Beyond Zero Series: Climate-Friendly Campuses

Building Energy Exchange and NYSERDA are pleased to host this Beyond Zero series event, Climate-Friendly Campuses, focused on decarbonizing buildings at the campus scale, with reverberating benefits for entire communities. During this discussion, a panel of experts will discuss the unique opportunity for campus-level projects to accelerate decarbonization, and what strategies they enacted to achieve low-carbon, high-performance buildings.

Opening Remarks

Karren Bee-Donohoe, Associate Vice Chancellor for Capital Facilities at SUNY System Administration

Moderator

Nina Sharifi, Carbon Neutral Roadmap Advisory Council, Assistant Professor at Syracuse University

Speakers

Indu Lnu, Director of Energy at University at Albany, SUNY
Cecil Scheib, Chief Sustainability Officer, Office of the President, New York University

April 6, 2022 | 9 to 10:30 am | 1.5 AIA LU|HSW
Building Energy Exchange | be-exchange.org

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

be ex building energy exchange

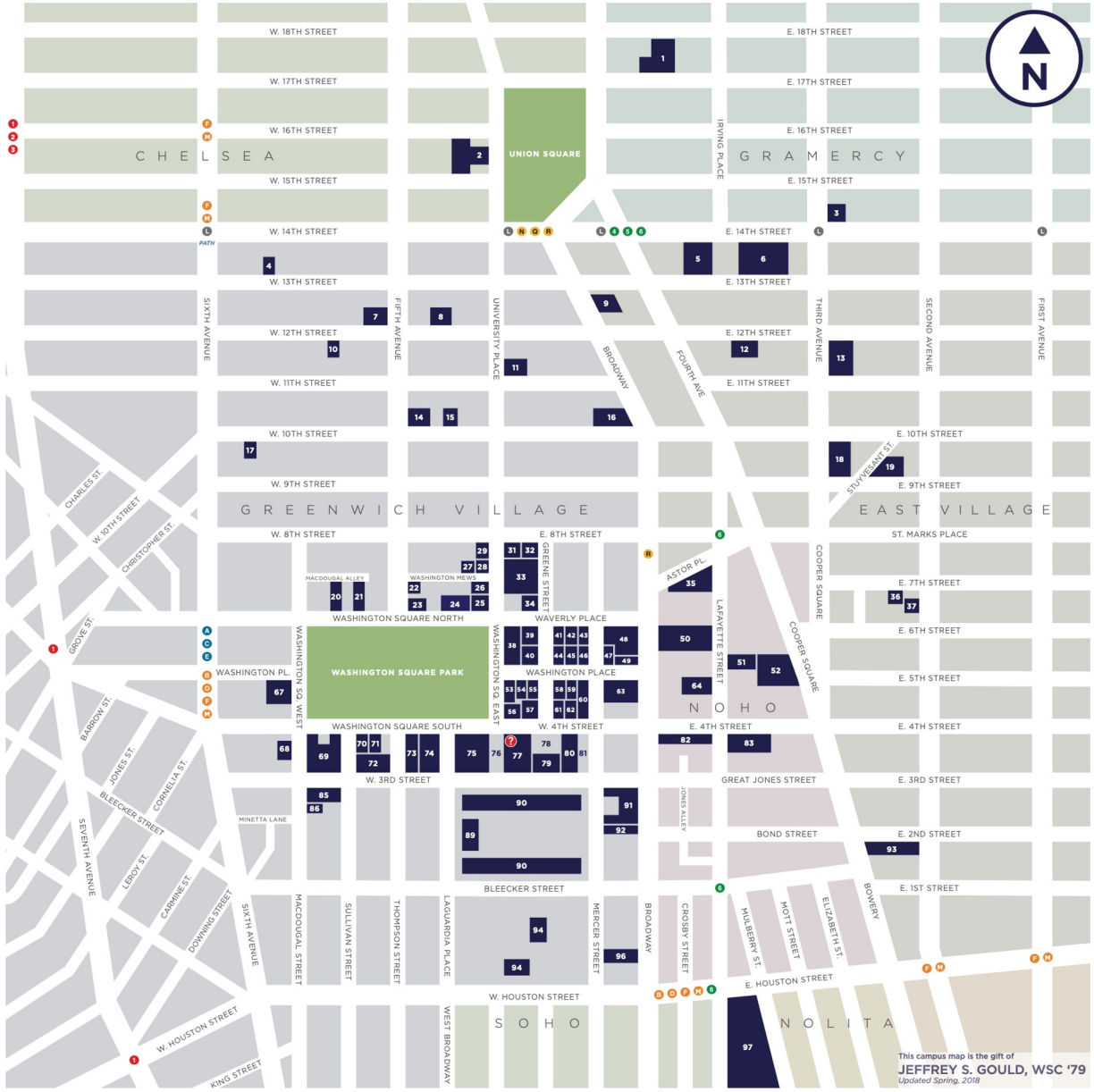
NYU | Sustainability

CLIMATE-FRIENDLY CAMPUSES: NYU

CECIL SCHEIB, CHIEF SUSTAINABILITY OFFICER

ABOUT NYU

- 15 global sites
- 3 degree-granting campuses
- 24,000 employees
- 60,000 students (largest private university in the US)
- In NYC (Manhattan and Brooklyn):
  - 200 buildings
  - 15,000,000 ft^2 built area
  - 1,800 utility accounts
  - 0.3% of NYC emissions



According to the Princeton Review's 2021 Hopes & Worries Survey

Commitment to the environment affects choice:

75%

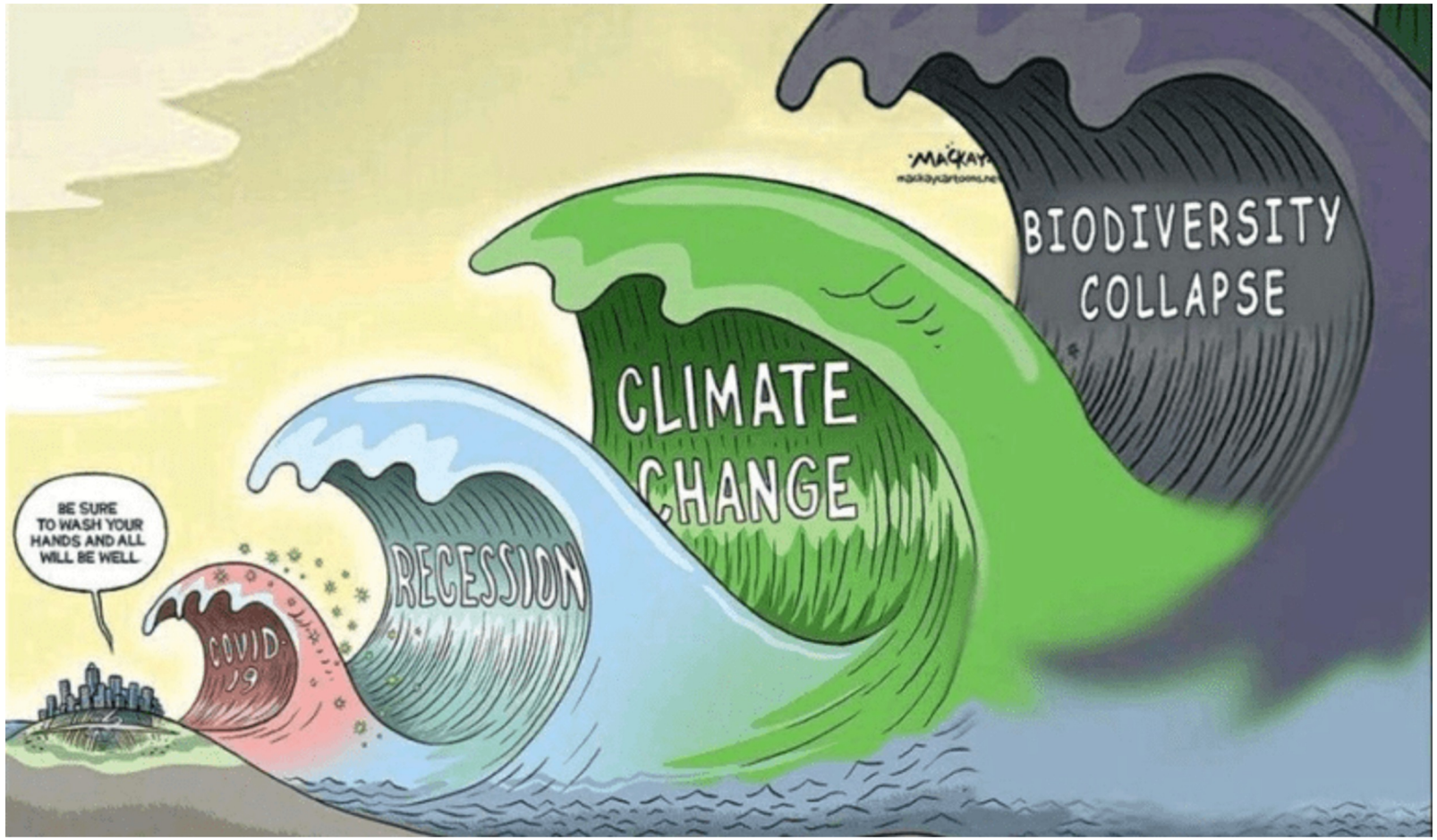
A college's environmental commitment **would** affect their decision.

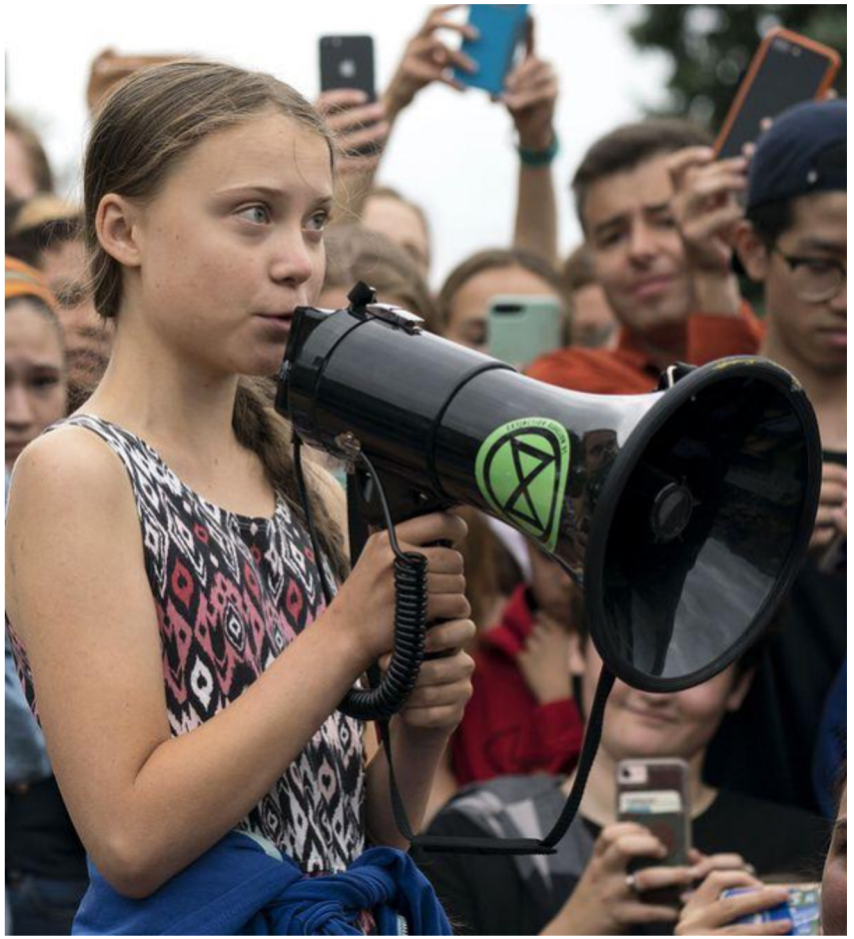
5%

Would have **no effect** on their decision.

