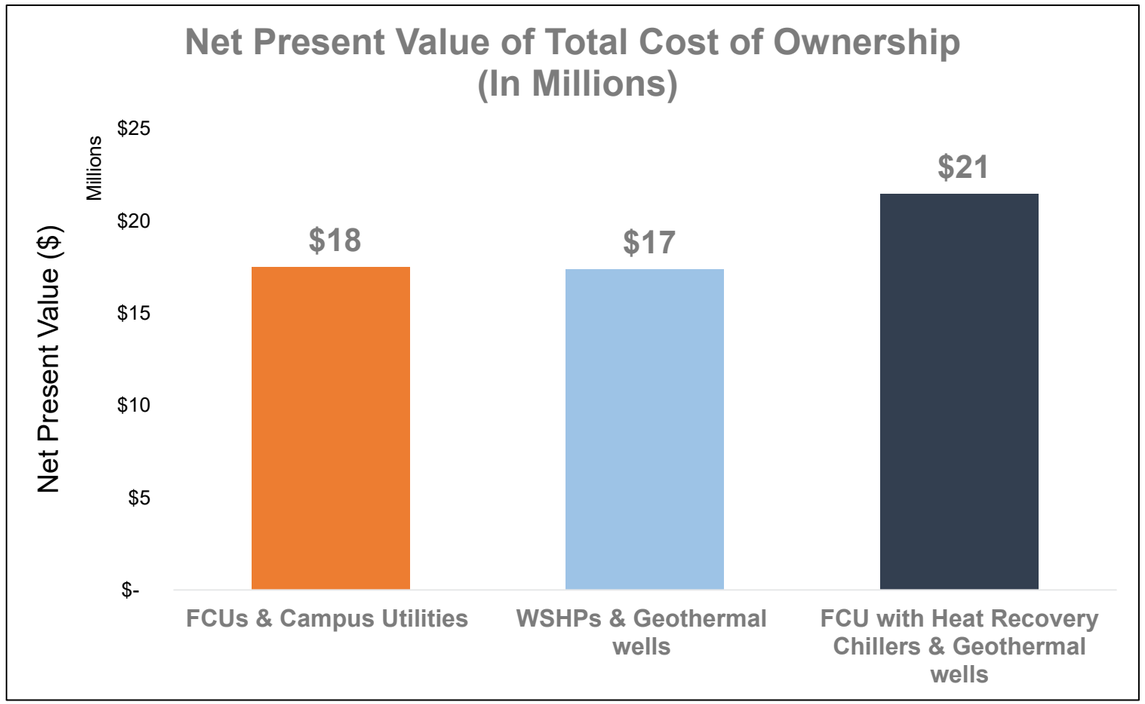
Systems Life Cycle Cost Analysis

Net Present Value of Total Cost of Ownership:

- Total lifetime cost (purchase, installation, energy, maintenance, replacements, etc.) converted into today's dollars so you can compare options fairly

NPV of TCO:

- FCUs & Campus Utilities - **$17,505,820**
- WSHPs & Geothermal wells - **$17,385,000**
- FCU with HRC & Geo wells - **$21,470,000**

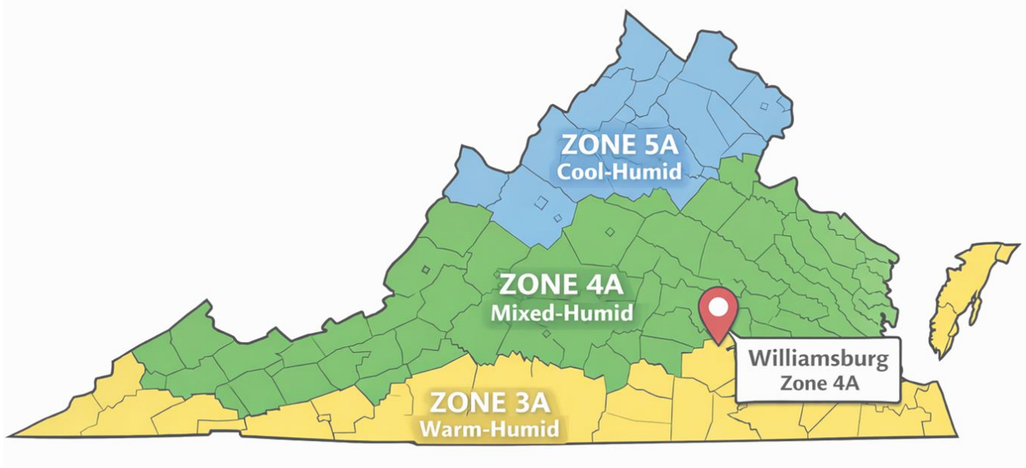


	Year of Payback
FCUs & Campus Utilities	--
WSHPs & Geothermal wells	15
FCU with Heat Recovery Chillers & Geothermal wells	None

