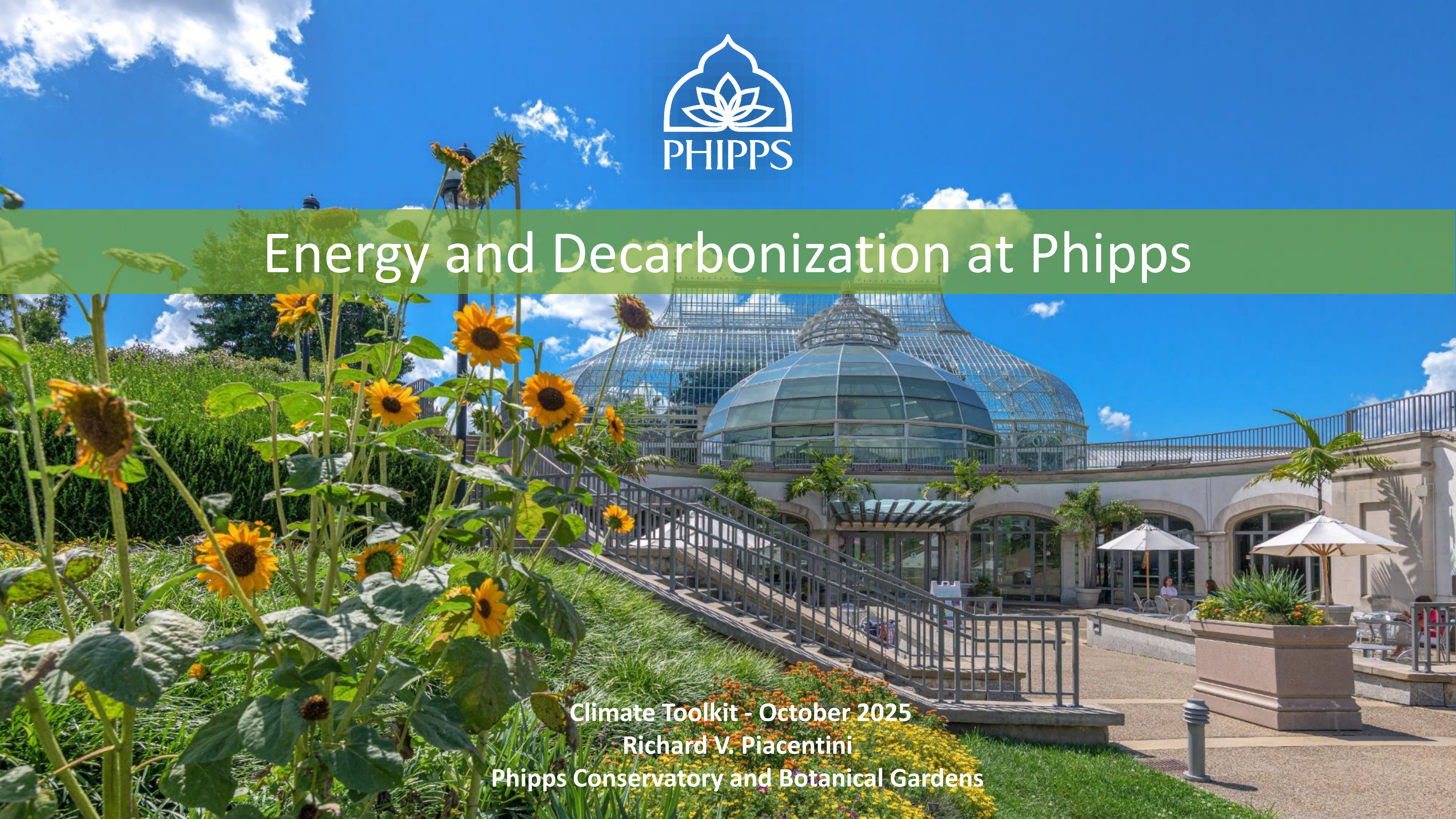
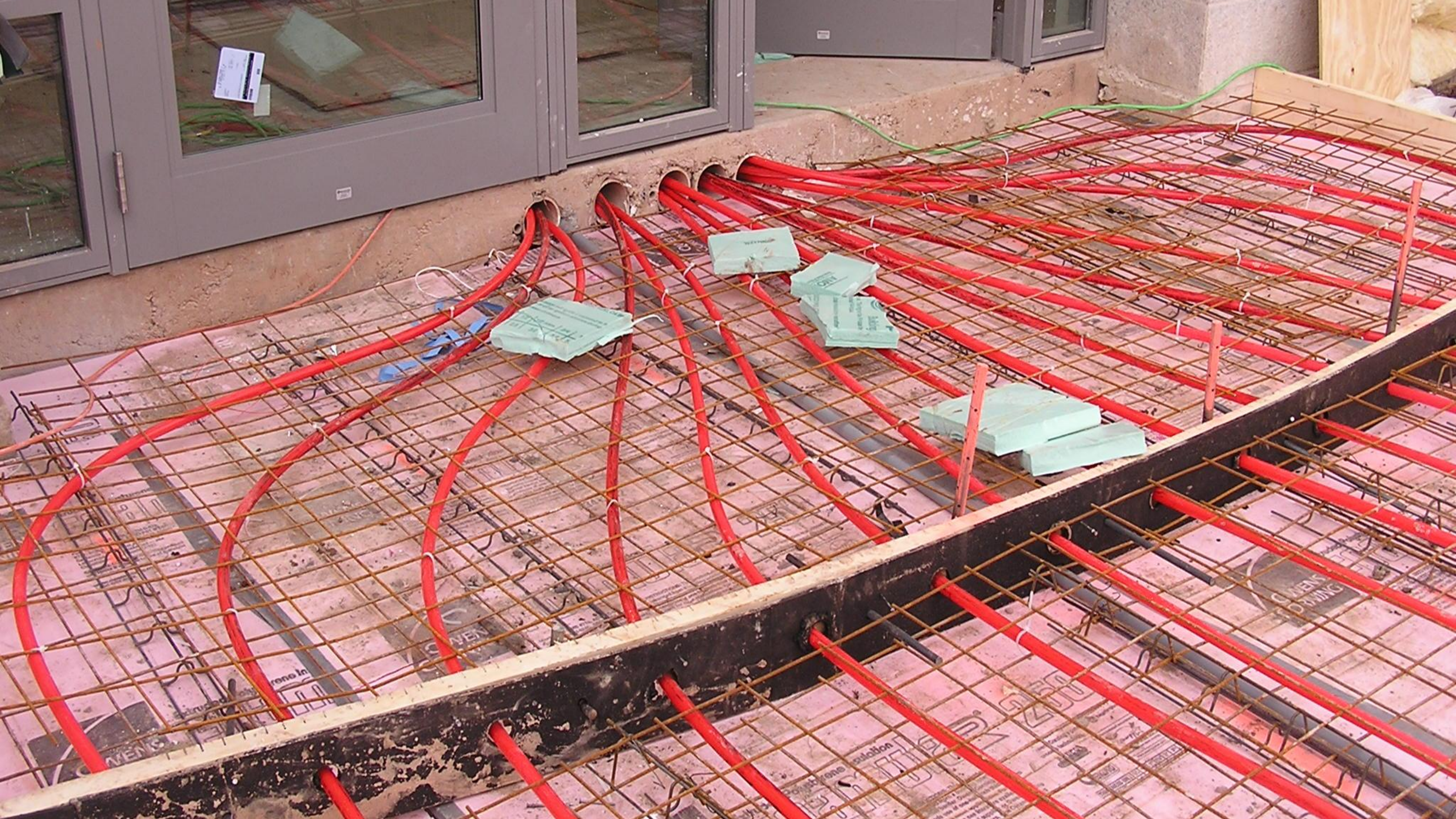