20%

Would not much affect their decision.


BE SURE TO WASH YOUR HANDS AND ALL WILL BE WELL
COVID 19
RECESSION
CLIMATE CHANGE
BIODIVERSITY COLLAPSE



“As the largest private university in New York City and one of the preeminent research universities in the world, NYU has the opportunity to set a powerful example of leadership on climate change. We can be a model for other universities, other sectors, and other cities, not only of what must be done but that it *can* be done.”

— NYU President Andrew Hamilton

“Higher education can lead in making a commitment to a dramatically reduced carbon footprint. When it comes to preserving the environment and reversing damage, we don’t have the luxury of time. If we can change our practices to evade a pandemic, surely we can change them to evade environmental ruination.”

— NYU Provost Katherine Fleming

CLIMATE ACTION PLAN

- 30% reduction in building-related GHG intensity (2007-2012)
- 50% reduction in building-related GHG emission intensity by 2025
- Carbon neutrality by 2040
- 25% reduction in food-related GHG emissions by 2030

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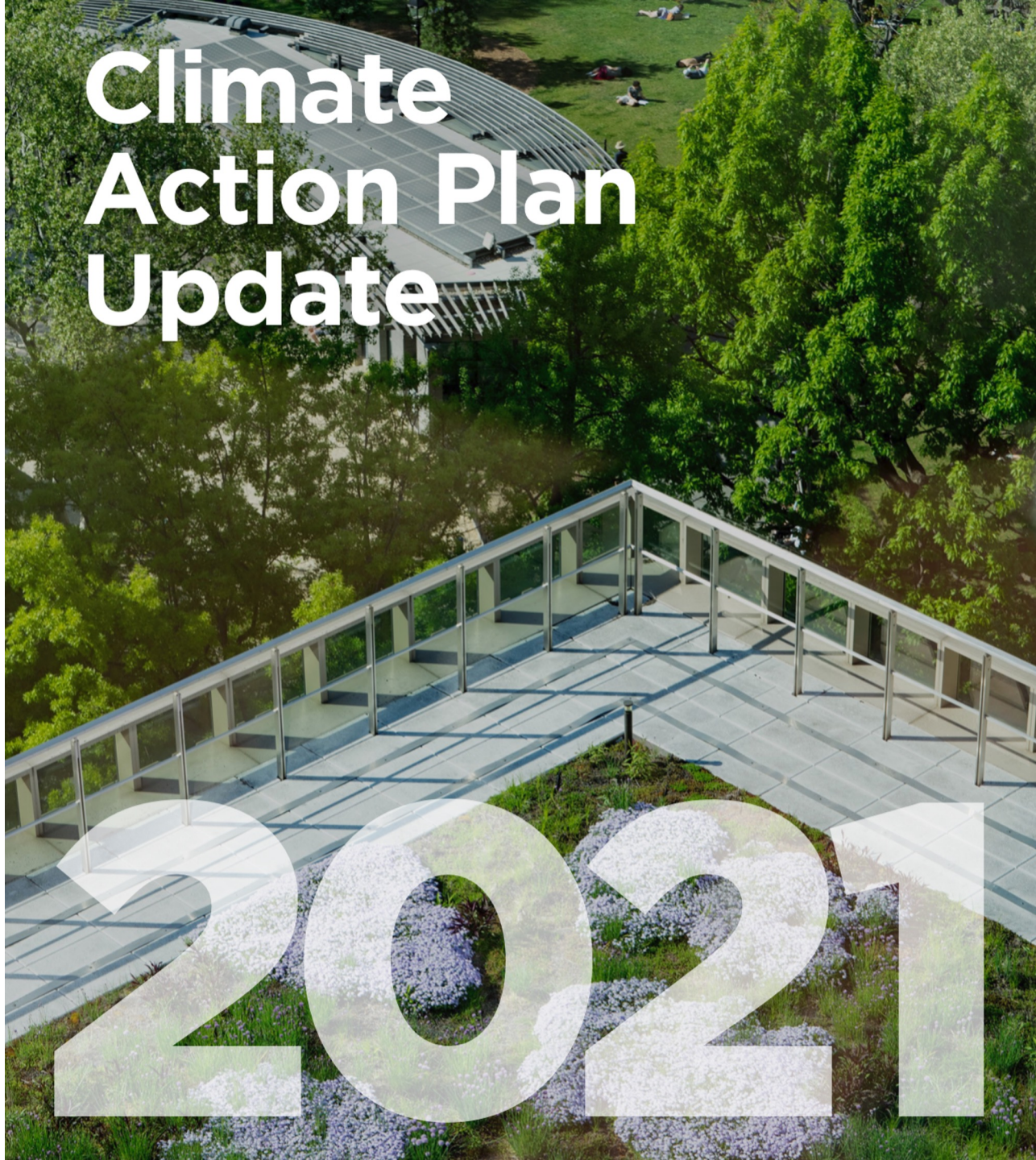

CLIMATE FRIENDLY BUILDINGS ARE HEALTHIER BUILDINGS

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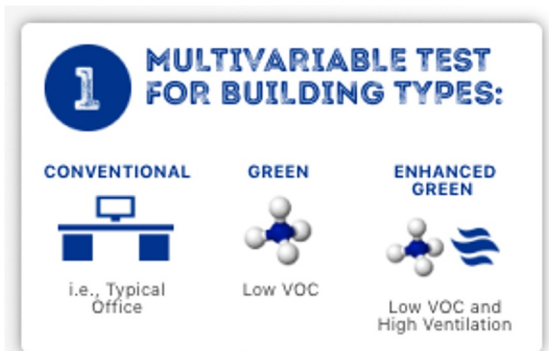
THE IMPACT OF GREEN BUILDINGS ON COGNITIVE FUNCTION

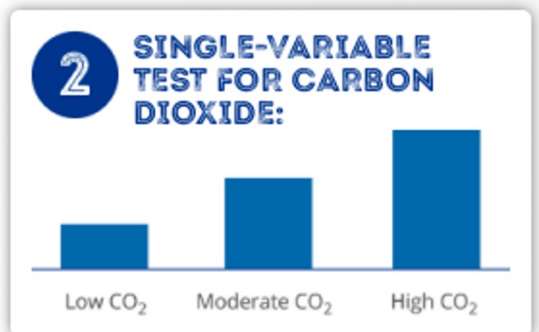
STUDY 1: INDOOR ENVIRONMENTAL QUALITY

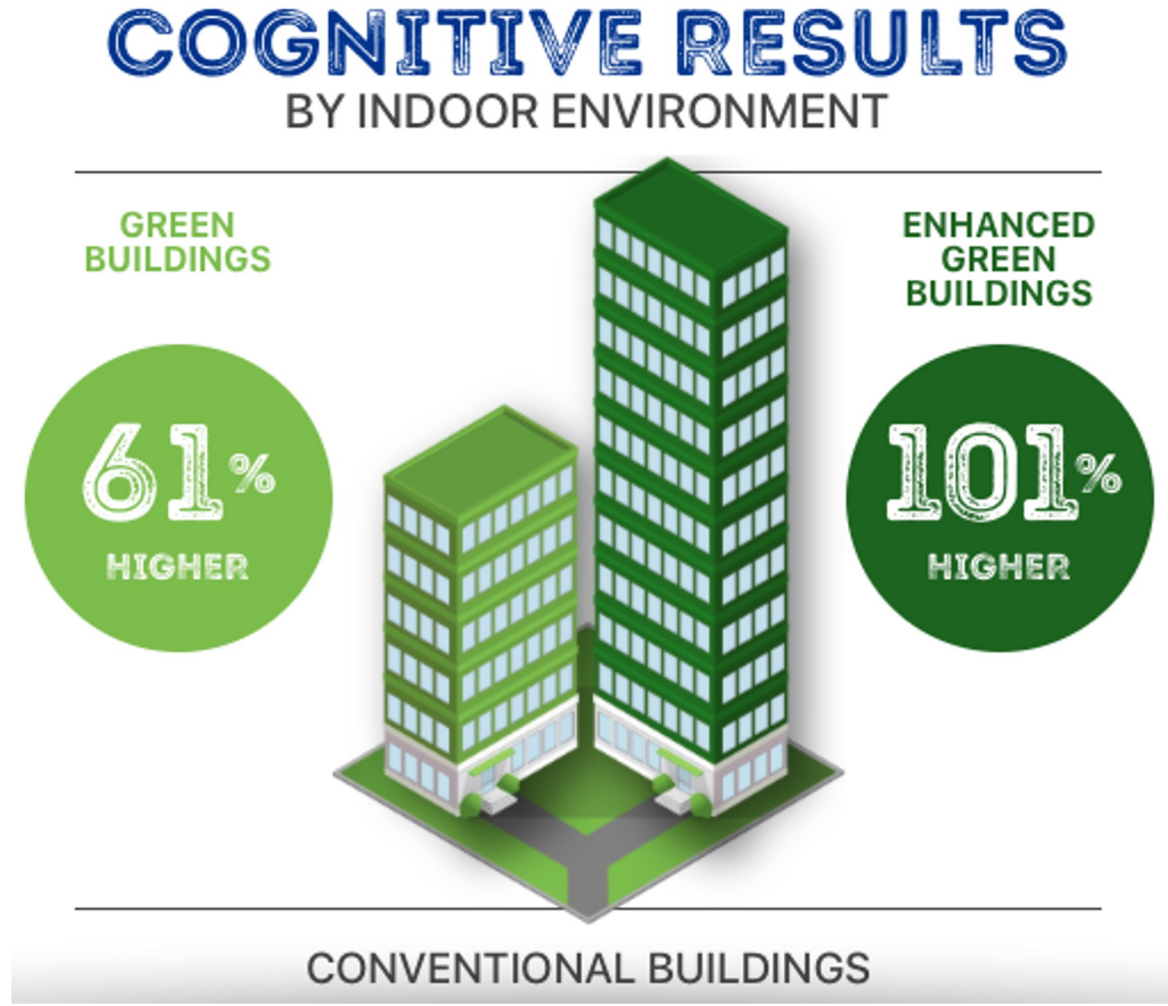
Economic, Environmental and Health Implications of Enhanced Ventilation in Office Buildings

Piers MacNaughton [1,*], James Pegues [2], Usha Satish [3], Suresh Santanam [4], John Spengler [1] and Joseph Allen [1]

[1] Department of Environmental Health, Harvard T.H. Chan School of Public Health, Landmark 409 West, 401 Park Drive Boston, MA 02115, USA
[2] United Technologies Climate, Controls & Security, Syracuse, NY 13221, USA
[3] Psychiatry and Behavioral Sciences, SUNY-Upstate Medical School, Syracuse, NY 13210, USA
[4] Industrial Assessment Center, Biomedical and Chemical Engineering Department, Syracuse University, Syracuse, NY 13210, USA