Design Criteria: Applicable Codes

Energy Codes

Virginia vs. Massachusetts



Aspect	Massachusetts DOER Energy Code	Virginia (VECC + VEES)
Baseline Code	2021 IECC with MA amendments	2021 IECC with Virginia amendments
Climate Zone	5A Cool-Humid	4A Mixed Humid
Code Structure	Base, Stretch, Specialized tiers	**Single statewide energy code** - Virginia Energy Conservation and Environmental Standard (VEES) applies to State funded buildings
Campus Housing Applicability	R-2/R-4; tier affects performance targets	IECC-based, Compliance via ASRAE 90.1-2019 modeling comparison VEES: High Performance Reqs – CWM took LEED pathway
Compliance Paths	Prescriptive or advanced performance pathways	IECC prescriptive or performance modeling
Electrification Policy	Specialized promotes electrification	No electrification requirement
Renovations/Additions	Stretch: new & reno; Specialized: new only	IECC existing building provisions
Utility Efficiency Policy	Mass Save supports higher-tier compliance	VEES drives incentives; not a mandate

Design & Analysis:
Passive House Analysis & Process: North Building

Baseline:

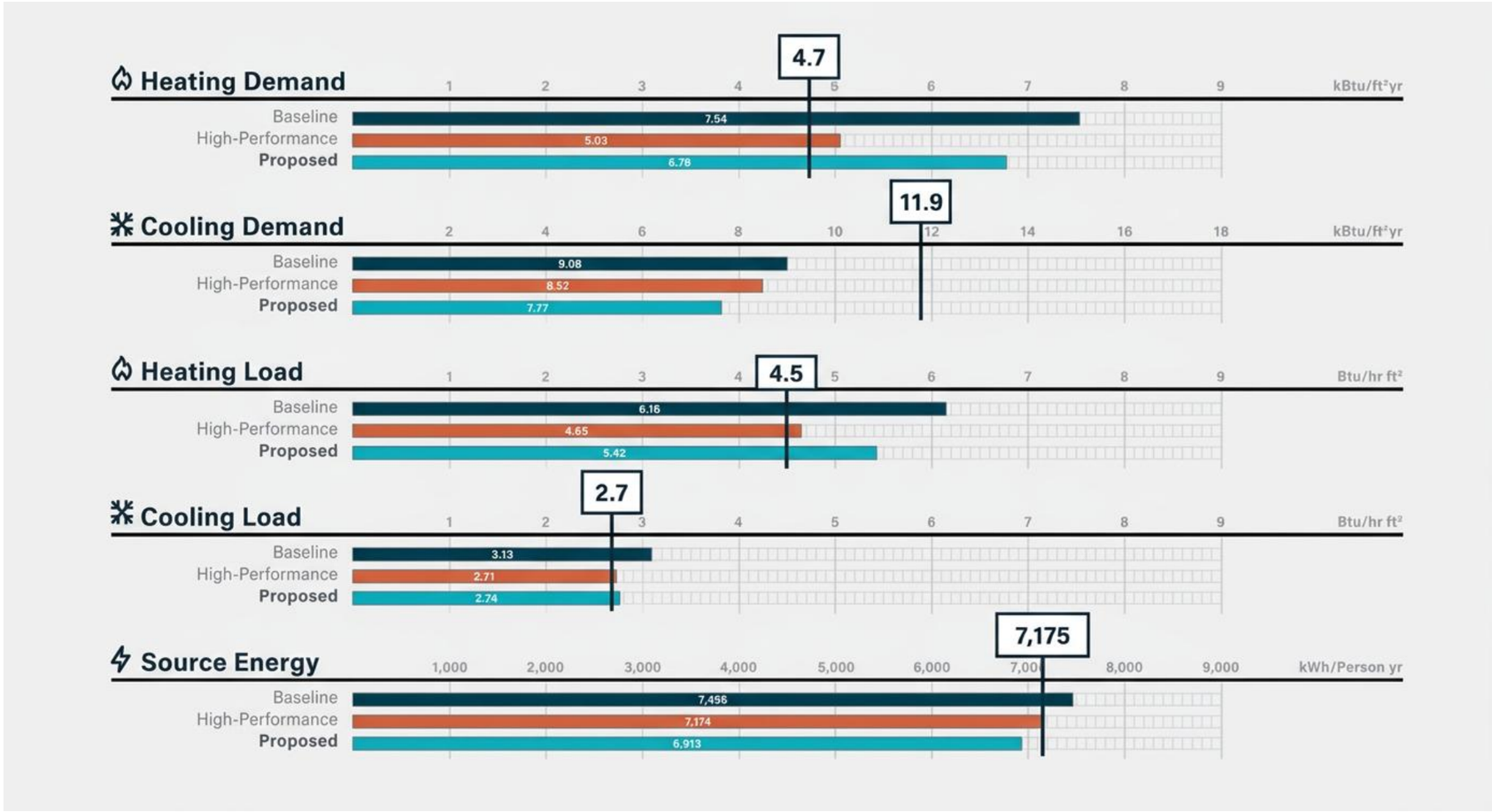
- Roof: R-25 | Wall: R-25 | Slab: R-10
- Double Glazed Windows & Curtainwalls
- SHGC of 0.32
- Airtightness 0.10 CFM50/SSF