Energy and Decarbonization at Phipps

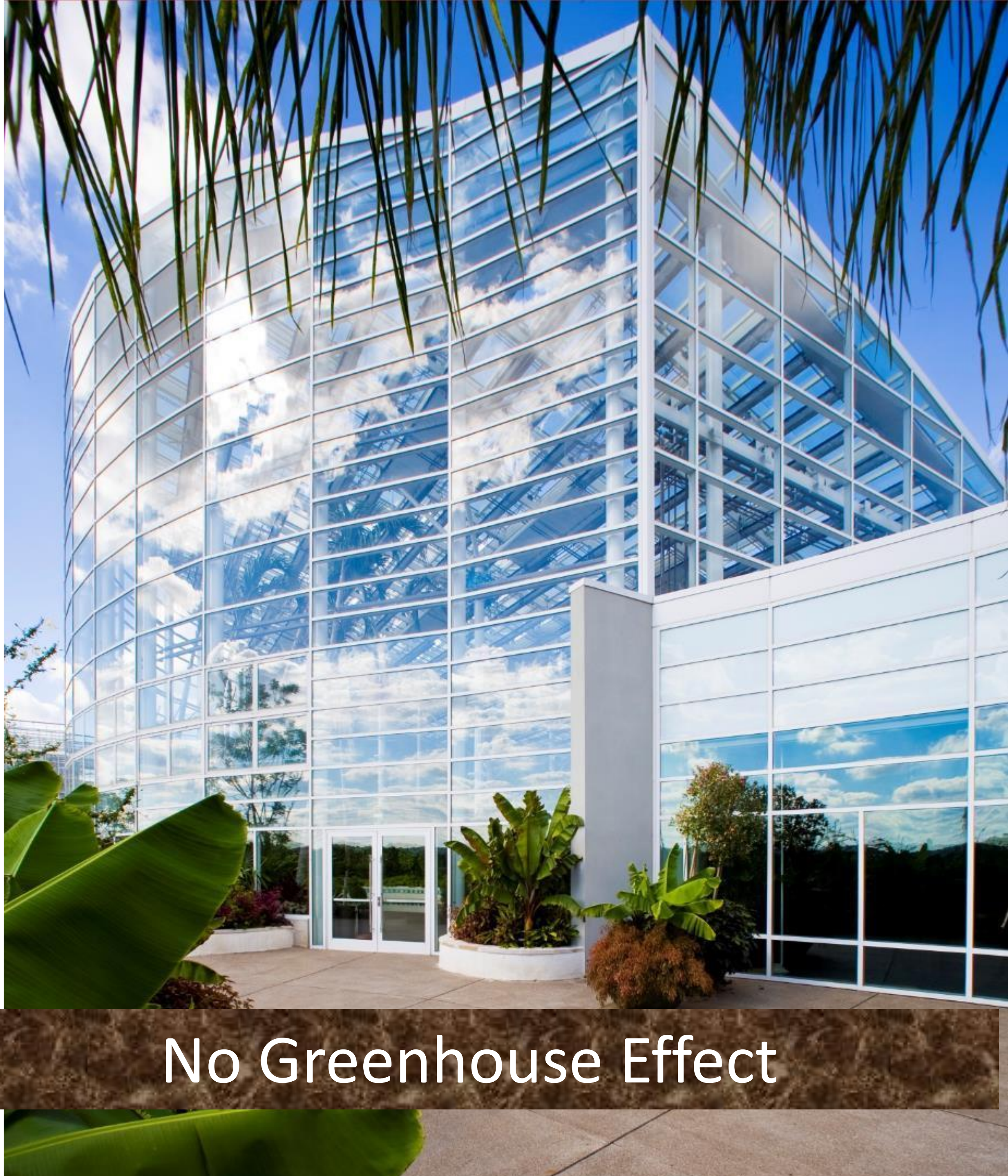
Climate Toolkit - October 2025

Richard V. Piacentini
Phipps Conservatory and Botanical Gardens

Visitor Center

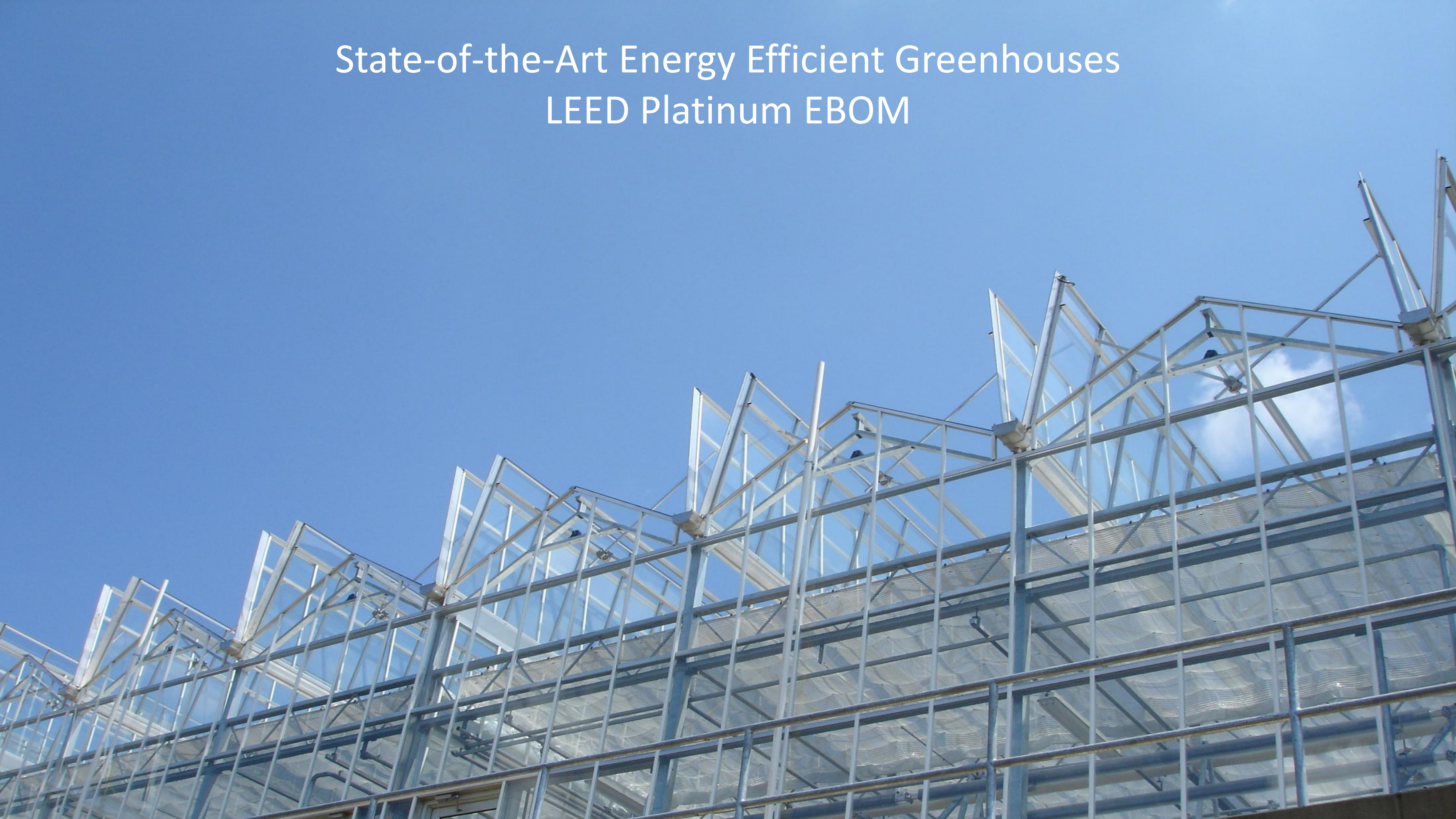


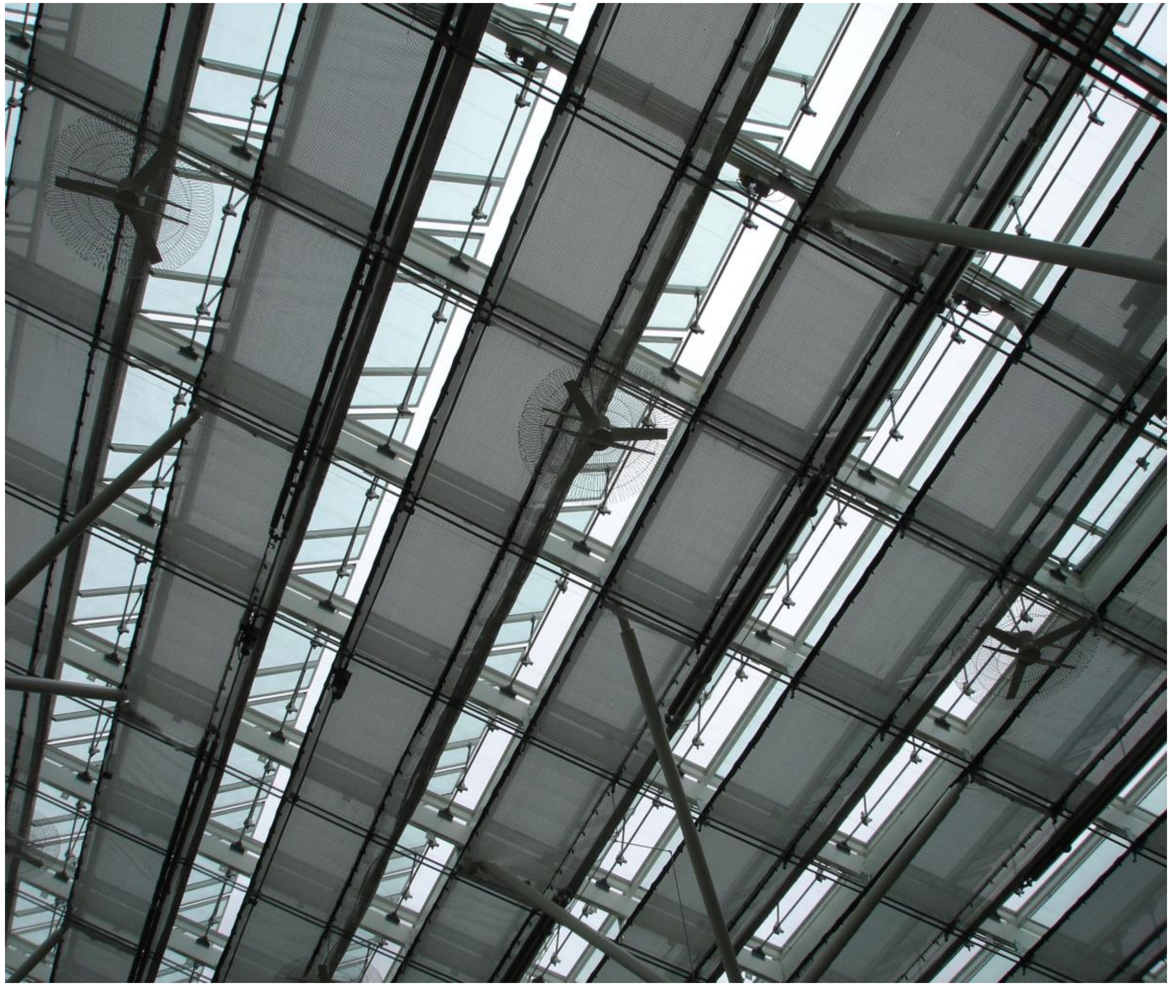
Greenhouses and Conservatory

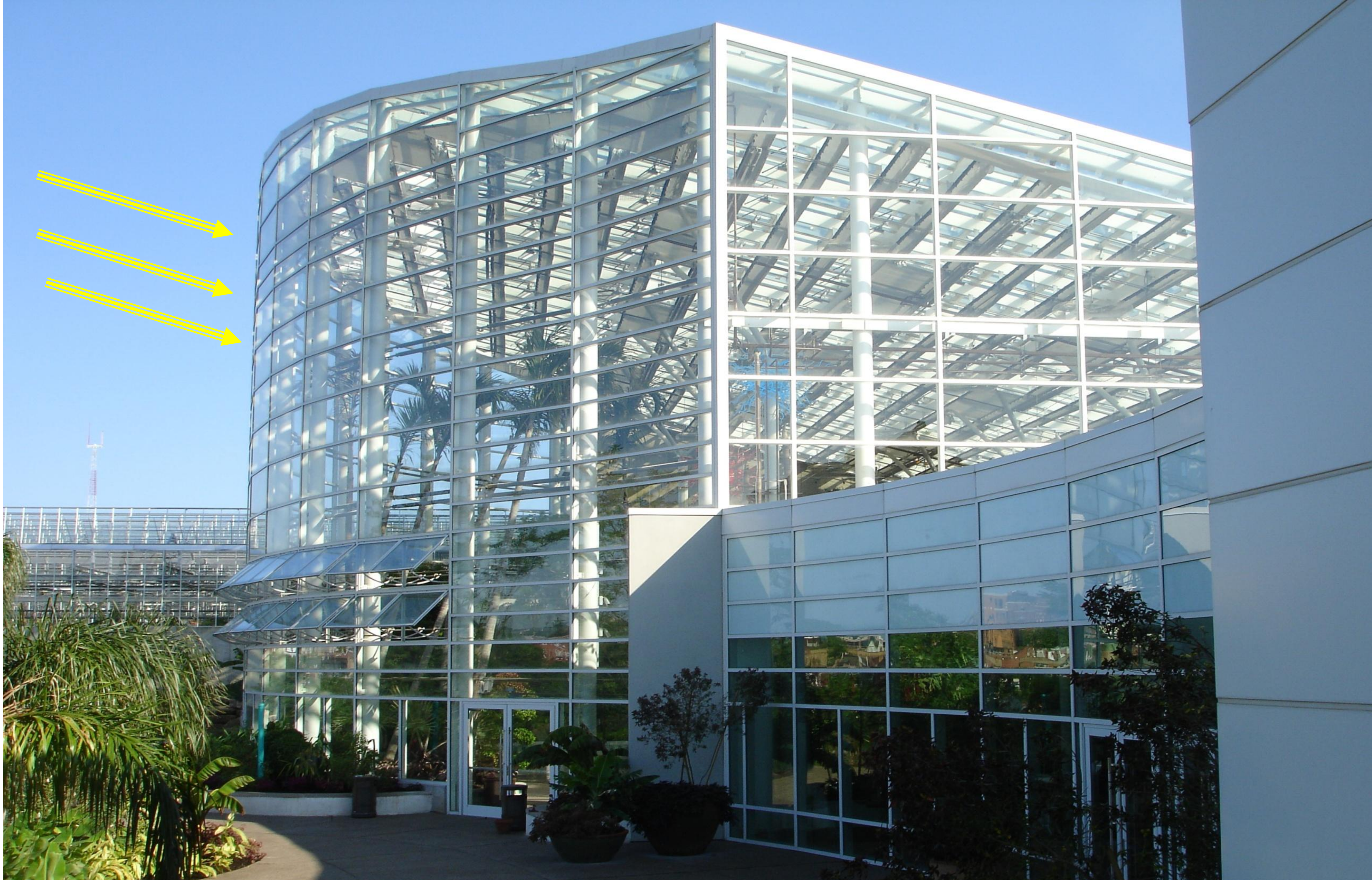


Very Energy Efficient

No Greenhouse Effect


State-of-the-Art Energy Efficient Greenhouses
LEED Platinum EBOM






KNAACK
JLG LIFT

Center for Sustainable Landscapes (2012)

LIVING BUILDING CHALLENGE℠

LEED PLATINUM 2013 — LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

