BUILDINGENERGY BOSTON

Scalable Ground Source Heat Pump Systems: Mass. Maritime Academy Case Study

David Madigan (vanZelm Engineers)
Betsy Isenstein (Massachusetts DCAMM)
Tamar Warburg (Sasaki)

Curated by Karno Widjaja and Michaelson Joseph

Northeast Sustainable Energy Association (NESEA)
March 28, 2023

Introduction/Overview

- Master Planning
  - Sasaki engaged to develop campus master plan
  - van Zelm engaged to develop carbon neutrality master plan
  - Master plan → roadmap for new buildings, renovations and new carbon neutral campus energy infrastructure
- Implementation
  - van Zelm / Haley & Aldrich engaged to develop concept design and Design/Build RFP – Phase 1
  - Design/Build contractor will be engaged for final design and construction
  - van Zelm / Haley & Aldrich will act as "Owner's Engineer" for DCAMM/MMA to oversee design and construction

Commonwealth Climate Goals

January 6, 2023
Governor Healey announces the first Massachusetts Climate Chief

United Nations

United States

MA Climate legislation

EO 594

DCAMM

MA 2050 Goal:

Reduce Fossil Fuels by 95%

"The climate crisis is Massachusetts' greatest challenge, but there is enormous opportunity in our response,…"
Governor Healey

DCAMM's Mission

We are stewards of the Commonwealth's assets. We care for the people of our state and the future of our planet.

Facilities Planning

Project Delivery

Property Management

Real Estate Services

Access & Opportunity

Contractor Services

We work with state agencies to create and manage forward-thinking, sustainable buildings to meet the needs of the Commonwealth's citizens and help achieve a zero-carbon future.

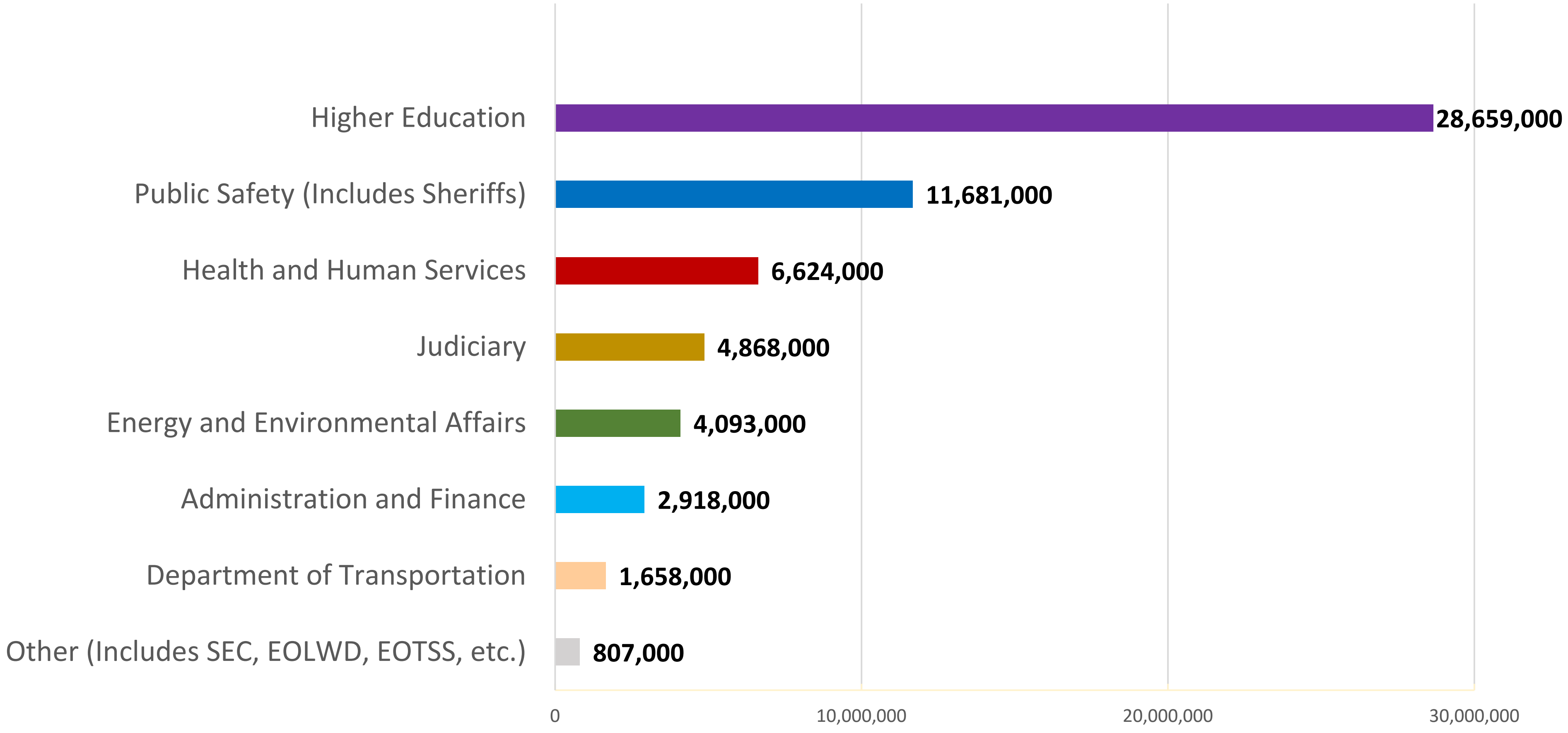
We are partners with fellow agencies to help them meet their strategic needs with fiscally responsible building and real estate solutions.