BRITTANY HALL (2013-2014)

- **Improved thermal comfort**
- **Upgraded double pane windows for quieter spaces**
- **Student control of space temperatures**
- **More resilient mechanical systems**

81%
reduction in space heating energy use

43%
reduction in GHG emissions

49%
reduction in operation costs

RUBIN HALL (proj. 2023-2024)

- **All-electric design**
- **Triple-glazed windows**
- **Outdoor air supply**
- **High resiliency**
- **Passive House certification**
- **$2M NYSERDA support**

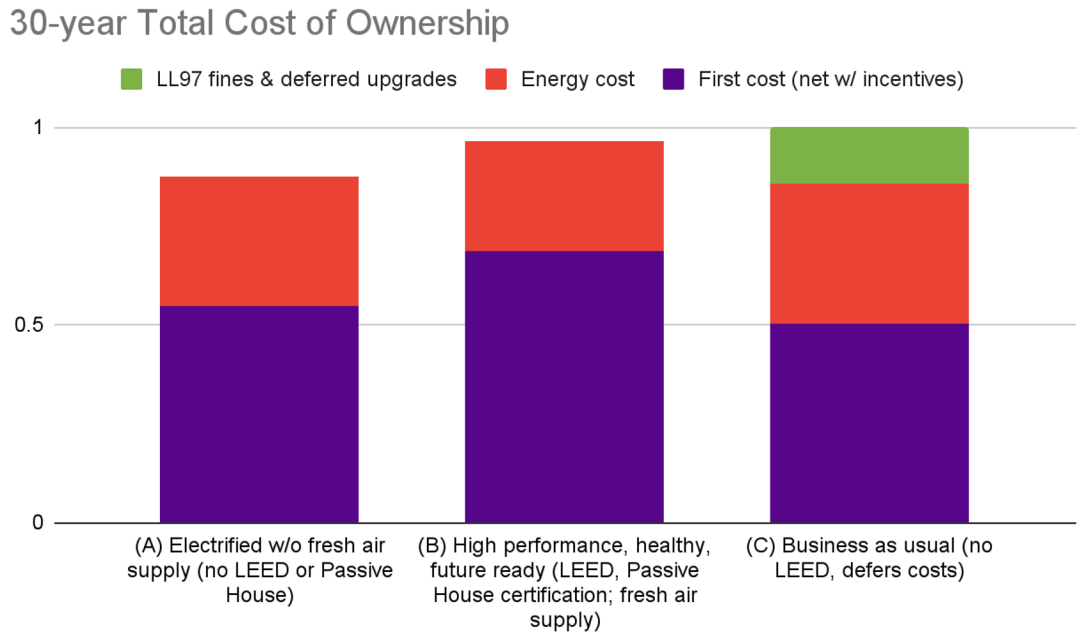
100%
reduction in fossil fuels

100%
potential reduction in GHG emissions

3.5%
reduction in 30-year total cost of operation

BUSINESS CASE

- Adding fresh air supply was major cost, but required for LEED, Passive House - and health/comfort!
- 30-year total cost of ownership less than “business as usual”, assuming eventual electrification is required



LEED	❌	✅	❌
Reputational benefit (EnerPHit)	❌	✅	❌
Least outdoor noise in rooms	❌	✅	❌
Greatest comfort and health in rooms	❌	✅	❌
Avoids future costs towards 2040 goal	?	✅	❌
No LL97 fines	✅	✅	❌
Good sightlines for Landmarks review	✅	✅	?
Least in-unit maintenance	✅	✅	❌
Ventilation	None (open windows)	Filtered outdoor air supplied	None (open windows)
Heating & Cooling	Electrified	Electrified	Gas boiler & cooling tower
Incentives	<$1M; eligibility unclear	>$2 million	Not eligible

2040 GOAL: CARBON NEUTRALITY

1. REDUCE BUILDING ENERGY USE

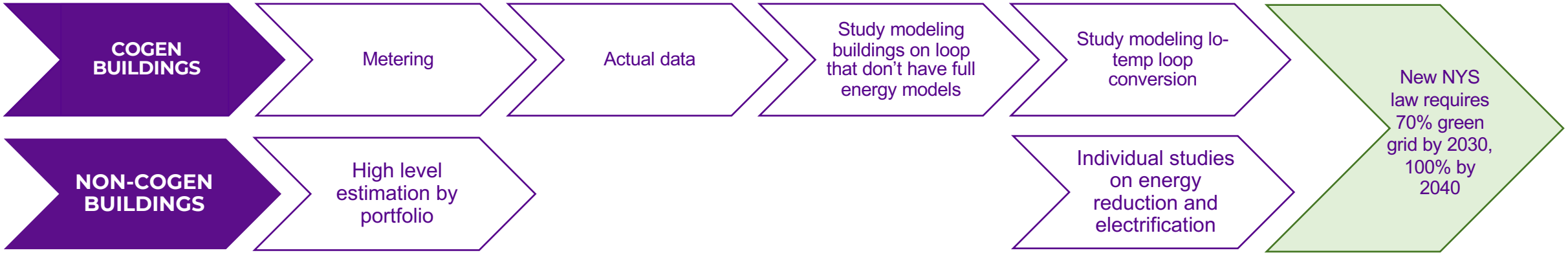
- Capital projects
- Capital replacement
- Efficiency projects
- Behavior change
- +Academic Computing
- +Labification

2. STOP USING FOSSIL FUELS

- Cogen efficiency
- Lo-temp loop conversion
- Electrification

3. PURCHASE GREEN ENERGY

- Onsite generation
- Purchase agreements
- Direct from utility



NYU CENTRAL PLANT

- Natural-gas fired (oil backup)
- Interconnected to Con Ed
- Produces electricity, high-temp hot water (HTHW), chilled water (CHW)
- 45 buildings and ~50% of campus square footage do or will use at least one cogen-produced commodity
- Must be addressed towards 2040 carbon neutrality goal