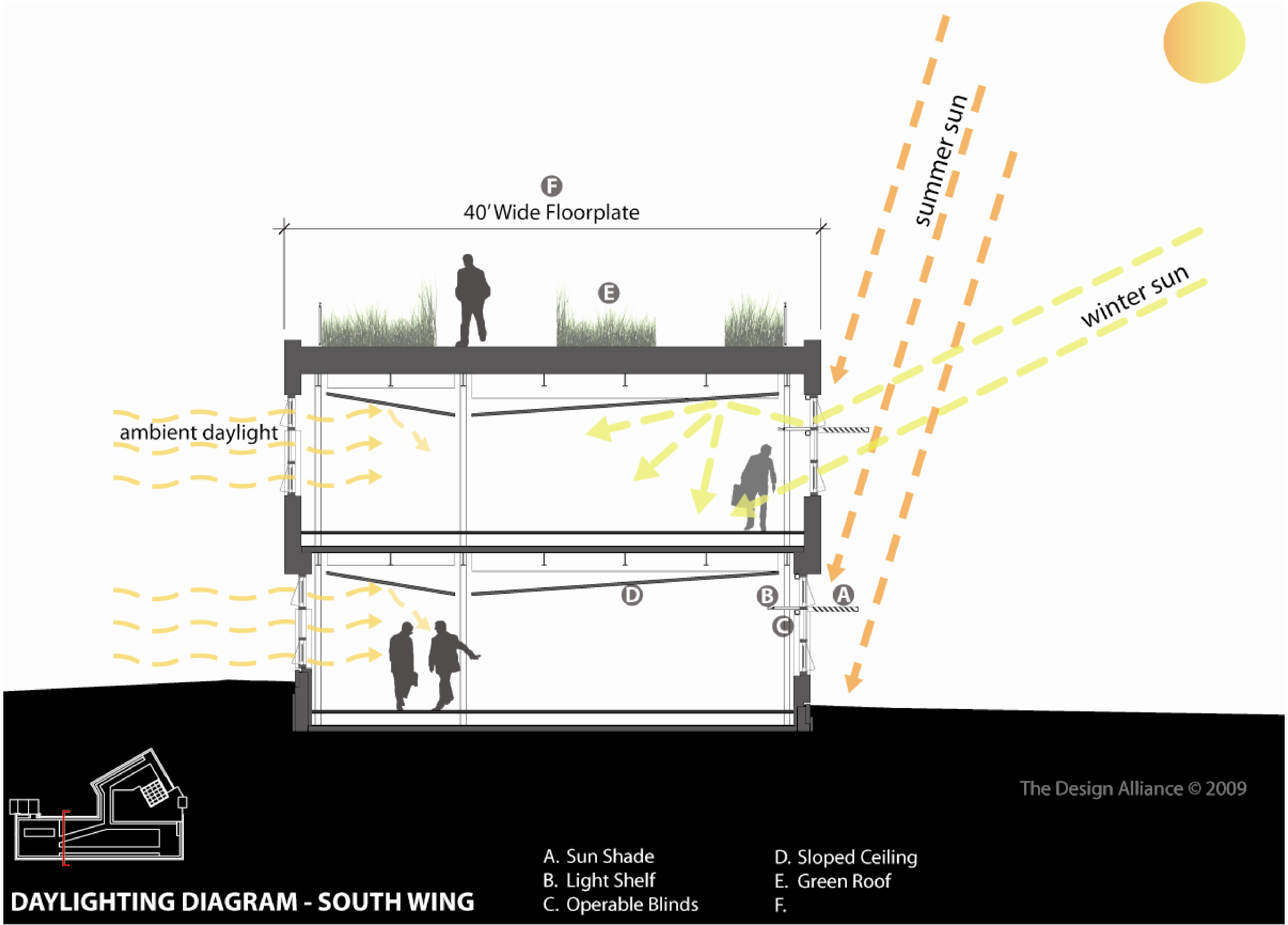
WELL PLATINUM 2014 — INTERNATIONAL WELL BUILDING INSTITUTE™

2019 SITES PLATINUM

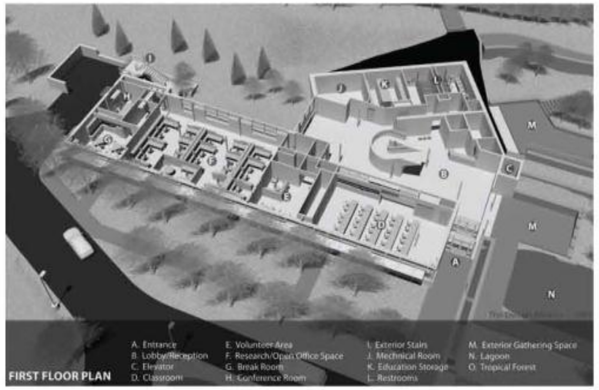
BREEAM® USA delivered by bre

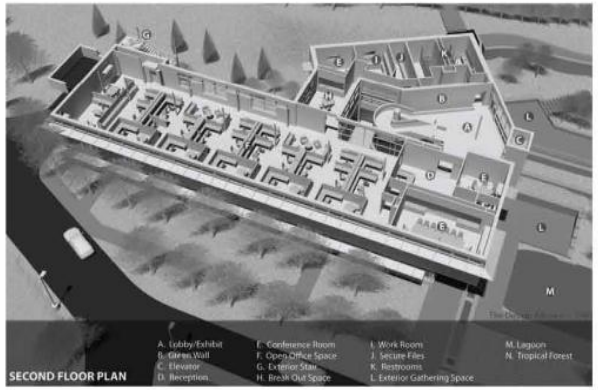
fitwel®

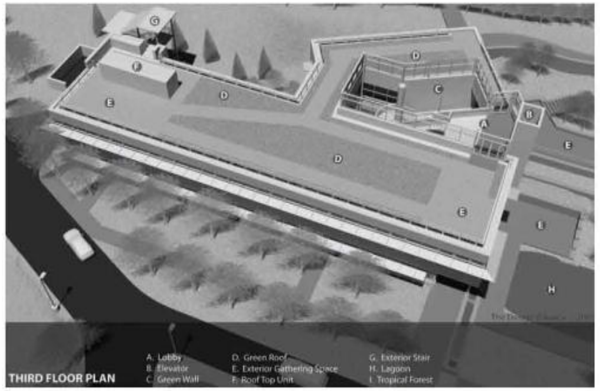
NET-ZERO ENERGY

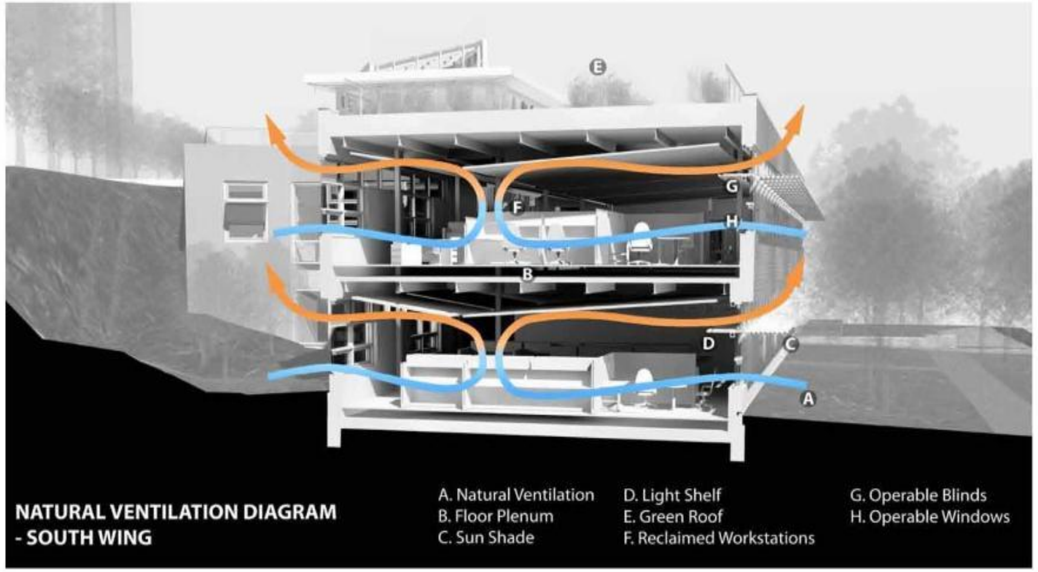

F
40' Wide Floorplate
E
summer sun
winter sun
ambient daylight
D
B
A
C
The Design Alliance © 2009
A. Sun Shade
B. Light Shelf
C. Operable Blinds
D. Sloped Ceiling
E. Green Roof
F.
DAYLIGHTING DIAGRAM - SOUTH WING