We support the growth of the Commonwealth's economy and actively engage with private sector partners to make it easier to do business with the Commonwealth.

We work to expand access, opportunity and equity to create more inclusive services, planning and outcomes for all the citizens of the Commonwealth.

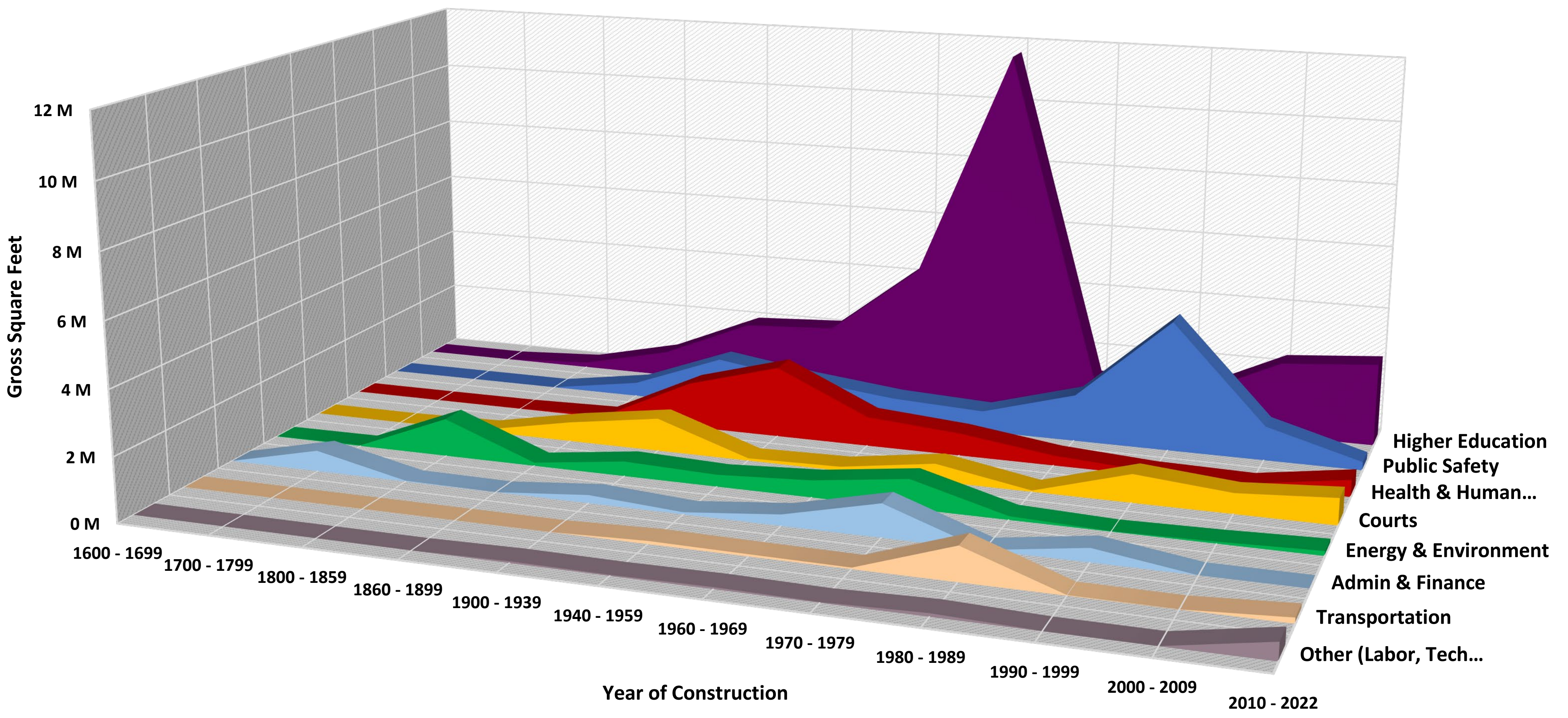
DCAMM Portfolio Size

DCAMM oversees the capital planning for over 1,700 major buildings comprising 61 million GSF