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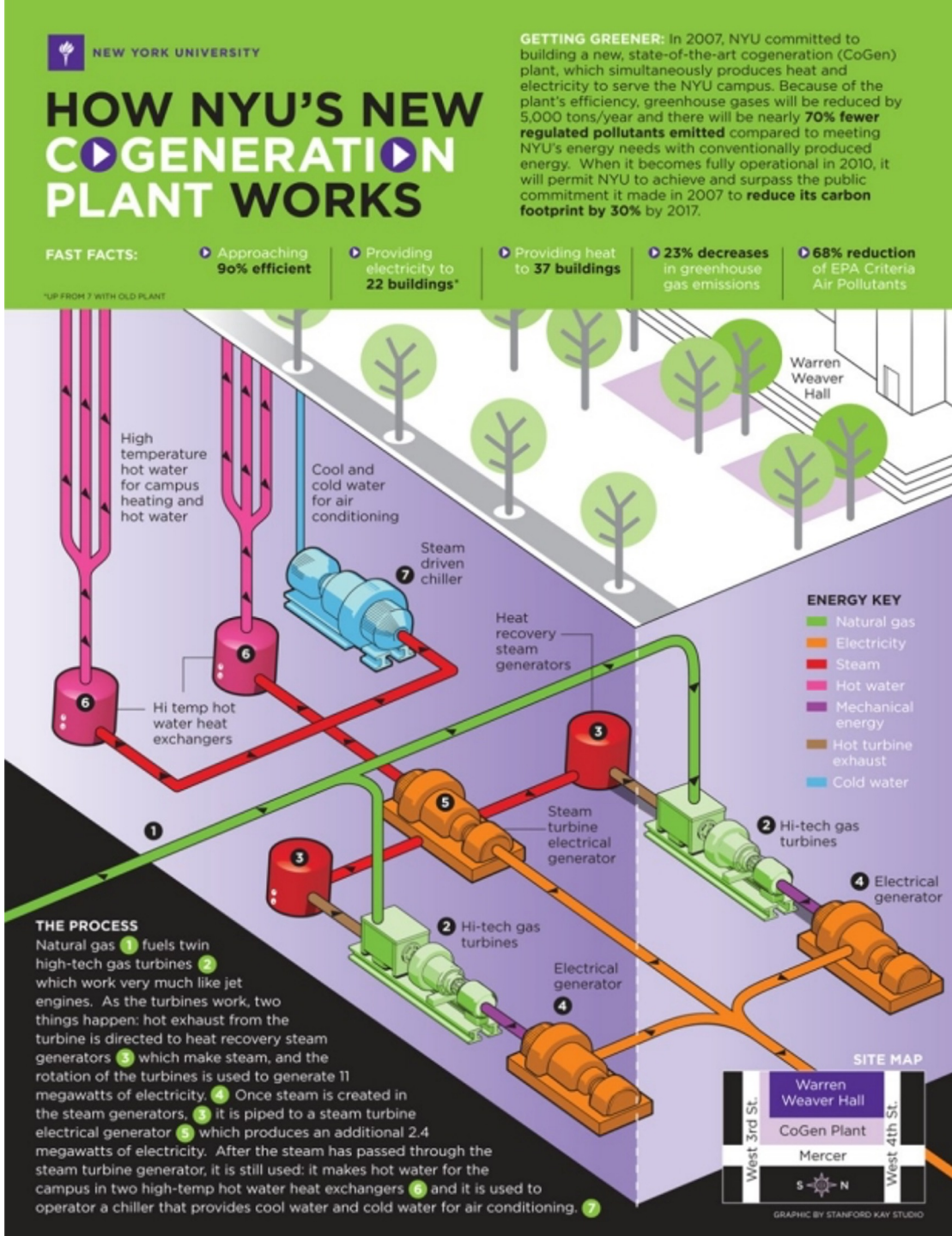
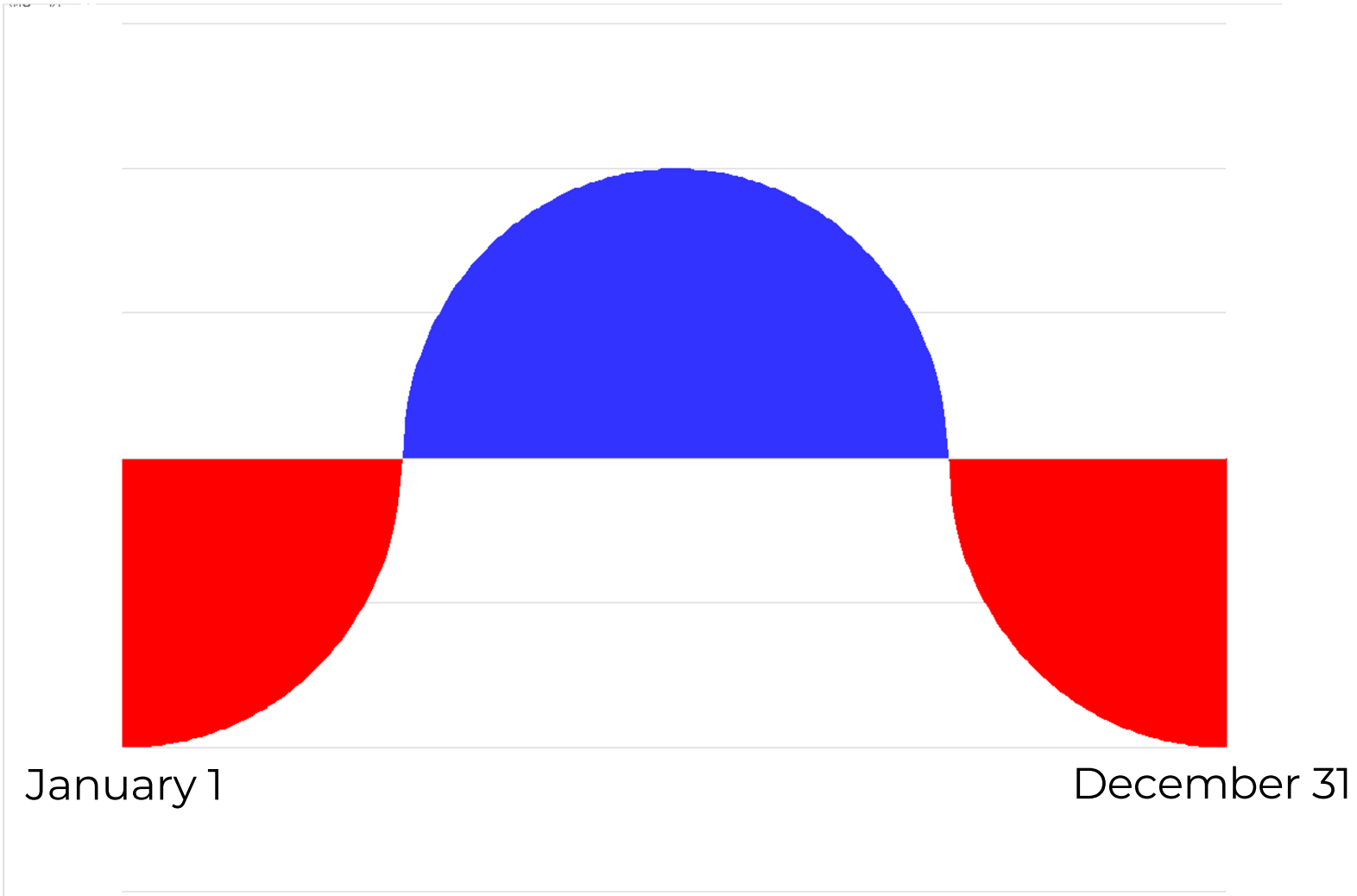
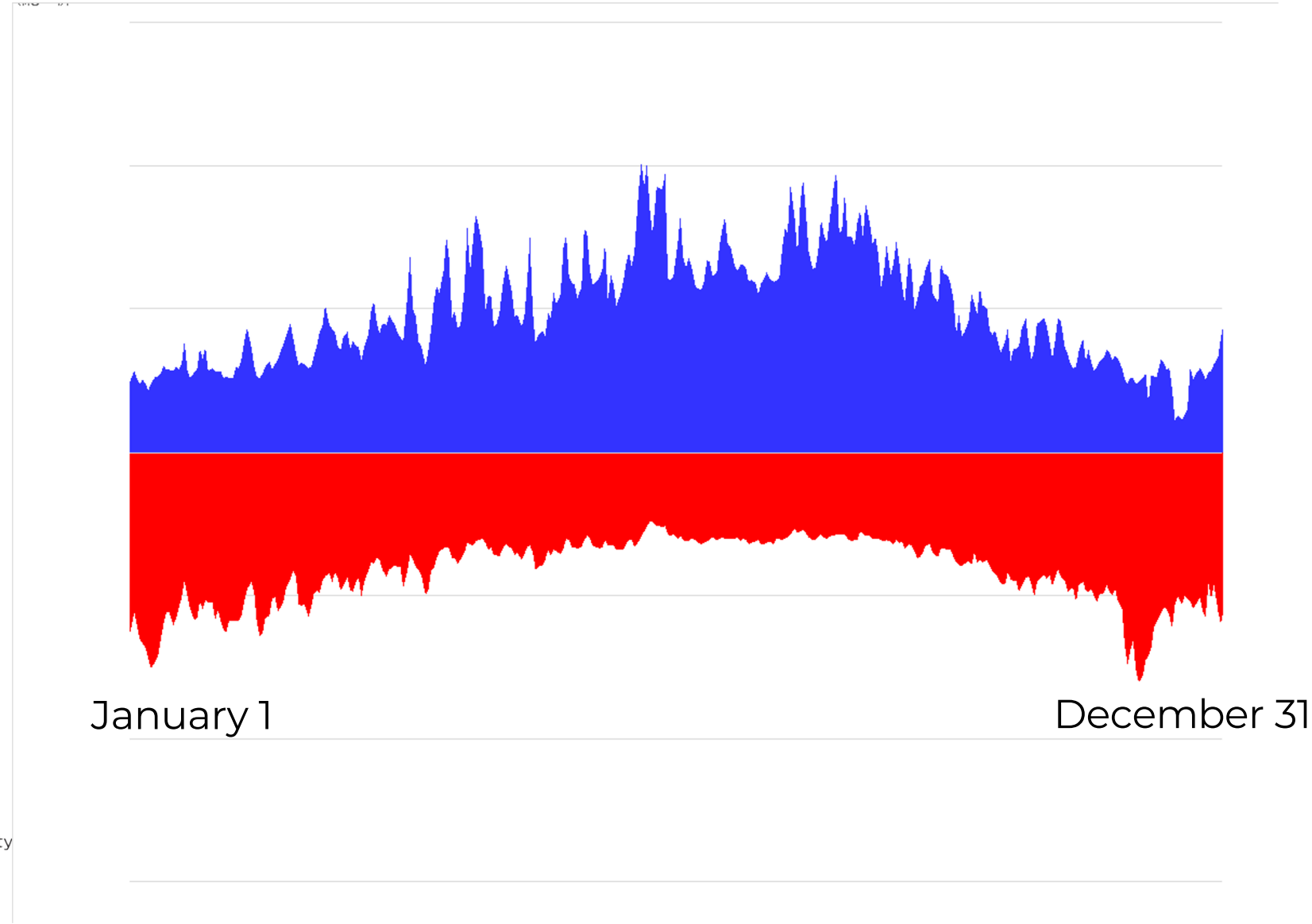