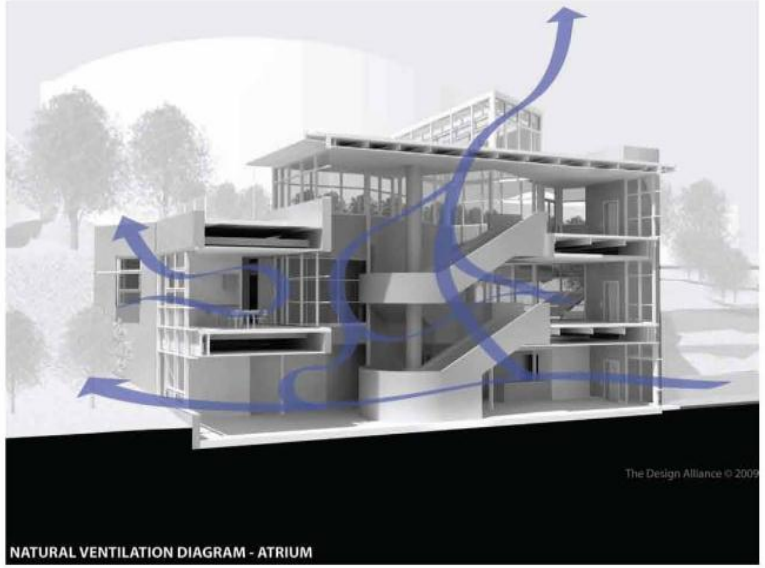
NATURAL VENTILATION



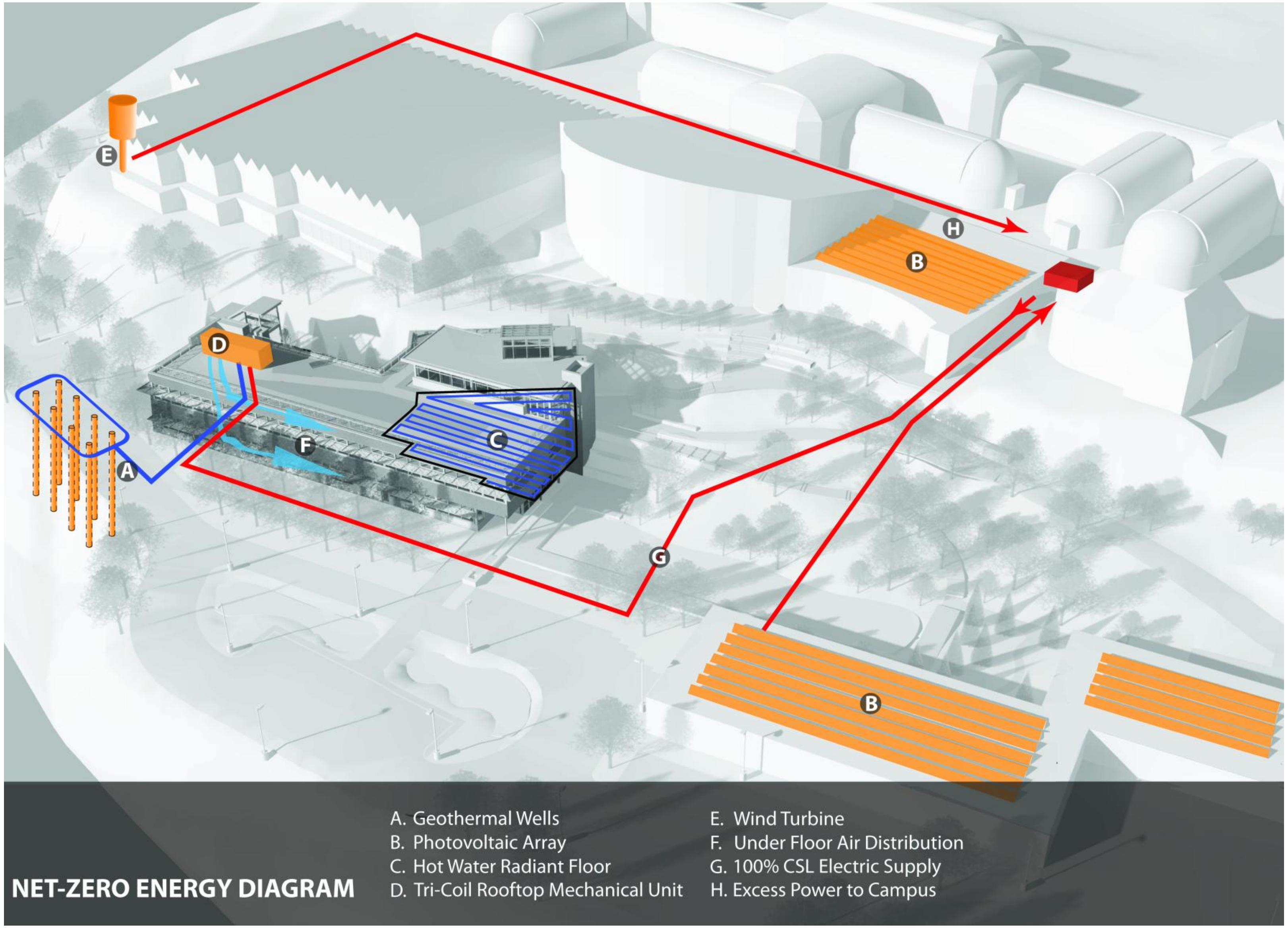








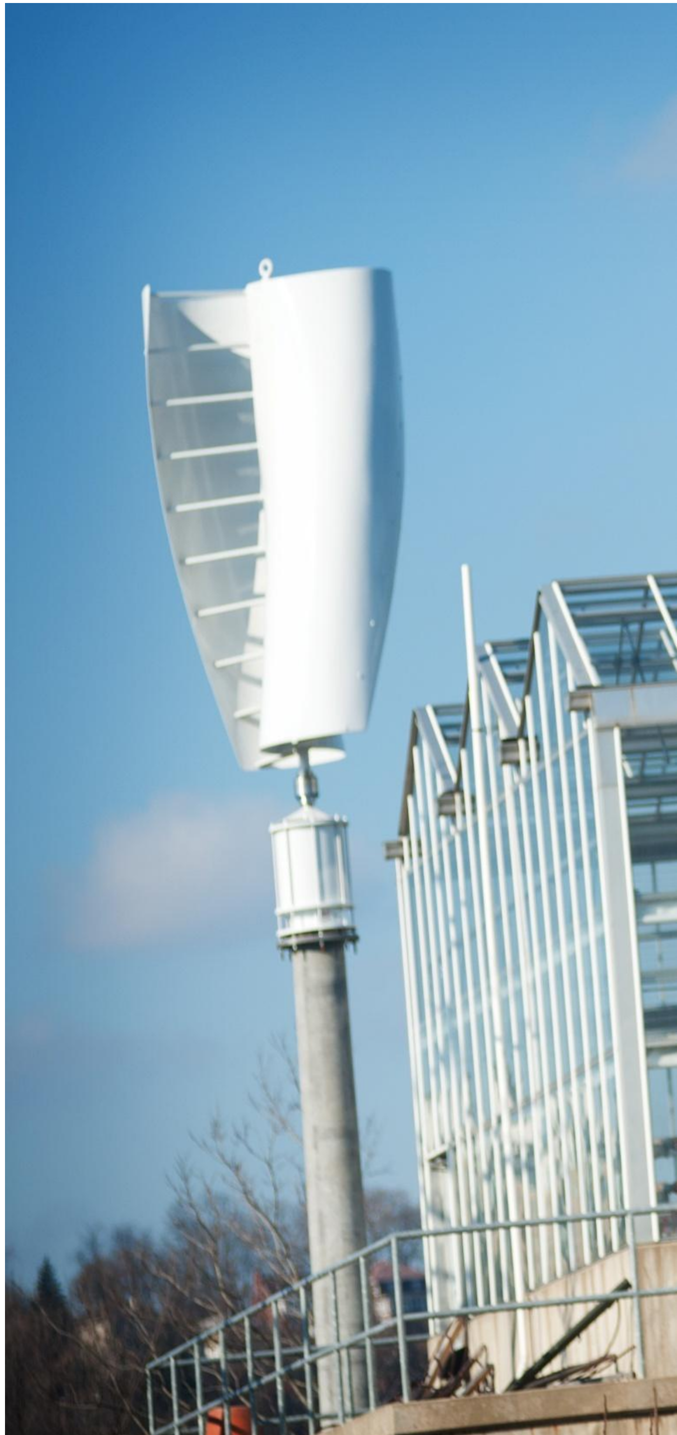

GP
DensGlass
Sheathing



Net-Positive Energy


biopcm

PV PANELS



The Nature Lab for Children's Programs (2015)