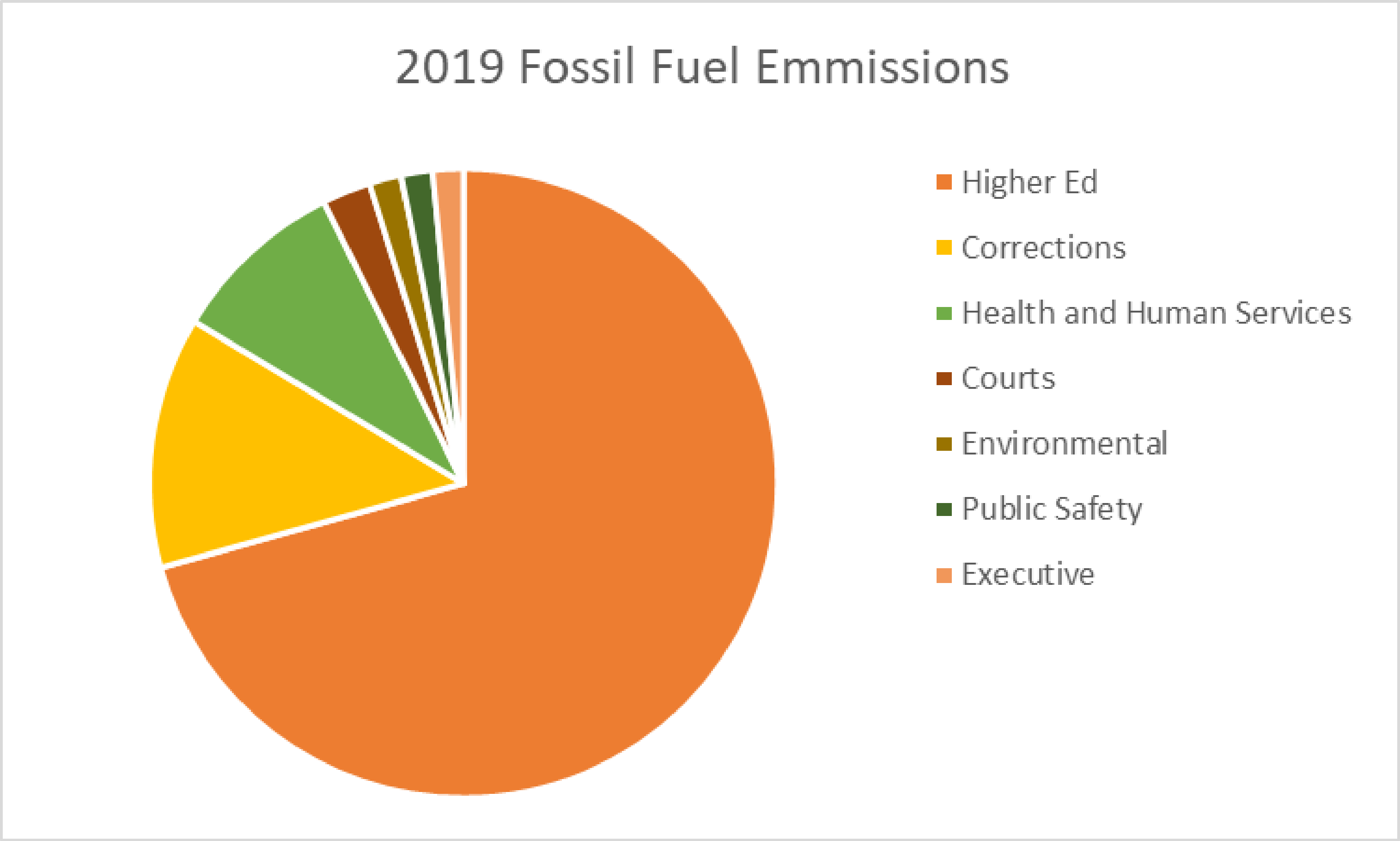


DCAMM Portfolio Age

Active Major State Building Portfolio by Year of Construction (gross square feet)



Operational Carbon from DCAMM Portfolio