High Performance:

- Roof: R-40 | Wall: R-25 | Slab: R-10
- Triple Glazed Windows & Curtainwalls
- SHGC reduces to 0.22
- Airtightness reduced to 0.06 CFM50/SSF

Proposed:

- Reduce WWR by 5%
- Roof: R-25 | Wall: R-25 | Slab: R-10
- Double Glazed Windows & Curtainwalls
- SHGC optimized to 0.27 on North, East & South & 0.22 on West façade
- Airtightness 0.10 CFM50/SSF



Proposed to Phius: Triple Glazed Windows & Curtainwalls | SHGC of 0.27 on all façades | Airtightness reduced to 0.06 CFM50/SSF

Design & Analysis:
Passive House Analysis & Process East Building

Baseline:

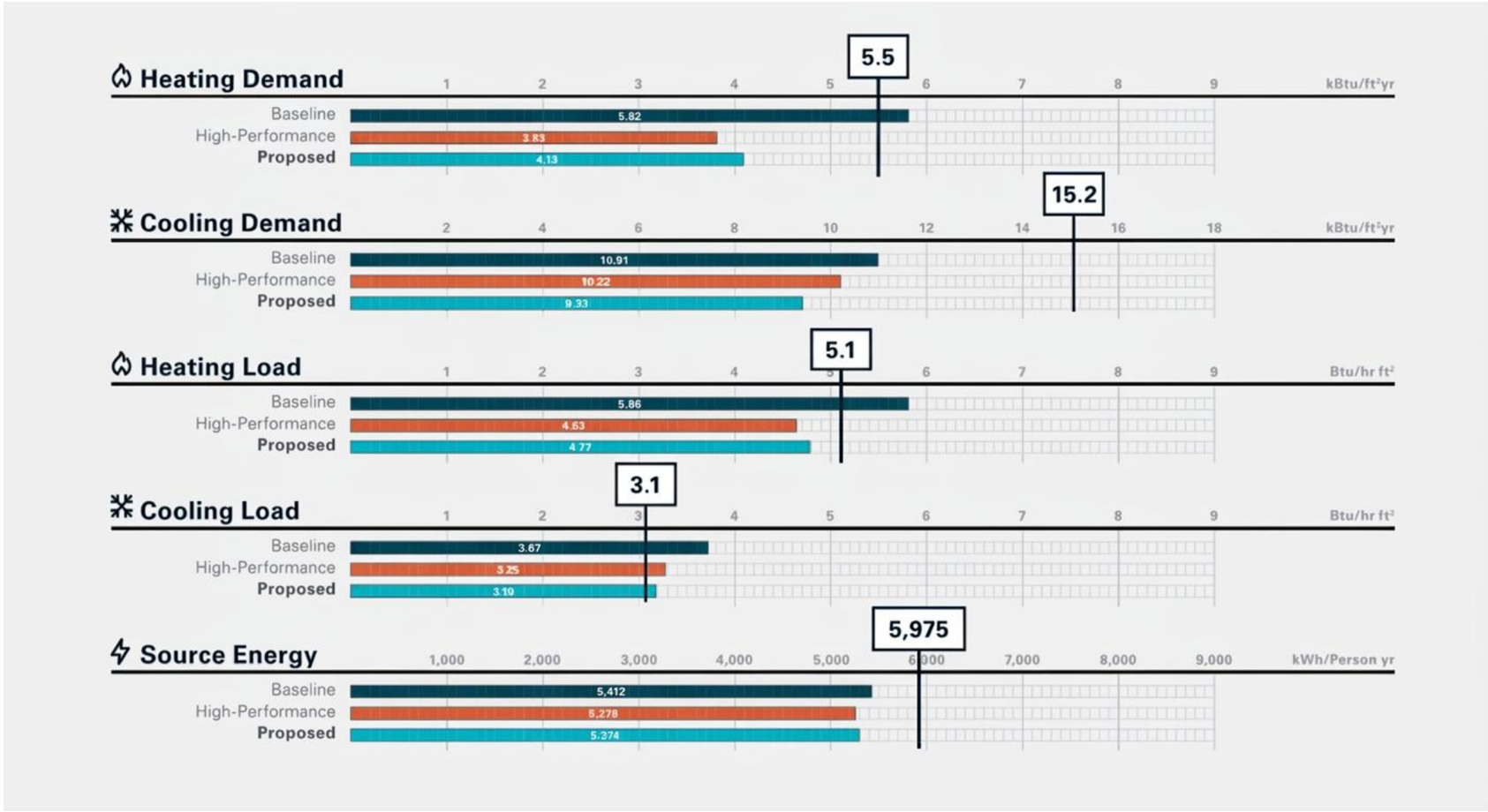
- Roof: R-25 | Wall: R-25 | Slab: R-10
- Double Glazed Windows & Curtainwalls
- SHGC of 0.32
- Airtightness 0.10 CFM50/SSF