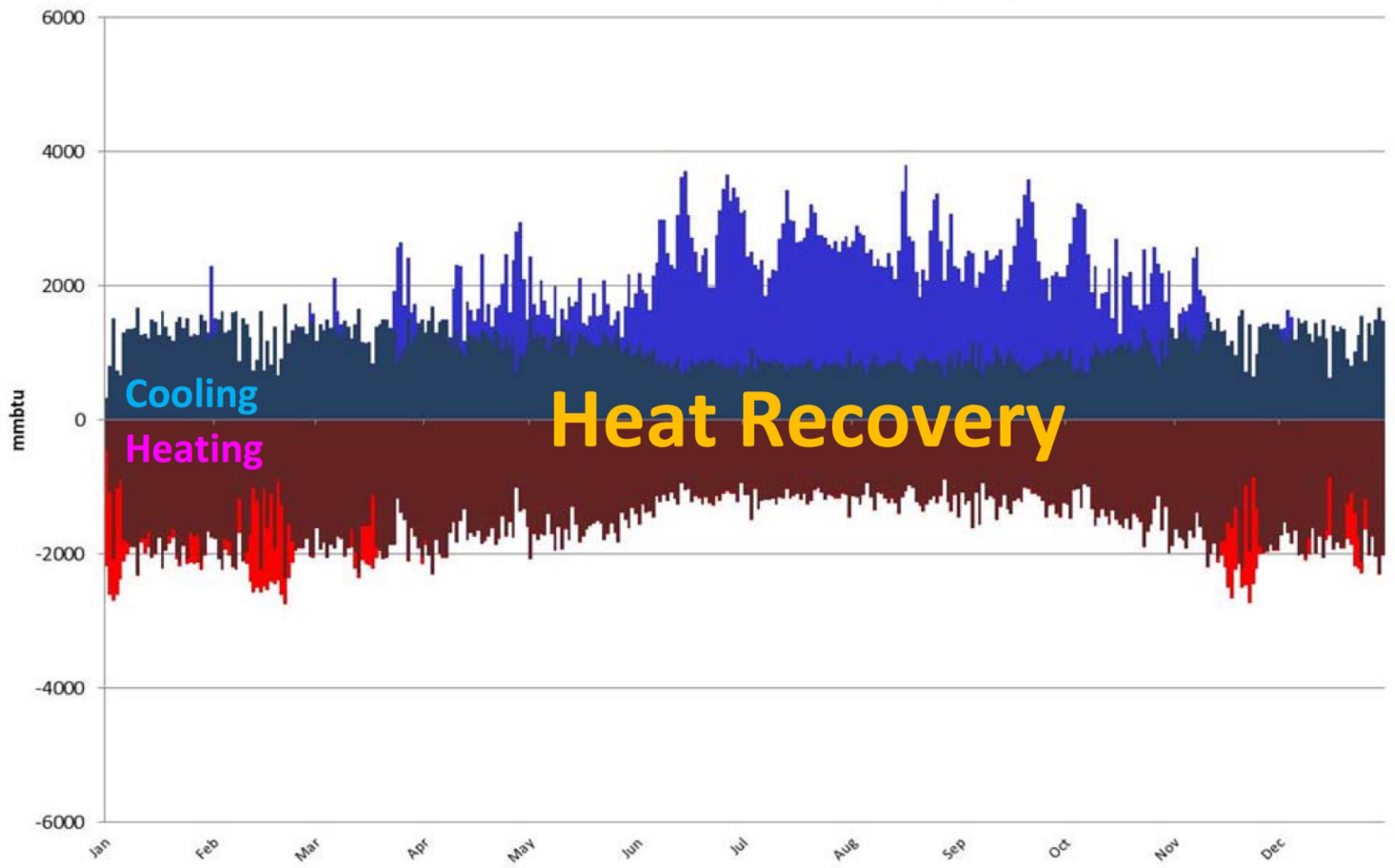
HOW WE THINK OF HEATING AND COOLING



HOW IT REALLY WORKS



ENERGY SAVING POTENTIAL



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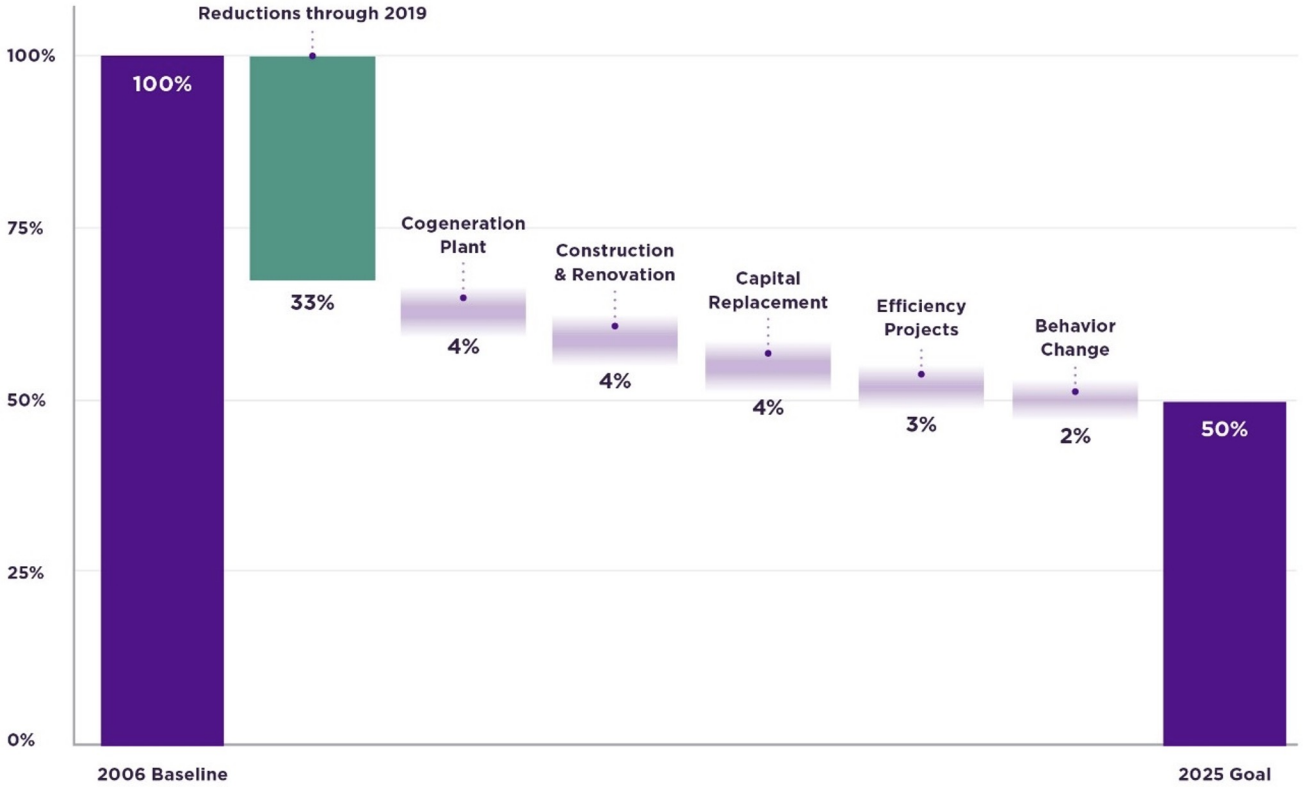
Electric heat pump utilizes waste heat from cooling as much as possible, then augments that with heat extracted from air, ground, or waters

CO-BENEFITS



- Thermal comfort for student and employee satisfaction and retention
- Improved indoor air quality aids academic success and reduces sick days
- Quieter indoor spaces reduces stress
- Lowered maintenance and insurance costs
- Increased building resiliency
- Enhanced reputation as climate leader

THANK YOU!

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nyu.edu/sustainability

UNIVERSITY AT ALBANY
State University of New York

ROAD TO CARBON NEUTRALITY

Indu Lnu
Energy Officer
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Energy efficient buildings with low EUI (SUCF Directive 1B-2 targets or lower)

Low temperature heating systems (supply water temperatures < 130F)

Beneficial electrification of heat and fleet/migrate from on-site fossil fuel combustion

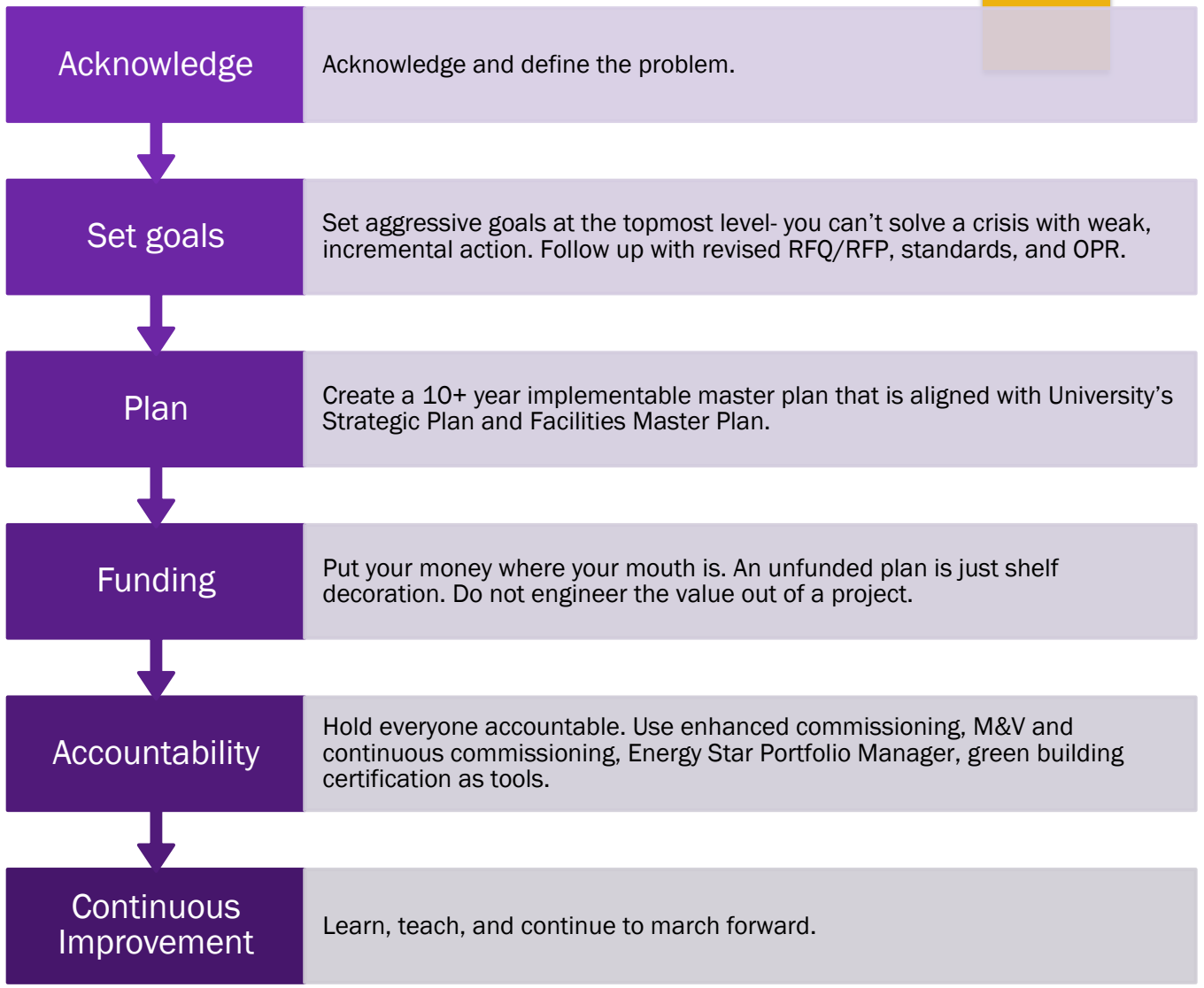
Renewable energy generation that matches campus use profile 24x7x365

Advanced data-driven operations/grid connectivity/ smart buildings

Well trained operators and educated and engaged users

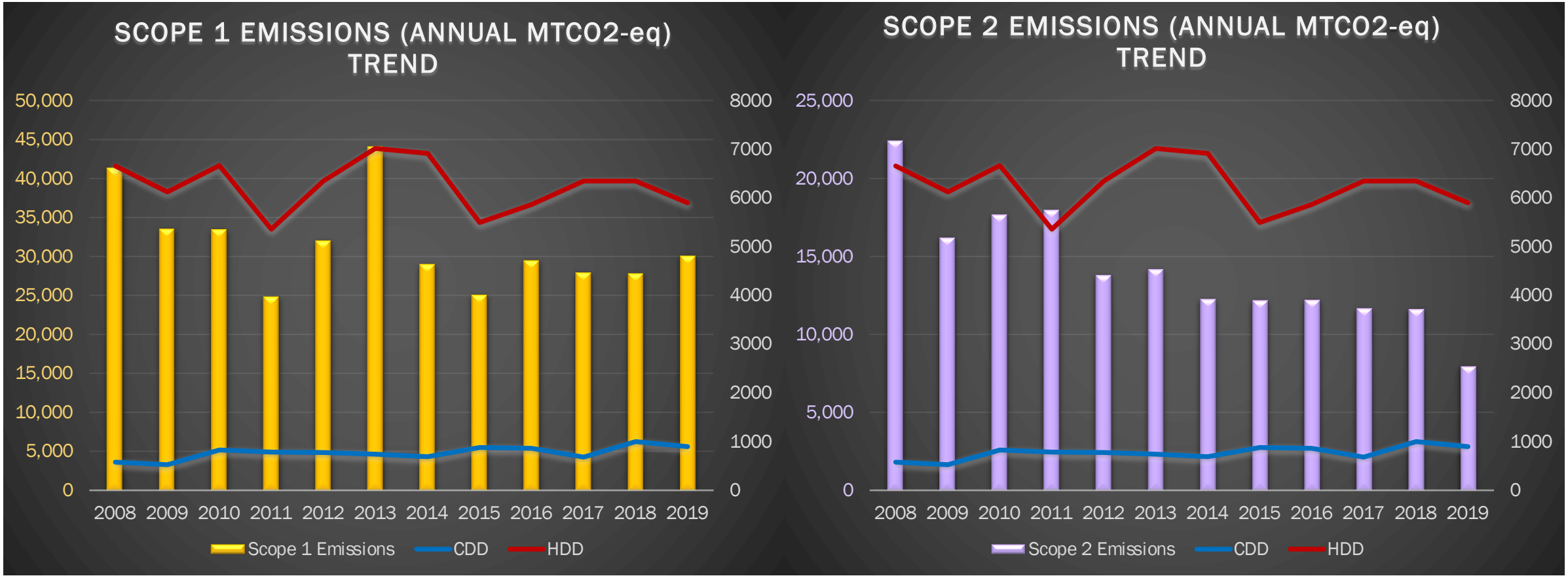
WHAT DOES A NET ZERO CARBON (NZC) CAMPUS LOOK LIKE?