2019 reflects pre-Covid energy use patterns

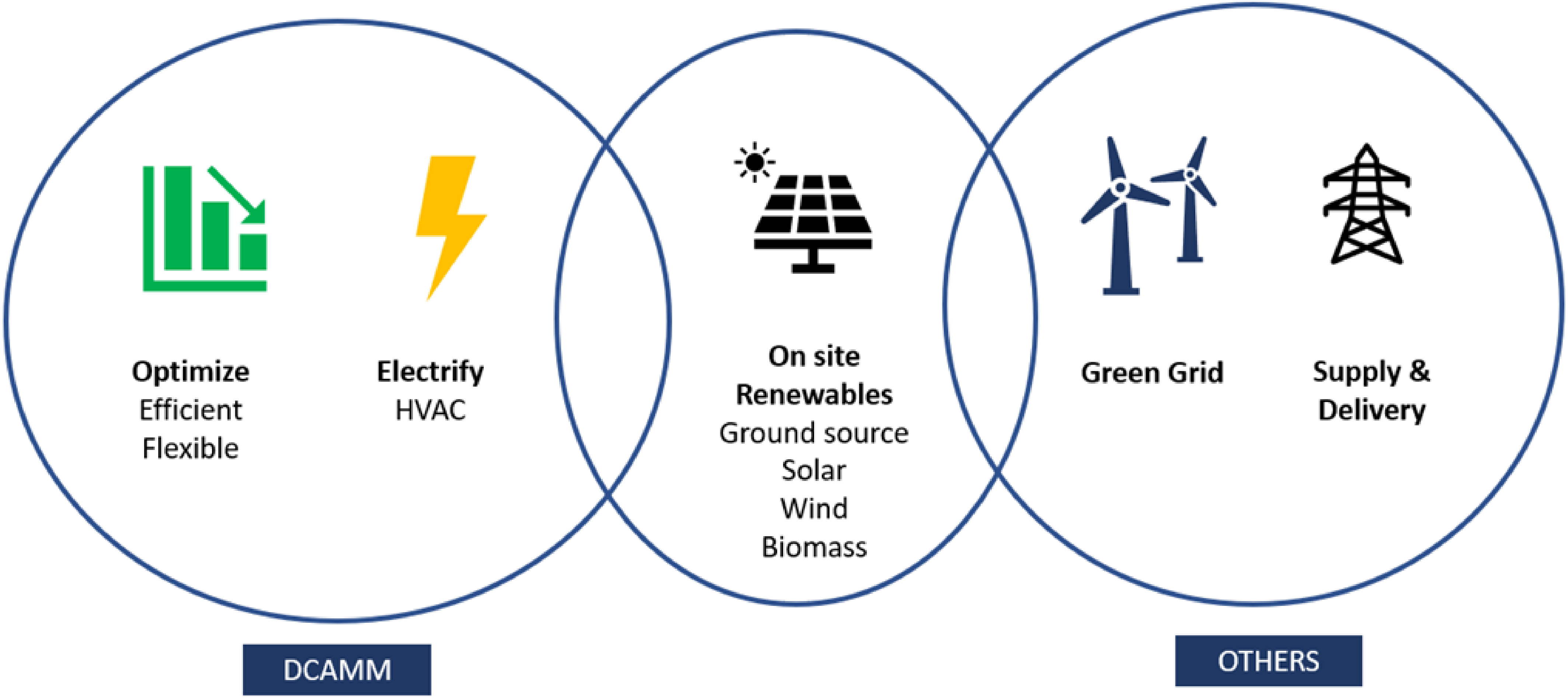
Zero Carbon Initiative: Agencywide effort to meet carbon reduction goals