High Performance:

- Roof: R-40 | Wall: R-25 | Slab: R-10
- Triple Glazed Windows & Curtainwalls
- SHGC reduces to 0.22
- Airtightness reduced to 0.06 CFM50/SSF

Proposed:

- Reduce WWR by 7%
- Roof: R-25 | Wall: R-25 | Slab: R-10
- Double Glazed Windows & Curtainwalls
- SHGC optimized to 0.27 on North, East & South & 0.22 on West façade
- Airtightness 0.10 CFM50/SSF



Proposed to Phius: Triple Glazed Curtainwalls (to meet PH comfort) | SHGC of 0.22 on all façades | Airtightness reduced to 0.06 CFM50/SSF

Design & Analysis:
Passive House Analysis & Process West Building

Baseline:

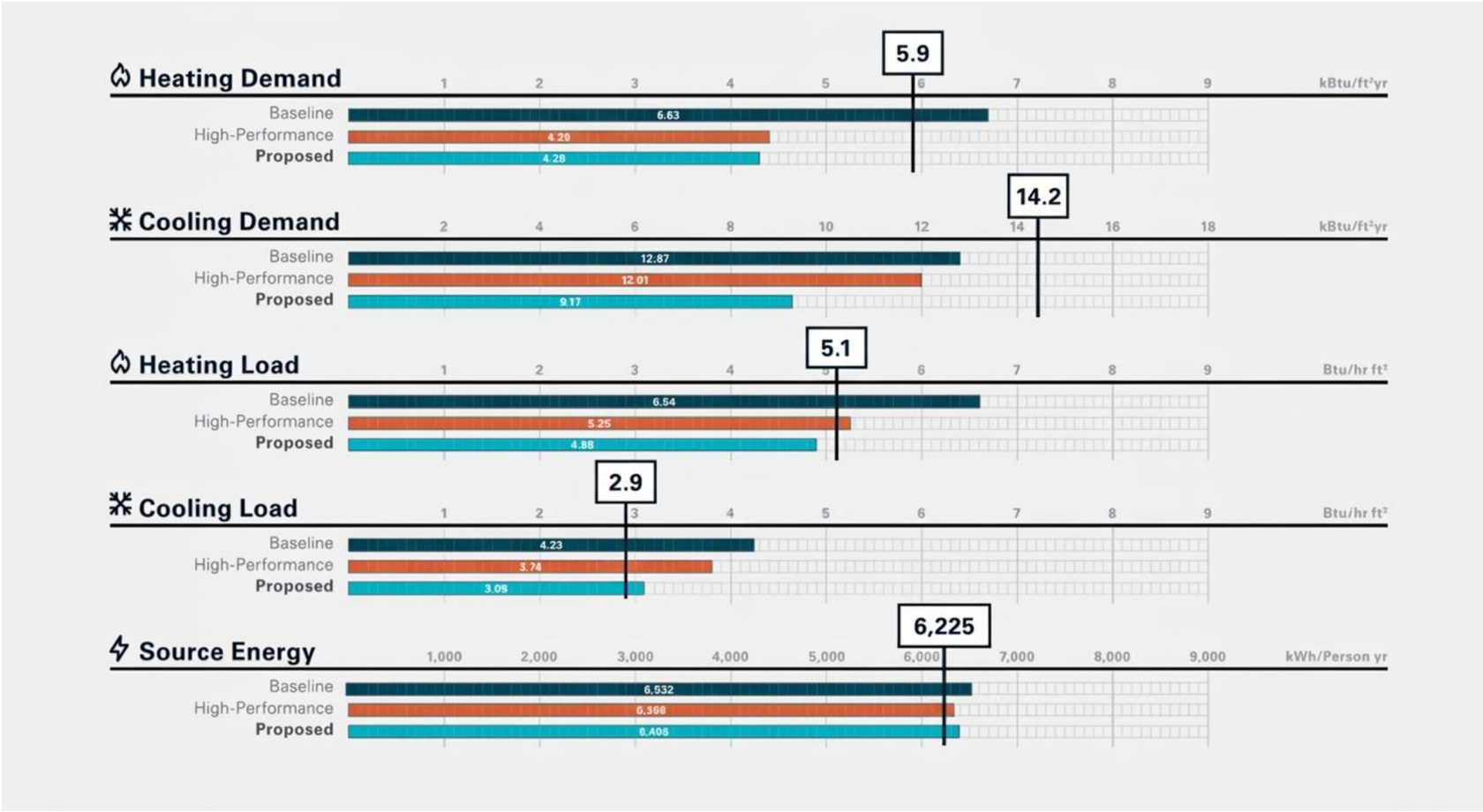
- Roof: R-25 | Wall: R-25 | Slab: R-10
- Double Glazed Windows & Curtainwalls
- SHGC of 0.32
- Airtightness 0.10 CFM50/SSF

High Performance:

- Roof: R-40 | Wall: R-25 | Slab: R-10
- Triple Glazed Windows & Curtainwalls
- SHGC reduces to 0.22
- Airtightness reduced to 0.06 CFM50/SSF

Proposed:

- Reduce WWR by 4%
- Roof: R-25 | Wall: R-25 | Slab: R-10
- Double Glazed Windows & Curtainwalls
- SHGC optimized to 0.27 on North, East & South & 0.22 on West façade
- Airtightness 0.10 CFM50/SSF



Proposed to Phius: Triple Glazed Windows & Curtainwalls | R-40 Roof | SHGC of 0.22 on all façades | Airtightness reduced to 0.06 CFM50/SSF

Design & Analysis: Glazing Comparison

Double vs. Triple Glazing

Energy modeling evaluated double vs. triple glazing. Triple glazing significantly improves heating performance and reduces peak loads. The incremental capital cost is high relative to the energy savings—particularly for cooling.

Lower operational cost savings are primarily due to the already high efficiency of the heat pump systems, not a lack of performance benefit from triple glazing.

Performance Impact:

- Cooling Energy: 0.4% reduction
- Peak Cooling: 8.3% reduction
- Heating Energy: 14.7% reduction
- Peak Heating: 17.7% reduction