ROAD TO CARBON NEUTRALITY



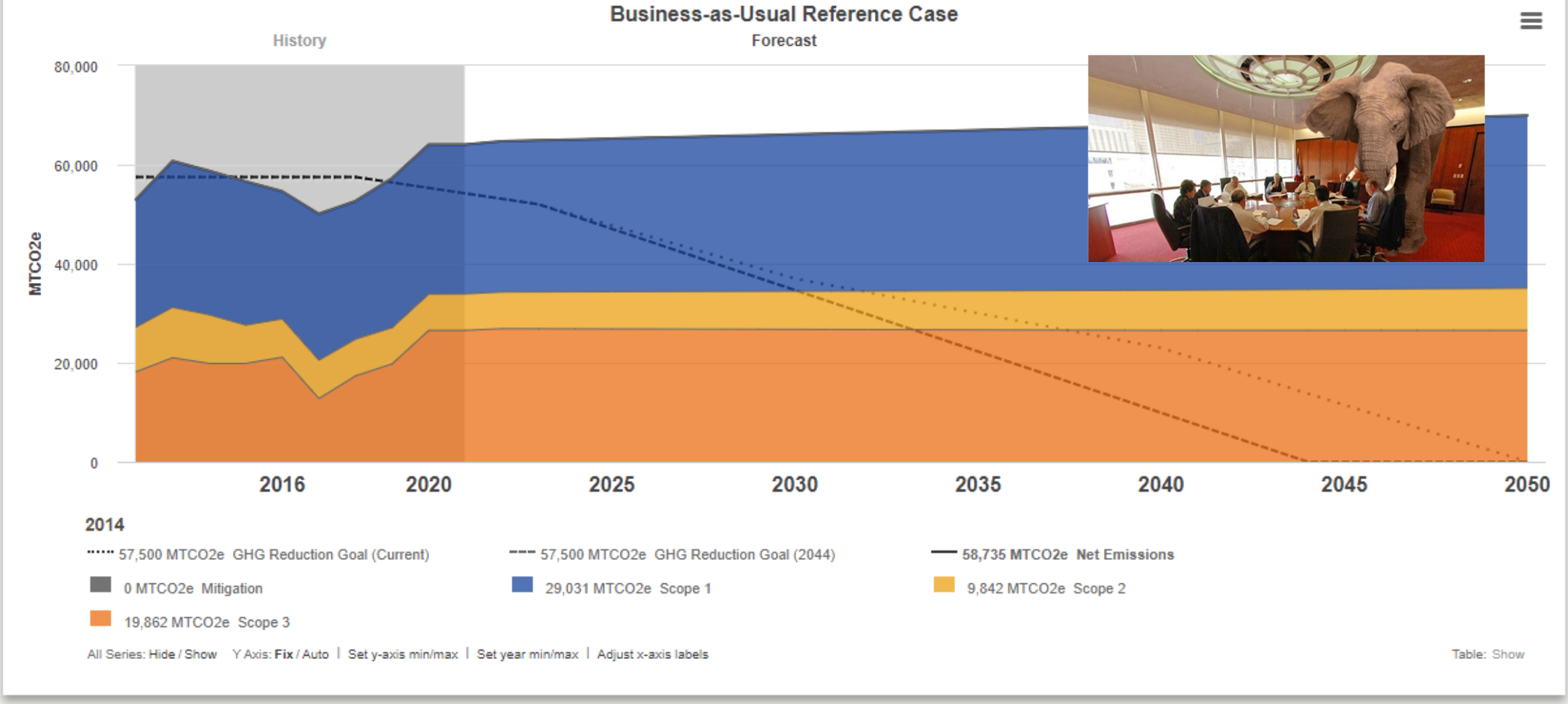
UALBANY: WHERE DO WE STAND?

TOTAL: 57,500MT, SCOPE 1: 52%, SCOPE 2: 14%, SCOPE 3: 34%

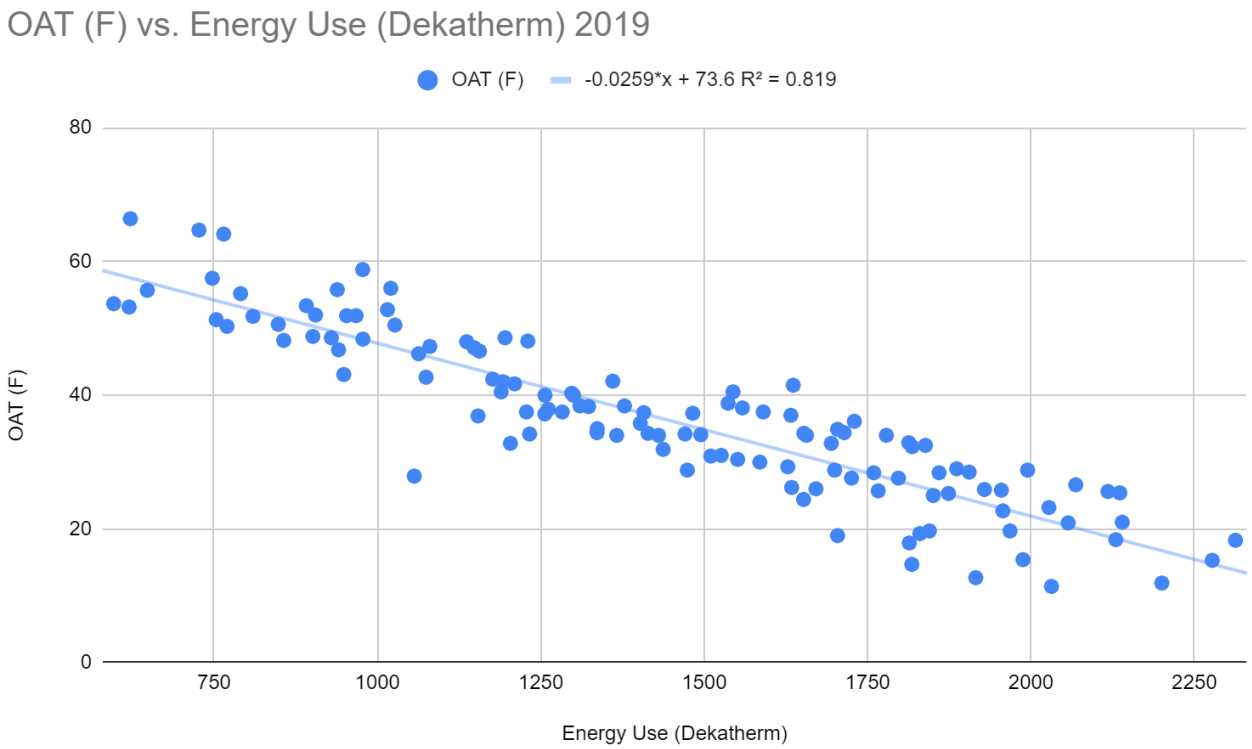


UPTOWN CAMPUS: BASELINE CARBON PROFILE

BAU | By Source, Detail | Overview | Portfolio 1 | Portfolio 2



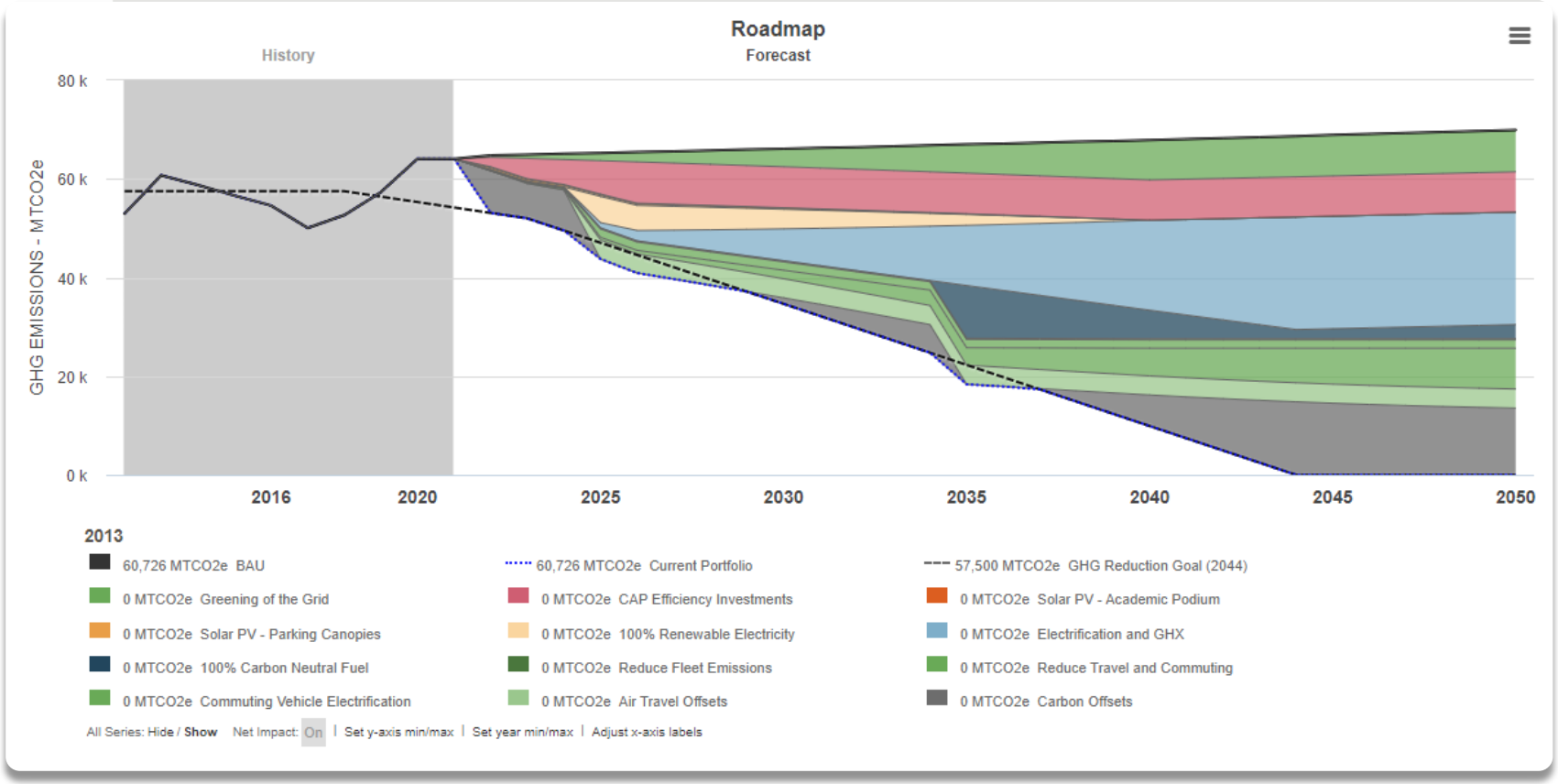
THE PROBLEM WITH HEAT



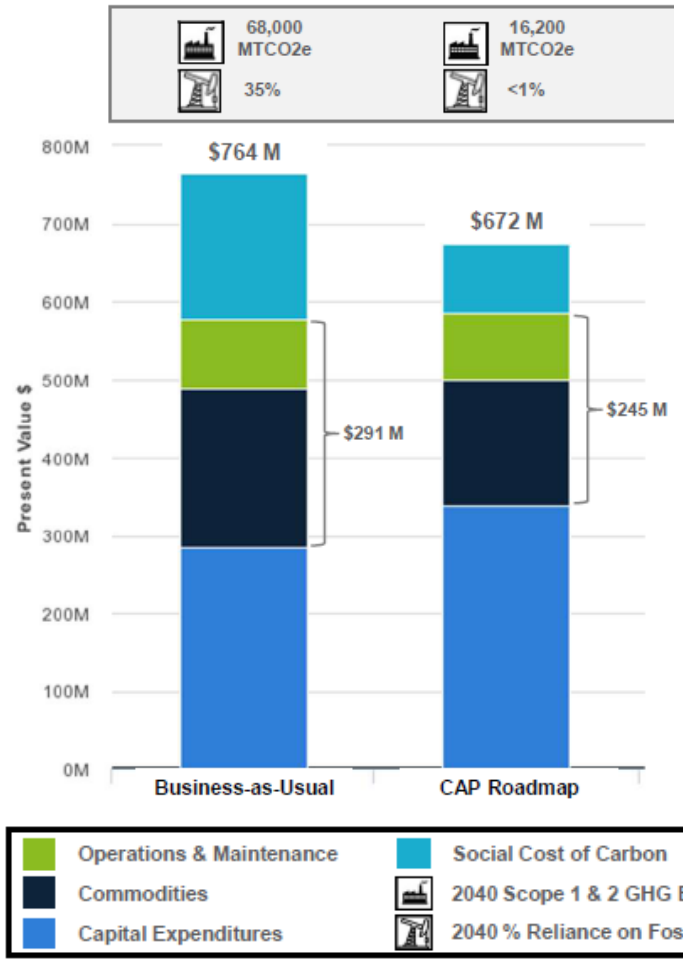
- Heating energy directly proportional to OAT
- R2 might be higher when DHW load is removed
- Indicates poorly insulated and leaky buildings and high ventilation rates
- Unlike electricity, renewable fuel sources are not cost-effective or readily available

HIGH LEVEL ROADMAP

- Carbon neutrality by 2044 UAlbany's 200th anniversary
- Electric grid is hopefully getting greener
- Beneficial electrification through geothermal heat pumps is a big part of the solution
- Scope 3 will become a bigger piece of the carbon emissions pie
- Carbon offsets will be required to get to carbon neutrality



HOW MUCH WILL THIS COST?