DCAMM ZERO CARBON INITIATIVE

Infrastructure	Existing Buildings	New Buildings	Roadmaps
Invest in low carbon central plants and building infrastructure for heating and cooling	Reduce operational carbon Ready buildings for decarbonized solutions	Plan, design, and build fossil fuel free buildings	Site specific plan for decarbonization, climate change adaptation, and resilience

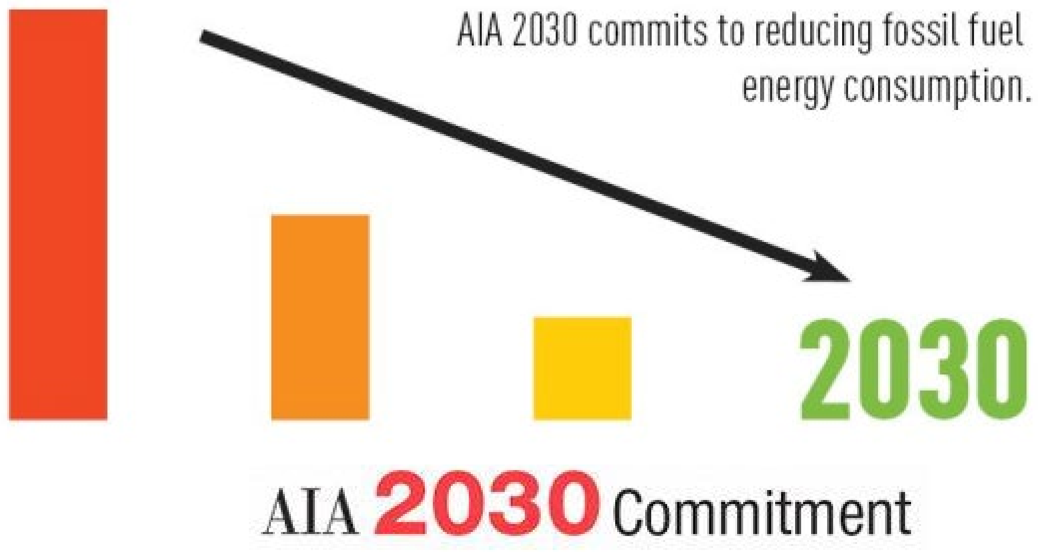
Efficiency, Demand Reduction, Renewables, Resilience

Decarbonization Strategies



We can’t do this alone

- Design teams
- Construction industry
- Client agencies
- EEA, DPU, DOER



How to participate

PRF74: Energy, Climate Action, and Facility Advisory Services contract on COMMBUYS

- January 1, 2022 – December 31, 2028
- Re-opens for new participants prior to December 2024

Designer Selection Board

https://www.mass.gov/orgs/designer-selection-board

Chapter 25A §11C

Design-Build (BoD approach)