Petal Certified

LIVING BUILDING CHALLENGE℠ 2.1

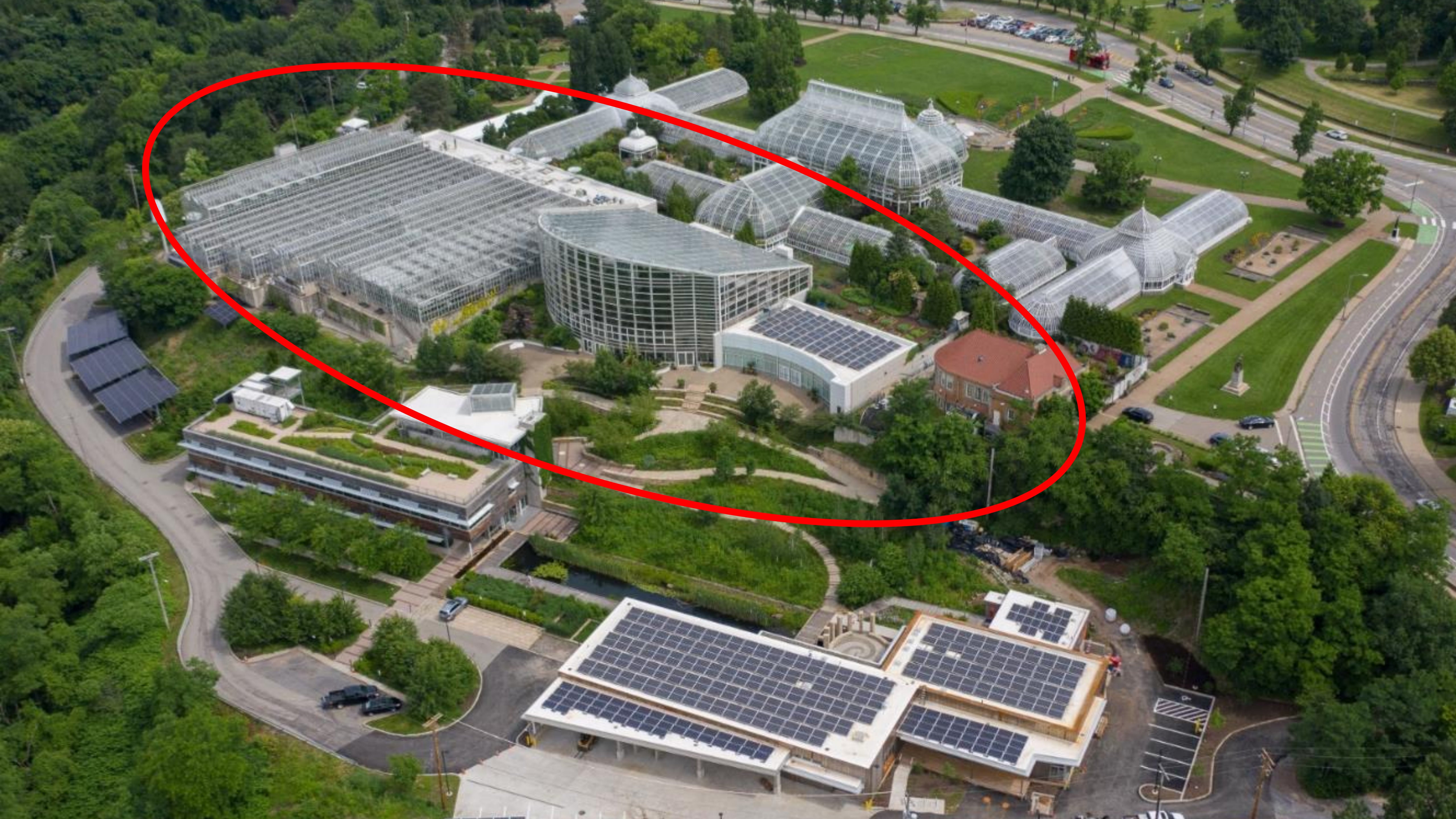
INTERNATIONAL LIVING FUTURE INSTITUTE

Exhibit Staging Center
A Maintenance Facility (2018)

LIVING BUILDING CHALLENGE 2.1

U.S. GREEN BUILDING COUNCIL LEED PLATINUM

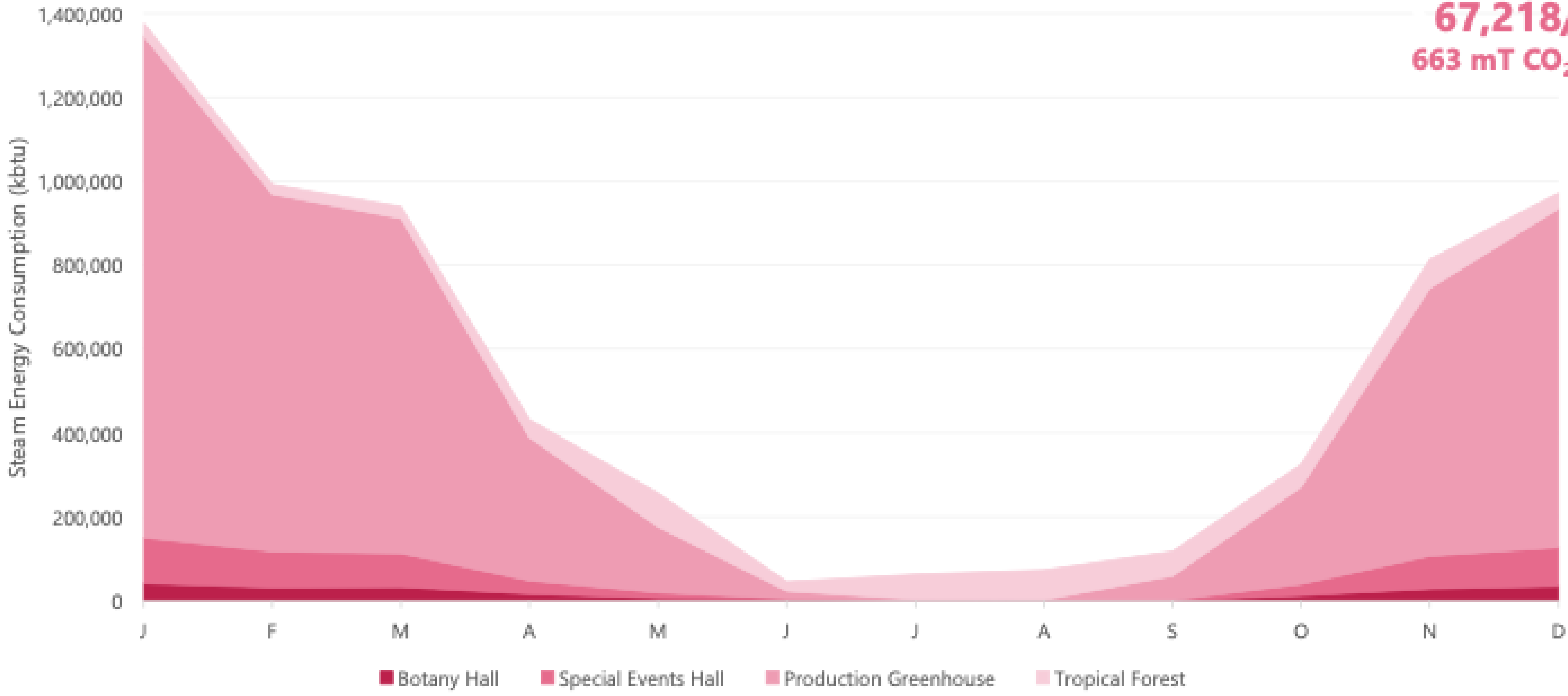
INTERNATIONAL WELL PLATINUM 2014 WELL BUILDING INSTITUTE



Understanding Current Demands | Steam Energy Consumption

6,402
mmbtu/year

67,218/year
663 mT CO_2e/year



Note: "Bellefield Boiler Plant" Scenario Capital Costs are estimated but not confirmed.

Study Parameters

	Bellefield Boiler Plant	Heat Pump	Geothermal	Solar PV	Solar Thermal
Scope	-	full conversion	full conversion	in lieu of electricity demand	in lieu of HW demand served by BBP
Equipment & Capacity	Peak Load: 7,425 MBH (620 RT)	4 70 ton and 7 50 ton (total 630 ton) Clima-Cool Modular Chiller Heaters with Cooling Towers with electric boiler back-up	84 wells totaling 255 tons with electric boiler back-up	196 kW Solar Photovoltaic Array	115 kW, 1000 kg/hr domestic hot water capacity, glycol fluid based
Timeline	Last replacement in 2006	ASAP or staged conversion	ASAP or staged addition	ASAP or staged addition	ASAP
Primary Fuel Source	Steam via Natural Gas	Electricity	Electricity	Steam solar PV to offset current electricity demand	Steam solar thermal production to offset current DHW demand
Approximate Capital Cost	$100k	$500-800k	$2.4-2.8M	$600-900k	$200-350k
Space	-	~1,000 ft^2	~77,000 ft^2	~28,000 ft^2	~28,000 ft^2
Additional Considerations	outdated systems, possible surcharge in the future		sub-cooling of ground overtime without cooling requirement	Phipps can be a net-positive electricity producer in the summer	requires significant preventative maintenance

Note: "Bellefield Boiler Plant" Scenario Capital Costs are estimated but not confirmed.