Climate Action Plan Roadmap

BUILDING BLOCKS

0 DECARBONIZATION OF ELECTRICITY

Greening of the Grid: State of NY Mandate for Zero-emission Electricity by 2040

1 STRATEGIC ENERGY MANAGEMENT (SEM)

SEM 1A: Efficiency Investments

SEM 1B: Deep Energy Retrofits + Building Conversions — $$

2 SOLAR + EV EXPANSION

2A: On-Site Solar: Selected Parking and Rooftops

2B: Off-Site Solar: Electric Vehicle (EV) Charging Stations

2C: EV Infrastructure: Electric Vehicle (EV) Charging Stations — $

3 CAMPUS ENERGY TRANSITION

3A: Thermal Network Expansion: Energy Sharing / Thermal Exchange Network (Low-temp Hot Water)

3B: Beneficial Electrification: Heat Pumps + Other Electric Low-Grade Heating Sources + Microgrid/ Batteries — $$$$

4 OTHER MITIGATION

4A: Fleet: Fleet Conversion to EV

4B: Commuting: Commuting Optimization and Electrification

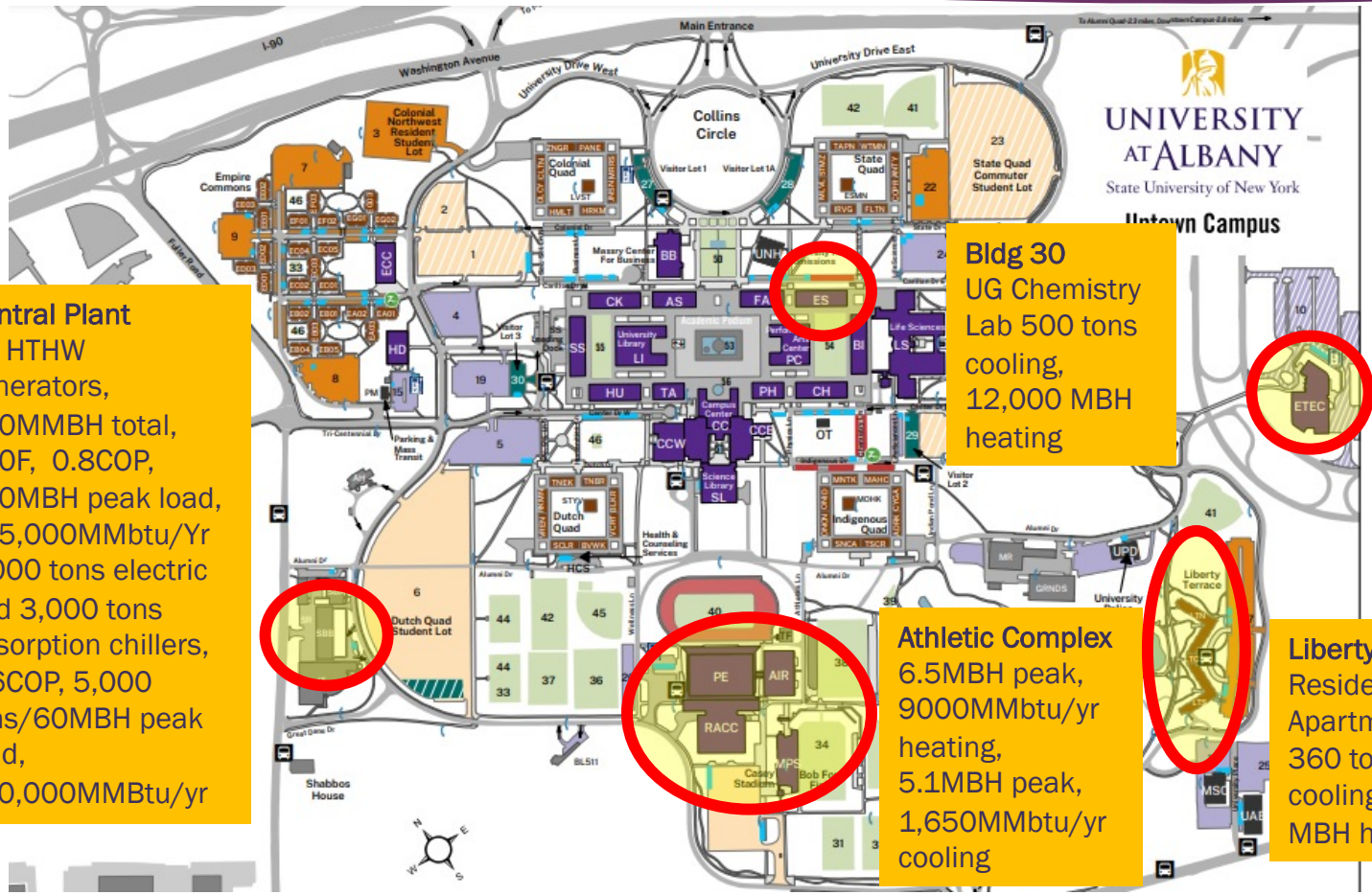
4C: Air Travel: Air Travel Offsets — $

5 RESIDUAL DECARBONIZATION

Residual Decarbonization: Sequestration + Offsets — $

BRAILSFORD & DUNLAVEY / CLIMATE ACTION PLANNING

WHAT WILL IT LOOK LIKE?



- **It depends**
- Distance from existing central plant and distribution network; Central plant capacity
- ETEC and Liberty: Geothermal HP was the lowest LCC even without SCC when compared to localized chillers/boilers or WSHP
- Athletic Complex: Connect to central plant or localized geothermal HP plant
- Bldg 30: Already on central plant. Wait till plant is fully electric and LTHW distribution system in place by 20?? or satellite geothermal HP plant on the east side of campus

Net Zero Carbon Campus Master Plan, $2M NYERDA grants, Phase 1 RFQ issued.

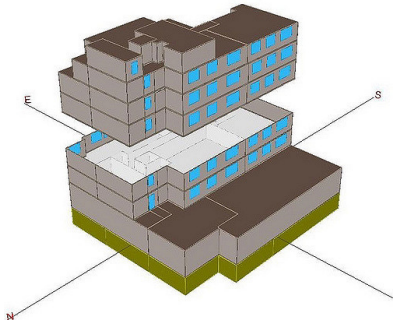
UNIVERSITY AT ALBANY
State University of New York

LOWERING ENERGY USE INTENSITY at ETEC

Owner's Project Requirements

ETEC

- ✓ It all starts with the OPR



- ✓ Iterative modeling

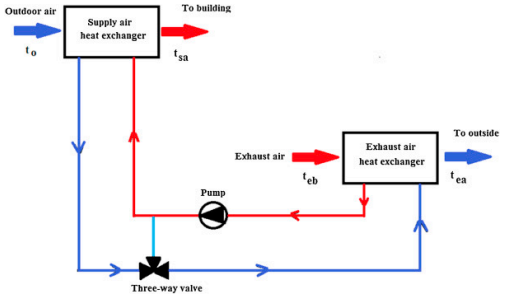
- ✓ Limit amount of glazing
- ✓ Enhanced building commissioning including envelope mock-up
- ✓ (2) 2-story atrium instead of (1) 4-story atrium

- ✓ **24% of energy use from plug loads**
- ✓ Switched Outlets
- ✓ Occupant engagement

- ✓ Occupancy sensors in labs to reduce Air Changes per Hour from 6 to 2
- ✓ Proximity sensors in fume hoods to reduce face velocity from 100 Feet per Minute (fpm) to 80 fpm
- ✓ Sash position limiters at fume hoods to limit sash opening to 18" to reduce airflow

- ✓ 0.54 W/SF Lighting power density
- ✓ Daylight controls

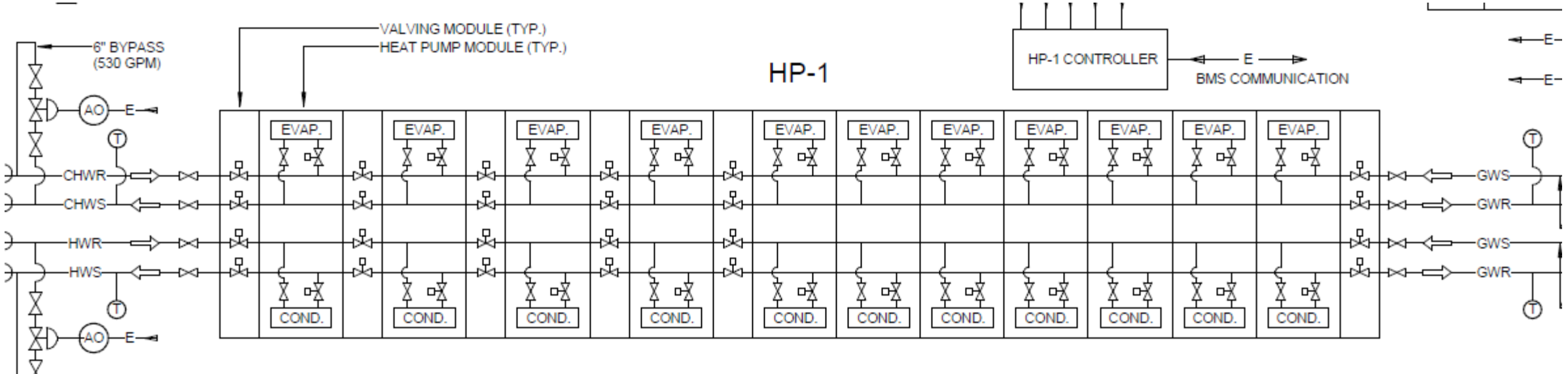
- ✓ Hot water system designed for 110-120F, only DHW at 140F
- ✓ Demand Based Ventilation
- ✓ Return air from non-lab spaces
- ✓ Glycol Heat Recovery