Incremental Cost: +$600K

	All DGU	All TGU	North Building			East Building			West Building		
Punch Window	DGU	TGU	TGU	DGU	TGU	TGU	DGU	TGU	TGU	DGU	TGU
Curtainwall	DGU	TGU	DGU	TGU	TGU	DGU	TGU	TGU	DGU	TGU	TGU
Cooling											
Energy Demand *Mbtu /yr*	1910.5	1903.4	1922.7	1920.1	1932.4	1922.3	1914.5	1926.4	1921.0	1917.5	1928.0
Savings over All DGU	0.00%	0.37%	-0.64%	-0.50%	-1.14%	-0.62%	-0.21%	-0.83%	-0.55%	-0.37%	-0.92%
Peak Load *kBtu/hr*	963.5	883.3	961.6	960.5	958.4	960.6	961.9	959.1	960.549	961.6	958.6
Savings over All DGU	0.00%	8.32%	0.20%	0.31%	0.54%	0.30%	0.16%	0.46%	0.31%	0.20%	0.51%
Heating											
Energy Demand *Mbtu /yr*	310.7	265.1	295.8	295.2	281.4	293.0	302.1	284.6	293.0	301.8	284.2
Savings over All DGU	0.00%	14.68%	4.79%	4.99%	9.46%	5.71%	2.77%	8.43%	5.70%	2.87%	8.53%
Peak Load *kBtu/hr*	561.2	461.6	526.0	547.7	515.8	521.0	552.5	513.0	523.4	551.5	518.0
Savings over All DGU	0.00%	17.74%	6.26%	2.41%	8.08%	7.16%	1.54%	8.58%	6.73%	1.73%	7.69%

Design & Analysis: Load Reduction from Glazing Optimization

Strategic SHGC Optimization

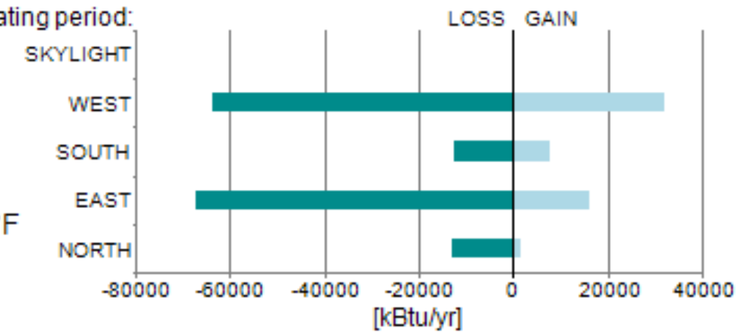
Passive House modeling was used to evaluate glazing performance by orientation and reduce cooling loads through targeted solar control. A mid-range SHGC (0.27) was applied to the north, east, and south façades, while a lower SHGC (0.22) was used on the west façade to mitigate peak solar gains. This approach achieved comparable load reductions to triple glazing in a more cost-effective manner

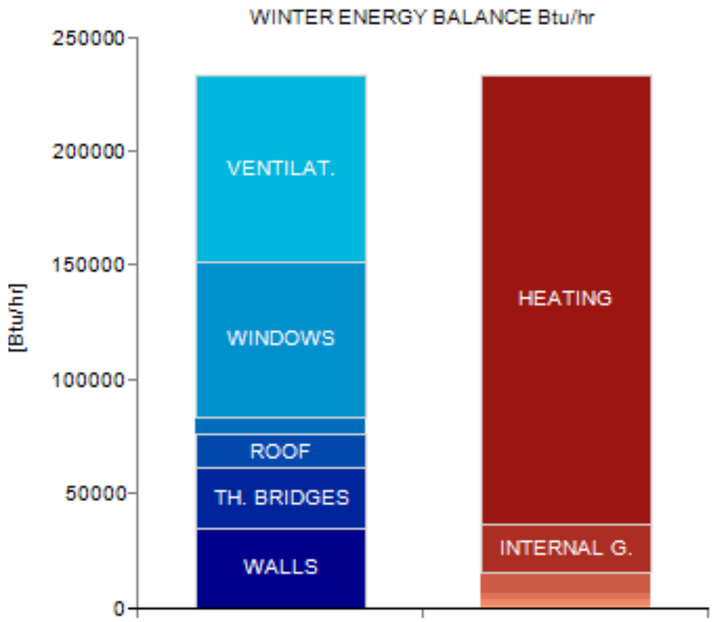
- **Cooling Energy:** 1.3% reduction
- **Peak Cooling:** 5.4% reduction
- **Heating Energy:** 3.2% reduction
- **Peak Heating:** 6.7% reduction