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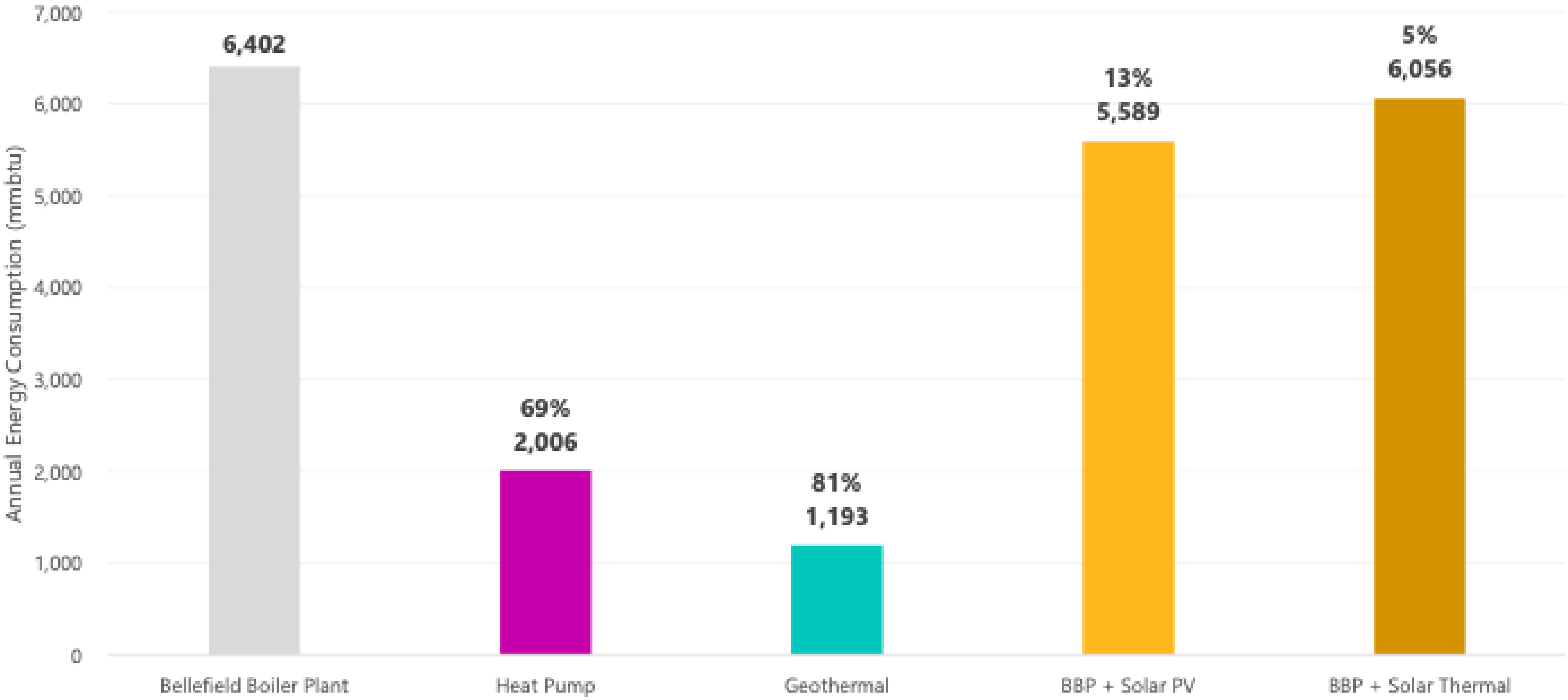
BURO HAPPOLD