49 kbtu/sf/yr site EUI
29 non-labs;185 labs

ETEC GEOTHERMAL HEAT PUMPS
Heating, Cooling, and Domestic Hot Water

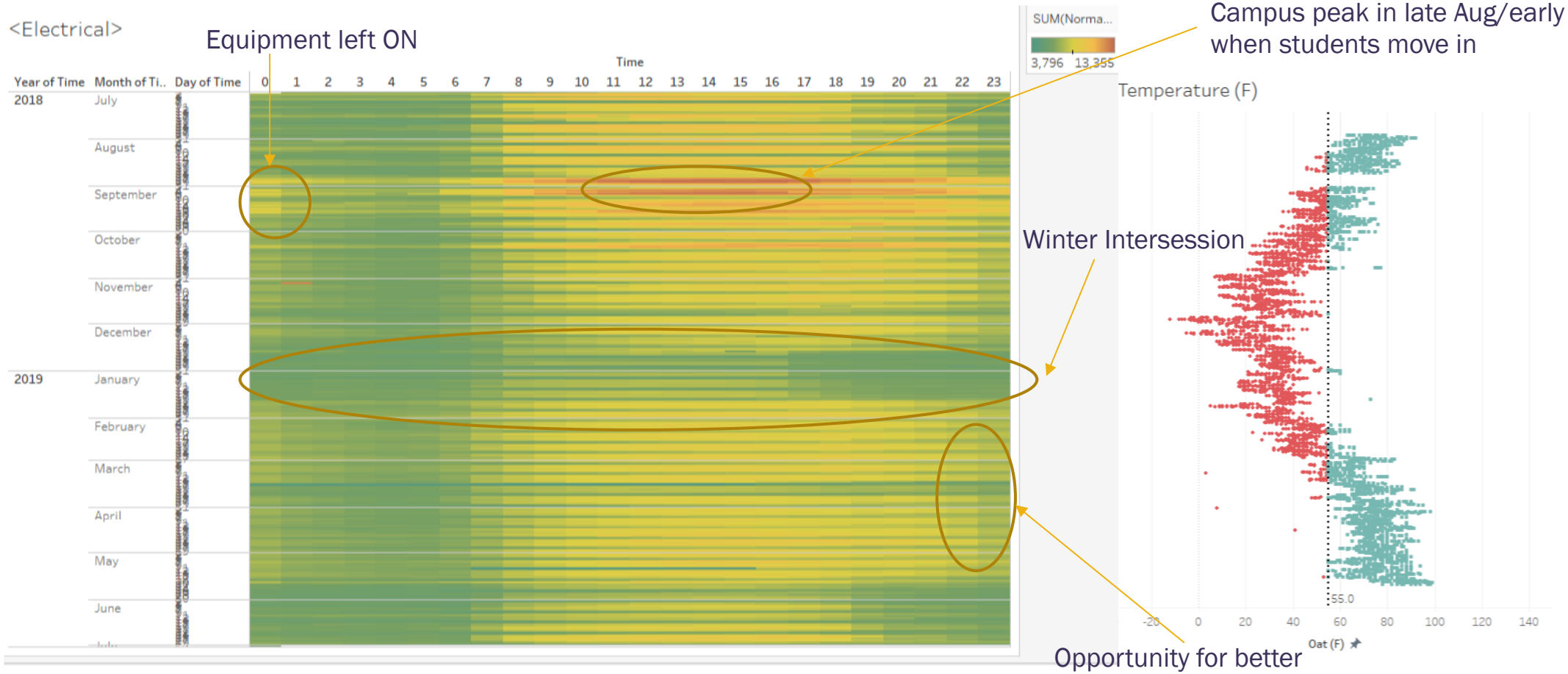
- 700 tons cooling/4000MBH heating peak load
- (14) groups of (190) vertical wells 499’ deep, 25’ o/c
- (1) group of (18) horizontal loops-590’ in length, 13” o/c
- **Well field cost: $1.9M. Lowest Life Cycle Costs**
- Heat recovery scroll modular chillers with (11) modules
- Allows simultaneous heating and cooling and redundancy
- Variable primary flow
- 5.13 cooling (17.51 EER), 4 COP heating, 7.5 COP simultaneous, 1.64 COP DHW heating



RENEWABLE ENERGY

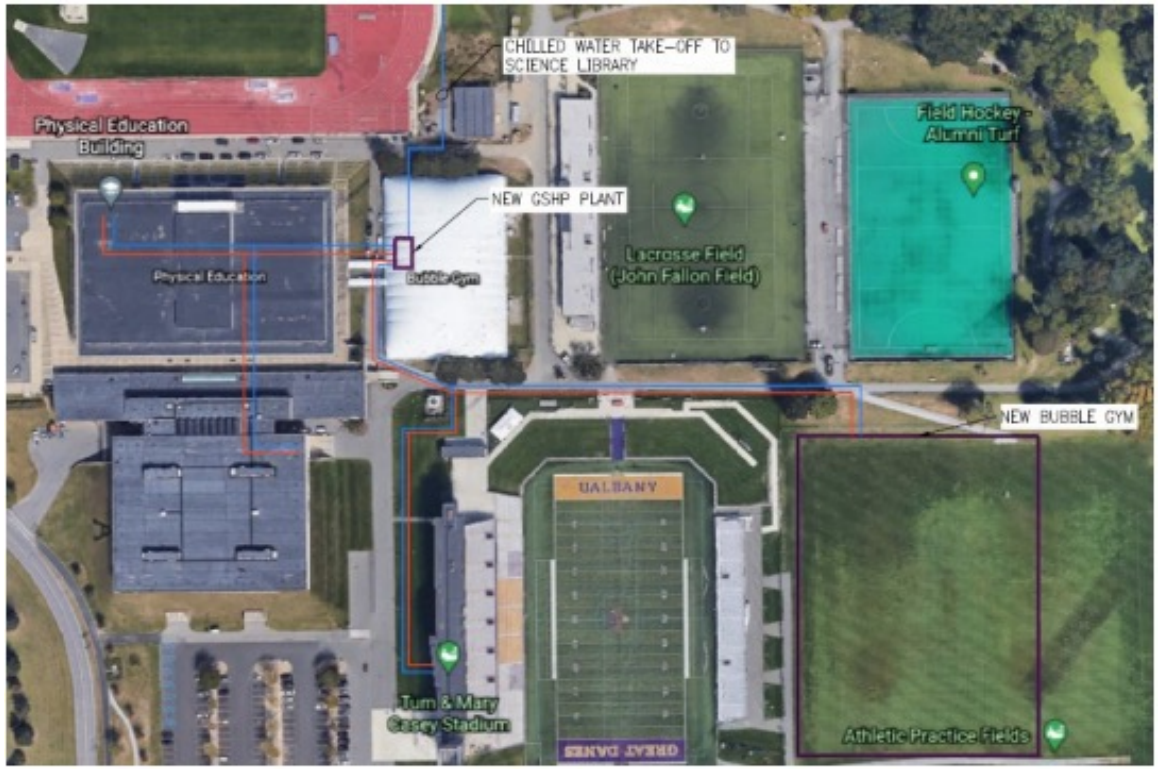
- 1.6MW solar photovoltaic system installed on podium roofs
- RECs will be retired on behalf of ETEC
- Generate 60% of the annual estimated electricity used by ETEC
- Negotiating a Virtual PPA with a large offsite LSRE as part of a 21-campus consortium to get to 100% renewable electricity
- Wait for grid to get 100% carbon free?

CONTINUOUS COMMISSIONING & M&V



ATHLETIC COMPLEX

Option 1: Connect to Central Plant for heating and cooling	Option 3: Heating and Cooling from new Geothermal Heat Pump Plant	Option Selected
○ Use existing High Temperature Hot Water lines for heating and domestic hot water ○ Install new Chilled Water lines	○ Use existing High Temperature Hot Water lines for domestic hot water ○ Install 210-bore well field ○ Build a new plant to house new 550-ton Ground Source Heat Pumps to provide heating and cooling	○ Install CHW and LTHW lines from central plant ○ Well field near central plant ○ Replace one or both absorbers with heat recovery chillers, upsize capacity
○ First Cost: $3.3M	○ First Cost: $12.4M	○ Spread across multiple projects
○ Annual Utility Costs: $190K ○ Use of fossil fuel for heating; Social Cost of Carbon: $140/Yr ○ Will need added chiller capacity at Plant; Not included in stated costs	○ Annual Utility Cost: $160K ○ Meets beneficial electrification goals; No on-site fossil fuel combustion ○ Social Cost of Carbon: $40K ○ Need space to house new heat pumps ○ Added O&M cost from distributed equipment	○ Will meet beneficial electrification goals ○ Better load balancing opportunities ○ First step in campus wide transition to LTHW
○ 30-Yr Life Cycle Cost: $11.3M	○ 30-Yr Life Cycle Cost: $17.0M	Leverages baseline capital investment



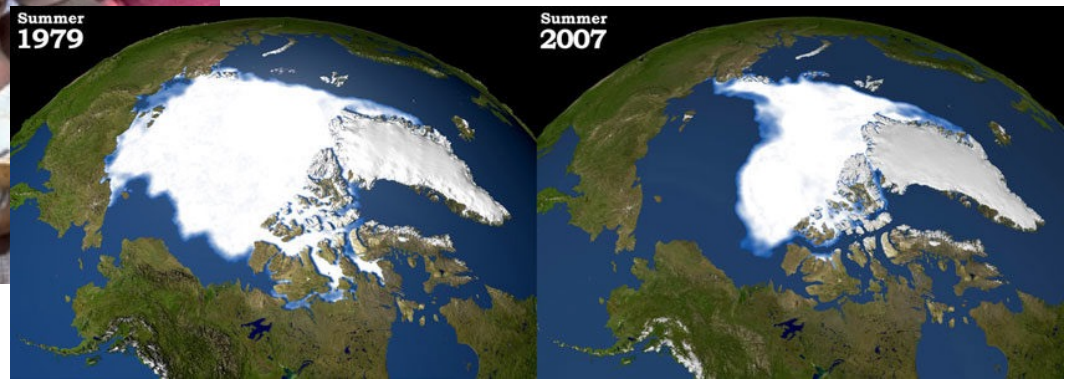
BLDG 30

- Designing for 110F entering water temperatures
- DHW: instantaneous electric or off 160F LTHW
- Heat Recovery Chillers at existing Central Plant to deliver 160F LTHW and 42F CHW and new 20” LTHW distribution to serve building OR
- New Central Plant at Northeast corner of campus with heat recovery chillers connected to well field at State Quad parking lot and/or Collins Circle and new smaller LTHW pipes to pick up science buildings on east side of podium

WHAT CAN WE DO TODAY ON ALL PROJECTS?

- Set aside **$40-$50/SF** in capital investment projects for deep energy retrofits and beneficial electrification
  - Beneficial electrification utilizing geothermal heat pumps/heat recovery chillers is a definite part of the solution and will account for 50-60% of the capital costs
  - Do not value engineer envelope measures: lost opportunity
  - Do not accept any cost/benefit analysis that does not include Social Cost of Carbon
  - Say no to simple payback. Use Life Cycle Cost Analysis instead
- Follow the Owner's Project Requirement (OPR)
- Ask for/provide an estimate of what it would take to get to beneficial electrification on capital projects, even if the project budget cannot support it. This will give us real numbers for future financial asks
- Make sure new and gut rehabbed/renovated buildings are designed and constructed for low temperature heating water (<130F). We have to spend this money anyway and it is cheaper to build it right the first time than redo/undo when we are ready for beneficial electrification.
- The electric grid will hopefully keep getting greener. So, focus efforts on Scope 1. On-site renewable electricity projects have a high $/CO2 emissions reduction compared to beneficial electrification projects. With limited $$, consider projects with higher CO2 savings/$.

IT'S TIME TO CLEAN UP OUR MESS



THANK YOU


be
ex
building
energy
exchange
discuss.
send questions via Zoom Q+A
Moderator
Nina Sharifi, Carbon Neutral Roadmap Advisory Council, Assistant Professor at Syracuse University
Speakers
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Cecil Scheib, Chief Sustainability Officer, Office of the President, New York University

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thank you.

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