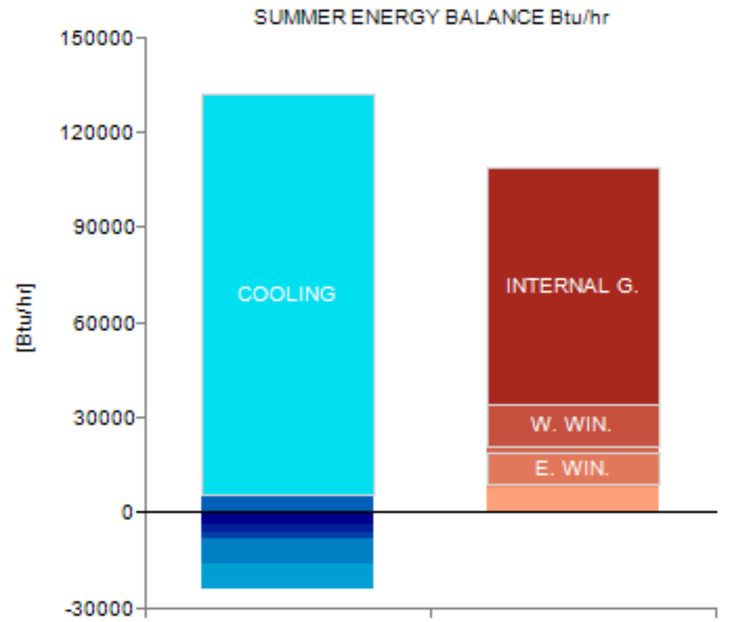
Incremental Cost: +$30K

Windows

Average SHGC:	**0.27**	
Average solar reduction factor heating:	**0.41**	
Average solar reduction factor cooling:	**0.39**	
Average U-value:	**0.302**	Btu/hr ft² °F
Total glazing area:	**3,898.4**	ft²
Total window area:	**5,427**	ft²







Energy Analysis

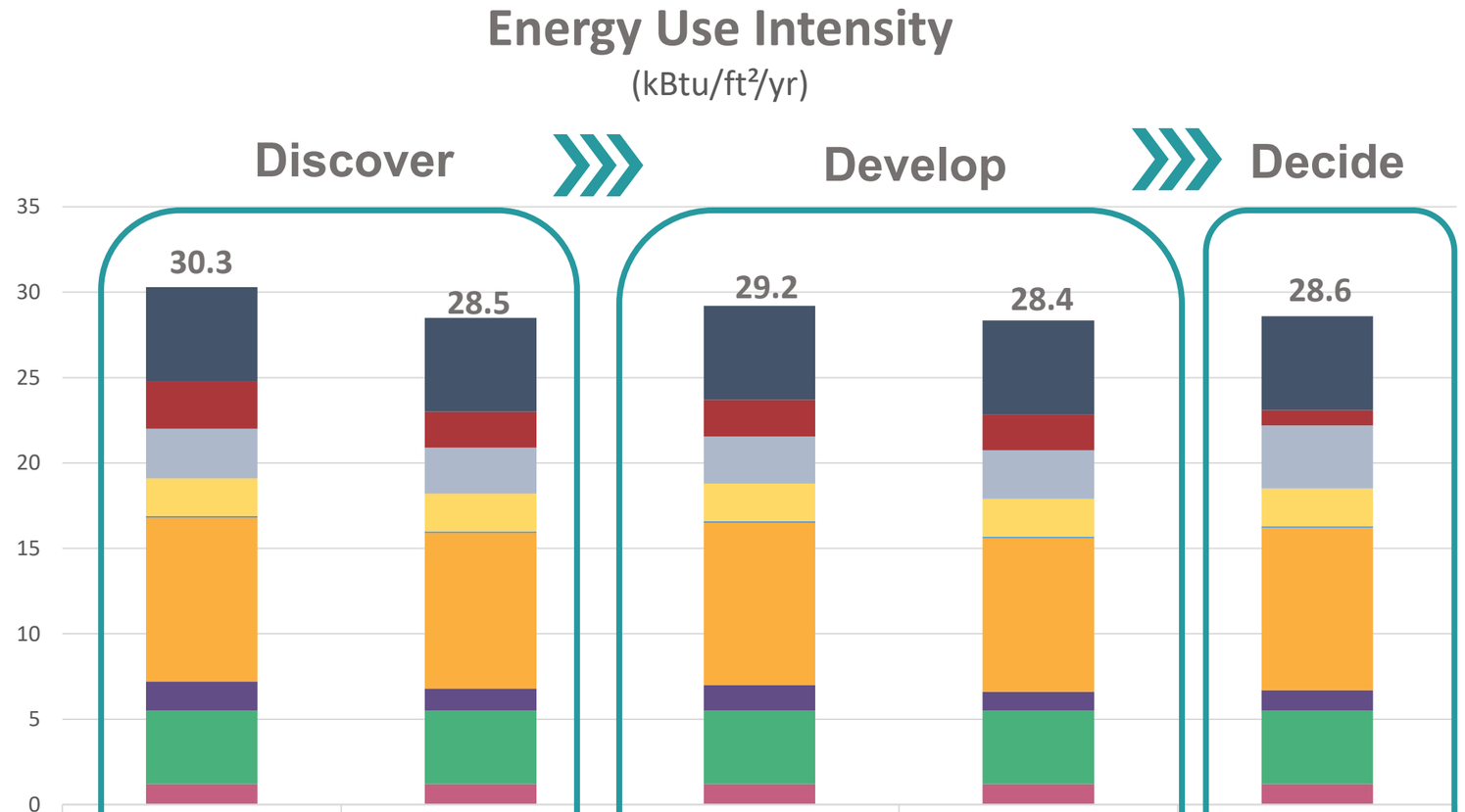
Careful implementation led to:

- Integrated envelope + systems strategy informed by energy analysis
- Reduced glazing + optimized SHGC → lower loads and right-sized systems
- Lower first costs while maintaining high performance
- Low EUI (excludes planned PV) - tracking **LEED Gold with Platinum potential**

Cost Impacts:

- Elimination of campus chilled water connection: **−$185K (direct savings)**
- Geothermal field right-sizing: **−$306K (direct savings)**
- Strategic SHGC Optimization: **+$30K**
- **Total Net Savings: −$461K**

Result: A coordinated design approach that reduced first costs while maintaining high performance, demonstrating that targeted envelope strategies can unlock significant mechanical and infrastructure savings.



	Baseline	High Performance	Proposed	Triple Glazed Windows	SHGC Optimization
Domestic Hot Water	5.5	5.5	5.5	5.5	5.5
Space Heating	2.8	2.1	2.2	2.1	0.9
Space Cooling	2.9	2.7	2.8	2.9	3.7
Internal Lighting	2.2	2.2	2.2	2.2	2.2
Exterior Lighting	0.1	0.1	0.1	0.1	0.1
Vent Fans	9.6	9.1	9.5	9	9.5
Pumps	1.7	1.3	1.5	1.1	1.2
Misc Equip	4.3	4.3	4.3	4.3	4.3
Elevators	1.2	1.2	1.2	1.2	1.2

(But They *Didn't* Stop Us)

- **Project scale**
  - First comprehensive housing-dining masterplan in the 328-year history of the institution, aiming to renovate and/or replace 80% of the existing housing-dining building portfolio
  - Phased project: phase 1 ~300,000 GSF w/ 939 beds, phase 2 ~ 133,000 GSF w/ 455 beds
  - Phase 2 (our project) designed during construction of phase 1

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  - Phase 2 (our project) designed during construction of phase 1

- Understand and acknowledge the importance of this project
- Be nimble and able to adopt the lessons learned (on the fly) from previous and ongoing projects
- **Focus on small design decisions that make a big difference- things can scale quickly**
- **Optimized building massing and orientation that supports passive strategies**

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  - Geothermal hadn't been used on this size of project
  - User expectations of controllability and comfort
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- Continued and regular engagement with all stakeholders
- Temper user expectations
- Facilitate tours and discussions with building maintainers and system vendors
- **Let data drive decision-making**
- **Right-sized, efficient mechanical systems matched to reduced loads**
- **Integrated strategies for electrification and future decarbonization**

(But They *Didn't* Stop Us)

- **Volatile political and economic factors**
  - Uncertainty of funding availability
  - Unexpected tariffs on raw materials, equipment, and country of origin

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- Leverage the knowledge and assistance of peers, Construction Managers, to make informed decisions on market trends
- Identify design and project goals- what's firm and what can be influenced by value management
- Have alternates in your back pocket
- **Identify priorities and impacts- collaborative buy in makes tough decisions easier to make**
- **A constructible solution within budget and schedule constraints**
- **Strategic glazing optimization balancing area and solar heat gain to deliver near–triple glazing performance at lower cost**

Q&A

Contact Us

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Thank you!

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