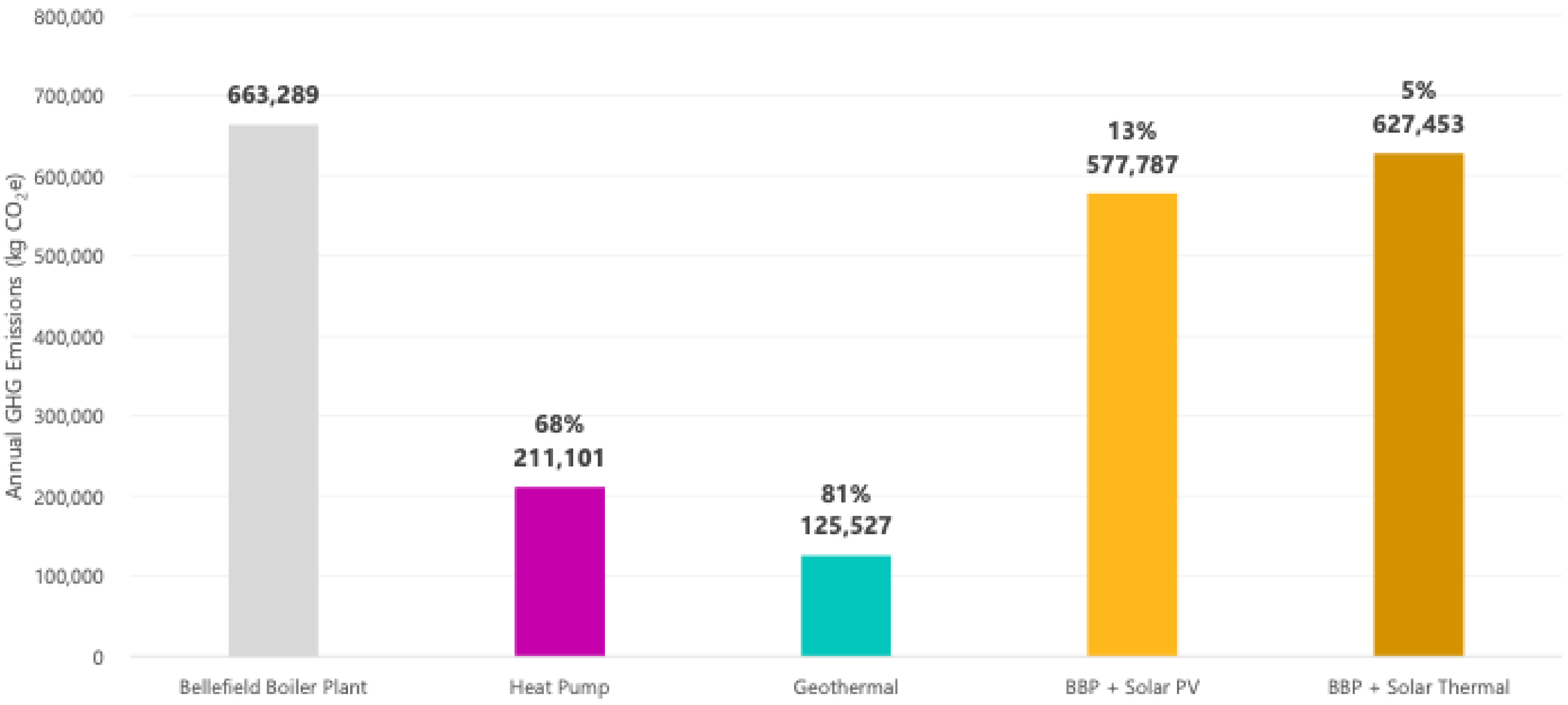
Summary – Year 1 Energy Performance



BURO HAPPOLD

Heat Pump **Geothermal** **Solar PV** **Solar Thermal**

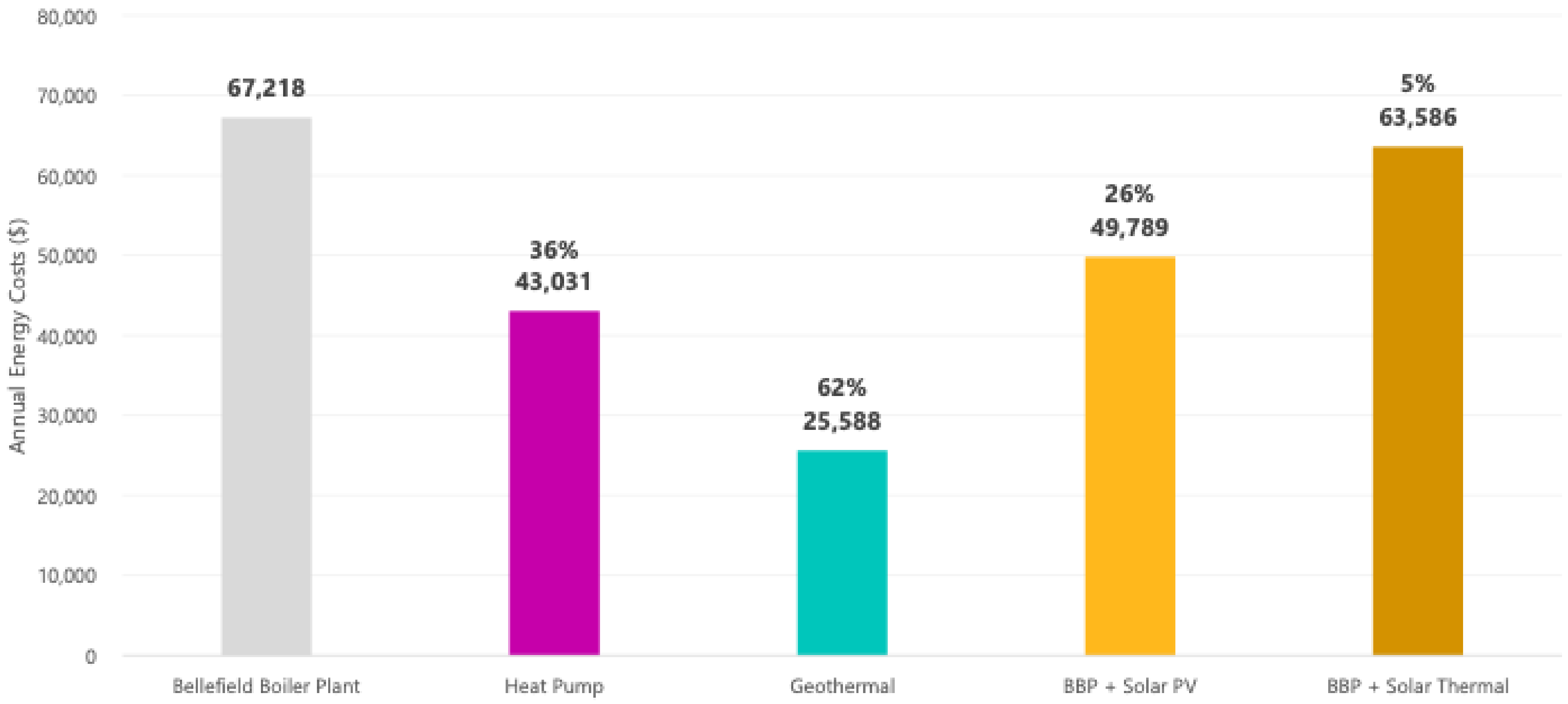
Summary – Year 1 Operational Emissions



BURO HAPPOLD

Heat Pump **Geothermal** **Solar PV** **Solar Thermal**

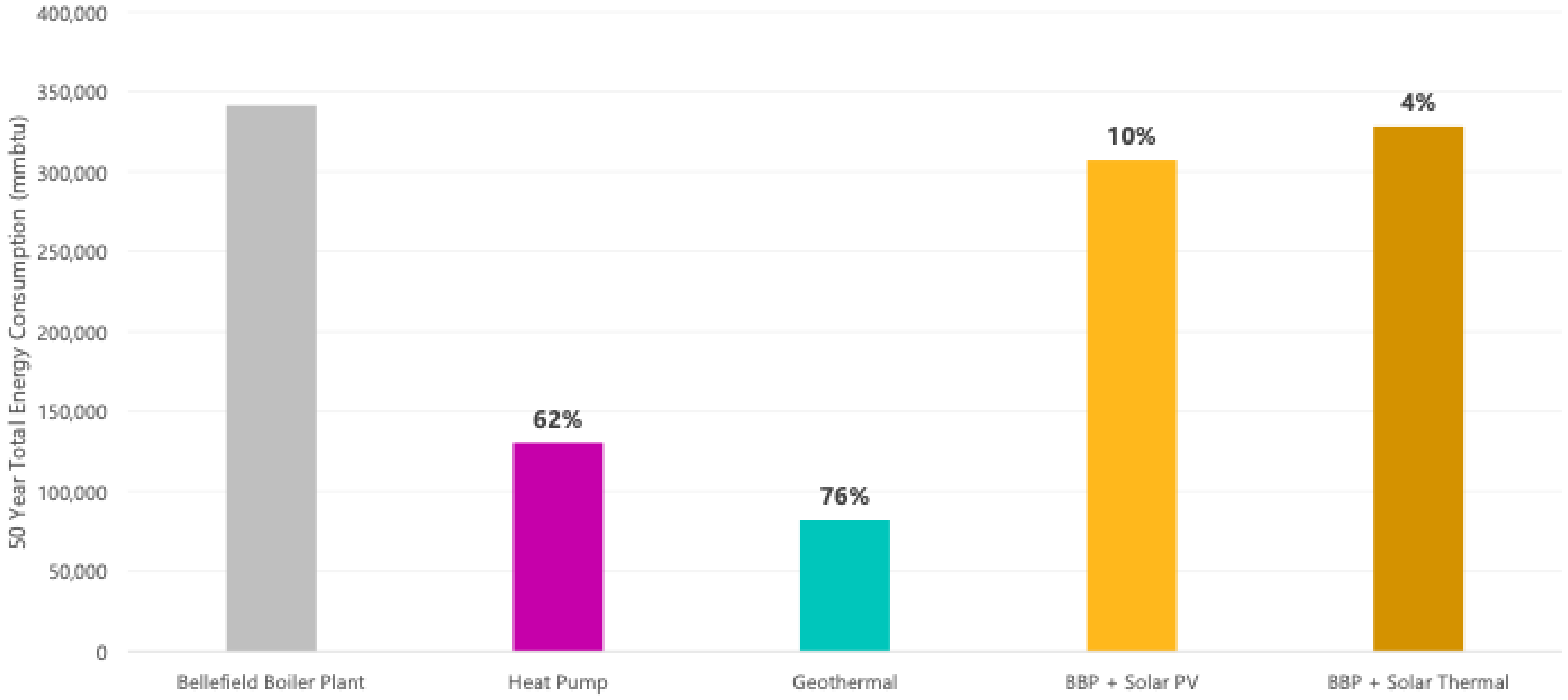
Summary – Year 1 Operational Costs



BURO HAPPOLD

Heat Pump **Geothermal** **Solar PV** **Solar Thermal**

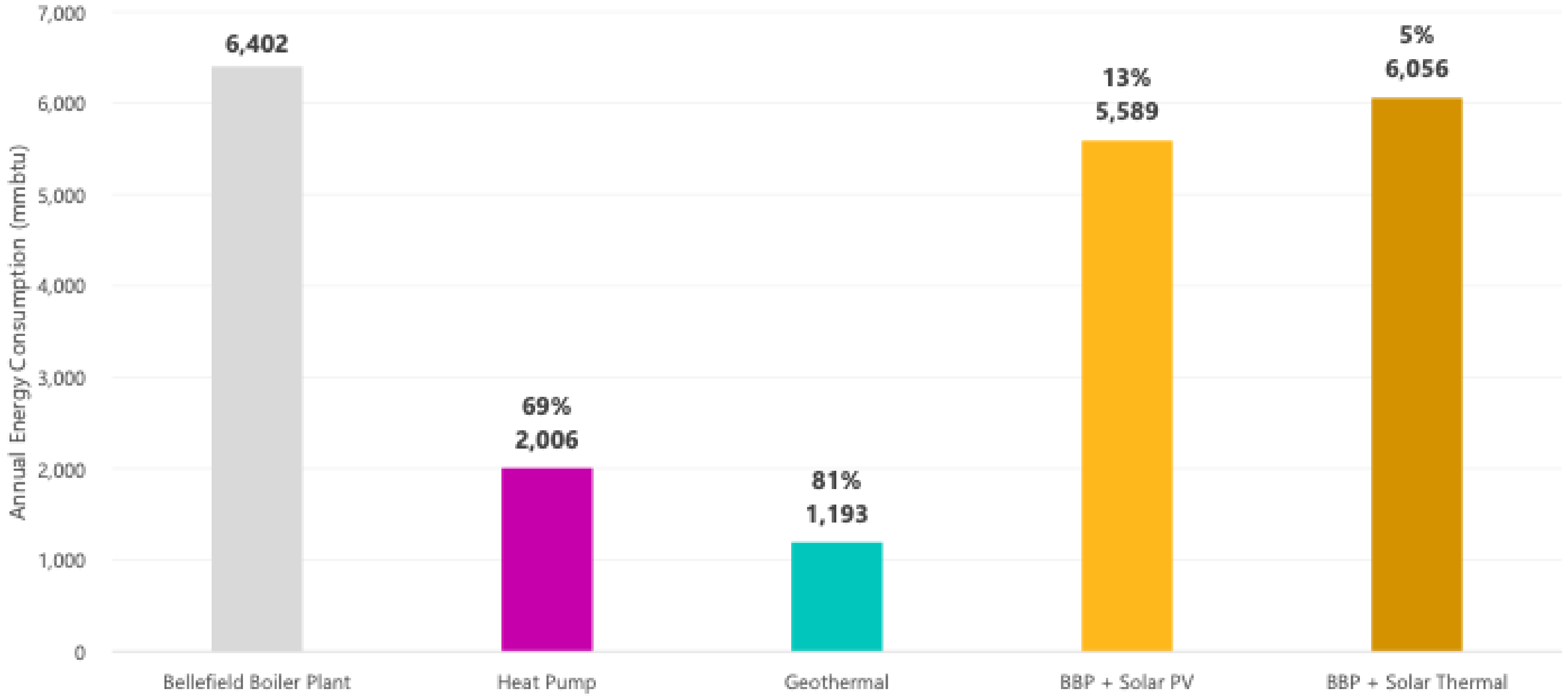
50 Year Energy Performance - Overall



BURO HAPPOLD

Heat Pump | Geothermal | Solar PV | Solar Thermal

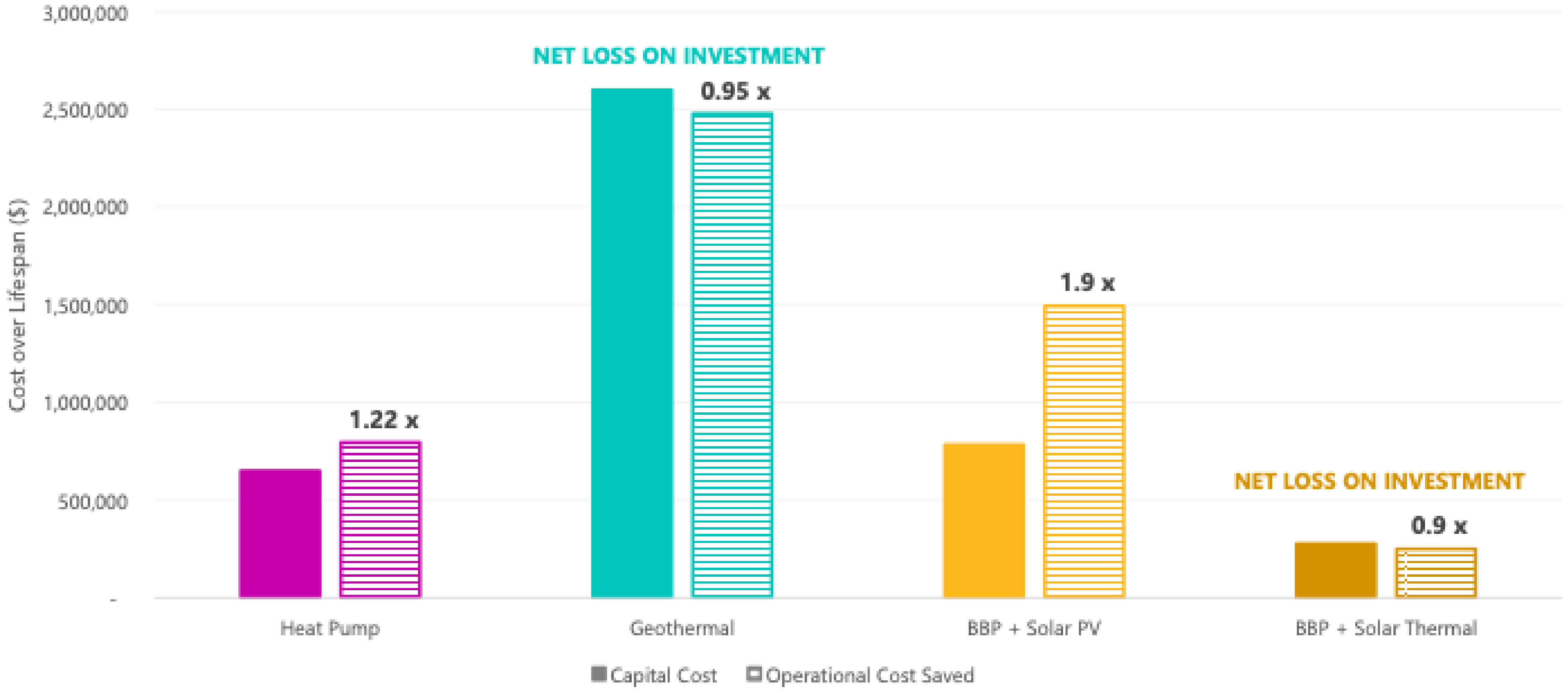
Summary – Year 1 Energy Performance



BURO HAPPOLD

Heat Pump | Geothermal | Solar PV | Solar Thermal

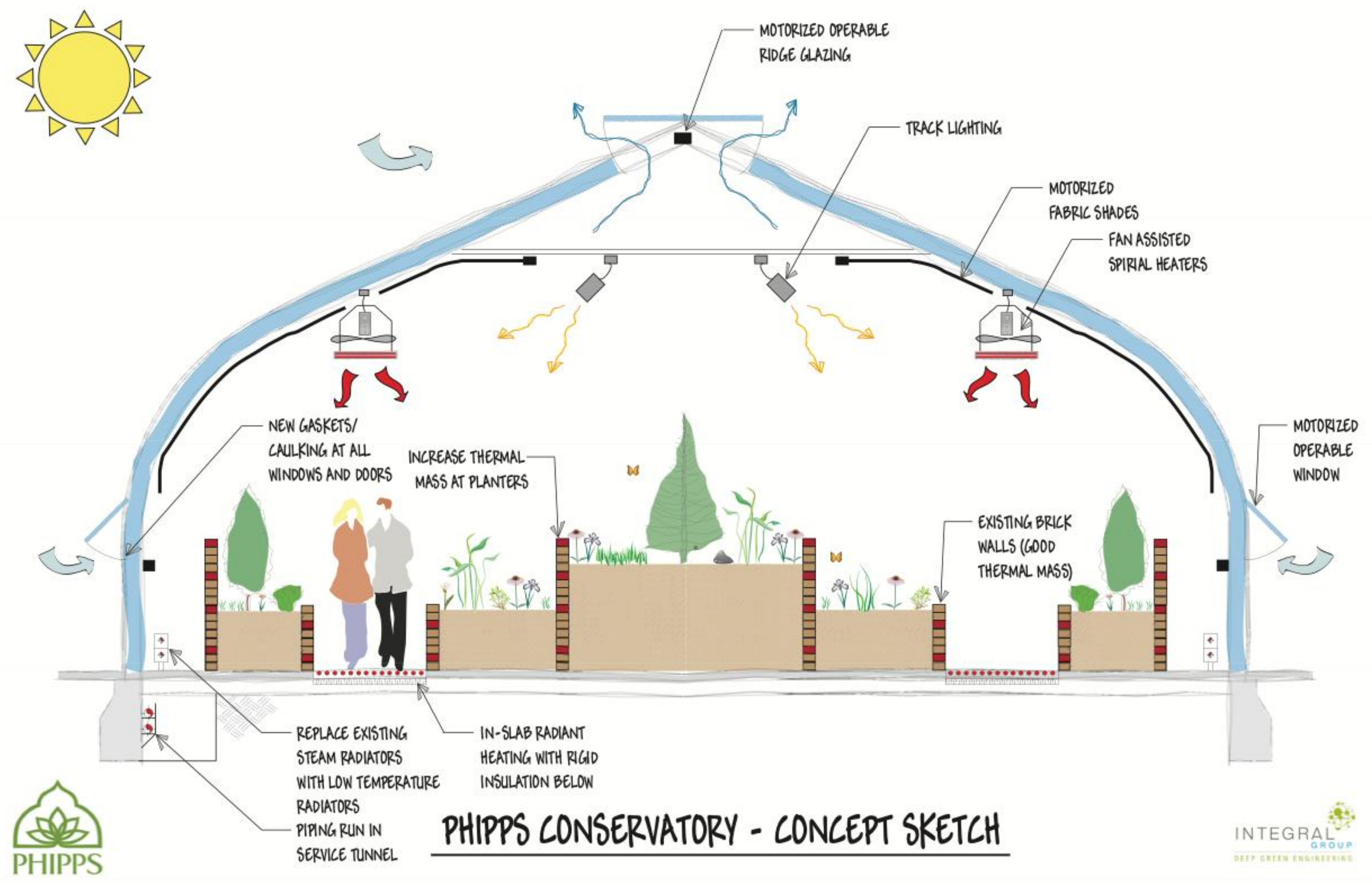
Capital Costs vs. Operational Costs Saved over Equipment Life Span



Heat Pump | Geothermal | Solar PV | Solar Thermal

Key Takeaways

Heat Pump	Geothermal	Solar PV	Solar Thermal
+ Full electrification is possible. + When considering long-term costs and emissions, it performs at a similar level as supplementing with geothermal but has significantly lower upfront costs. + Greater flexibility in the long term to add modules buildings are added to the campus. - Requires the most frequent replacements (~3x in 50 years), embodied carbon impacts should be considered.	+ Full electrification is possible. + Shows the highest energy savings in the short and long-term. + Installing only a portion of the maximum number of wells feasible that can meet some of the load is a better strategy while keeping capital low. This can be paired with the Heat Pump strategy for increased energy and carbon savings. - Energy and emission wise, it performs at a similar level as the modular heat pumps but has ~4x the upfront costs. - Net loss on investment. - Long term environmental impacts for the all 84 wells need to be understood.	+ The most cost effective (~1.9x return on investment). + Can be paired with the electrified Heat Pump or Geothermal option. - Can only meet a small amount of annual demand and not when most needed.	- Net loss on investment. - Can meet a very small portion of the load.

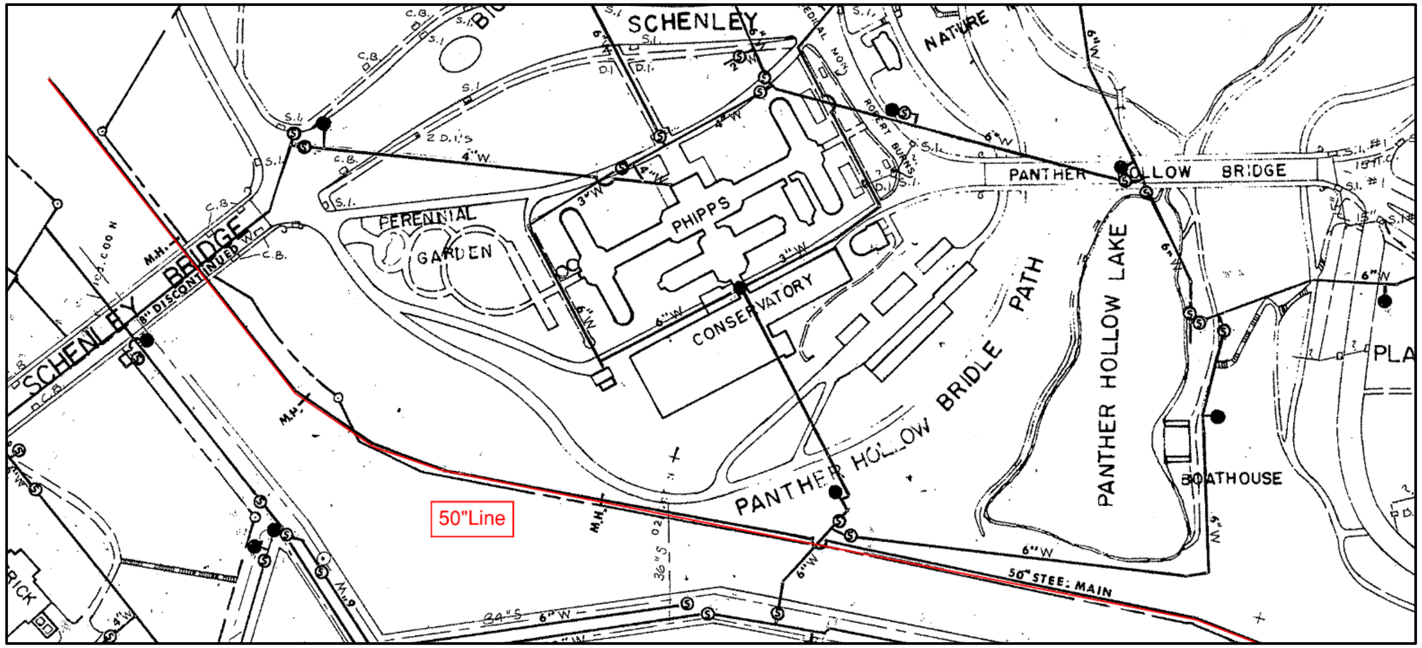


PHIPPS CONSERVATORY - CONCEPT SKETCH

SITE MECHANICAL SYSTEM OPTIONS MATRIX

	BASELINE	OPTION 1 FULLY-ELECTRIFIED HIGH PERFORMANCE GEOTHERMAL	OPTION 2 FULLY-ELECTRIFIED GEOTHERMAL	OPTION 3 MOSTLY-ELECTRIFIED GEOTHERMAL	OTHER OPTIONS EVALUATED
MECHANICAL EQUIPMENT		Primary: Secondary:	Primary: Secondary:	Primary: Secondary:	
SYSTEM DESCRIPTION	Existing state	Modern ground-source heating plant with supplemental electric boilers and high temp heat pumps	Geothermal loop with electric boiler for peak capacity	Geothermal loop with steam heating for 30% of peak capacity	Utilize waste heat from sewer line adjacent to Bellefield boiler plant This system has the below hurdles/ limitations, but is still potentially viable and could be studied in the next phase of design: • Scale - a larger scale is required to make this cost-effective. It could be an option for a district opportunity • Location - the large sewer main to the NW is relatively far away and down a significant hill • Type - the sewer main is combined stormwater and wastewater, which is less ideal for heat recovery due to variable flow and temperatures
FIRST COST		$$$$	$$$	$$$	
UTILITY COST	⚡⚡⚡⚡⚡	⚡	⚡⚡	⚡⚡⚡	
MAINTENANCE COST	🔧🔧🔧🔧🔧	🔧🔧	🔧	🔧🔧	
IRA POTENTIAL		🏛🏛🏛🏛	🏛🏛🏛	🏛🏛🏛	
EFFICIENCY / COP	0 — 0.85 — 4	0 — 3.47 — 4	0 — 3.32 — 4	0 — 3.29 — 4	
HEATING EUI	0 — 147 — 200+	0 — 34 — 200+	0 — 35 — 200+	0 — 36 — 200+	
CARBON EMISSIONS	🔥🔥🔥🔥🔥			🔥	
RESILIENCY	✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓✓	
ADVANTAGES	• High load density delivery • Existing state- no modifications required	• Achieves full decarbonization • Highly resilient, efficient design	• Achieves full decarbonization • Highly resilient, efficient design	• Lower cost from utilizing existing steam infrastructure • Simpler system control	
DISADVANTAGES	• High energy cost • High carbon footprint	• Large borefield footprint. May not fit on Phipps property • Complex control system	• Large borefield footprint. May not fit on Phipps property • Additional electric demand charges	• Large borefield footprint. May not fit on Phipps property • Retains existing steam and carbon footprint	

Sewer Heat Recovery



- City-owned land?
- Combined sanitary/stormwater?

Solar Field for 100% of Energy Needs

Electrification w/o geothermal

2.55MWdc Array

Thank You