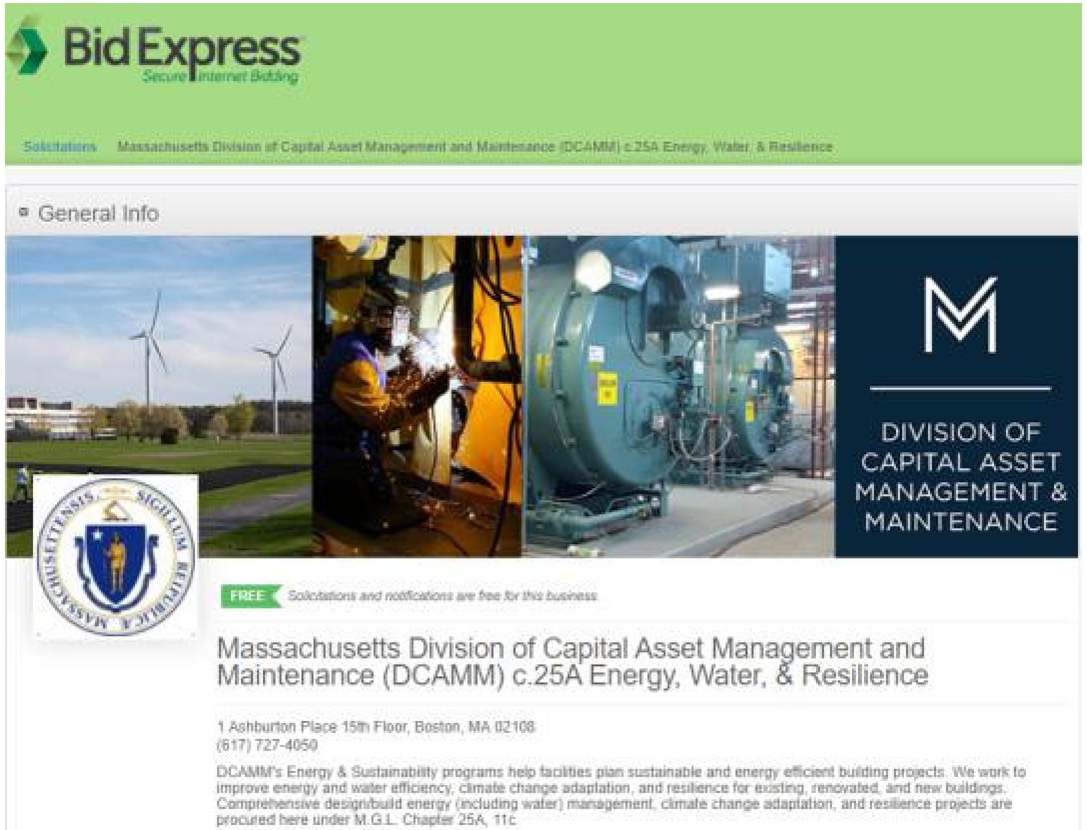
Energy + (hybrid approach)

New

M.G.L. Chapter 25A, §11C

M.G.L. c. 25A: DCAMM Energy Projects
Pursuant to M.G.L.c. 25A, DCAMM awards contracts to the offeror that demonstrably possesses the skill, ability and integrity necessary to perform faithfully energy management services.

RFPs on Bid Express at
c.25A E-Bid Room



To participate:

1. **Register with Bid Express**
2. **Complete the DCAMM C25A verification process**
3. Instructions at: https://www.mass.gov/how-to/bid-on-dcamm-c25a-energy-projects

The Master Plan is an invaluable opportunity to address climate change, and foster the resilience of Mass Maritime, the community, and the planet.

CAMPUS PLANNING

SCUP 2022 Jury's Choice Award
University of Kentucky Diversity, Equity, and Inclusion Facilities and Spaces Plan

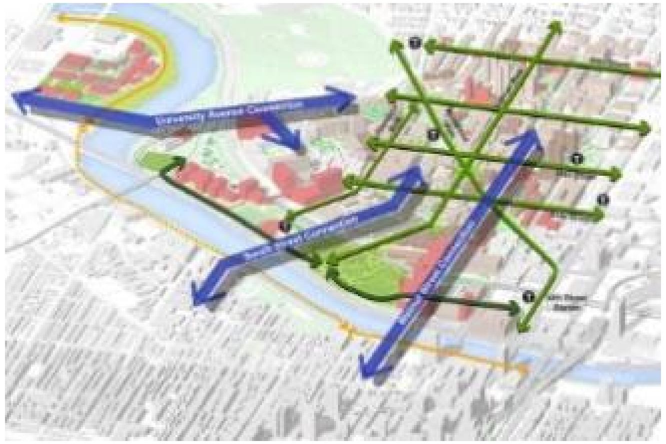
SCUP 2022 Merit Award
UC Berkeley Campus Master Plan

SCUP 2020 Honor Award
Emory University Framework Plan

SCUP 2018 Honor Award
Arizona State Mesa Campus Master Plan

SCUP 2016 Merit Award
University of Washington Seattle Campus Master Plan

SCUP 2015 Merit Award
University of Texas at Austin Medical District Master Plan

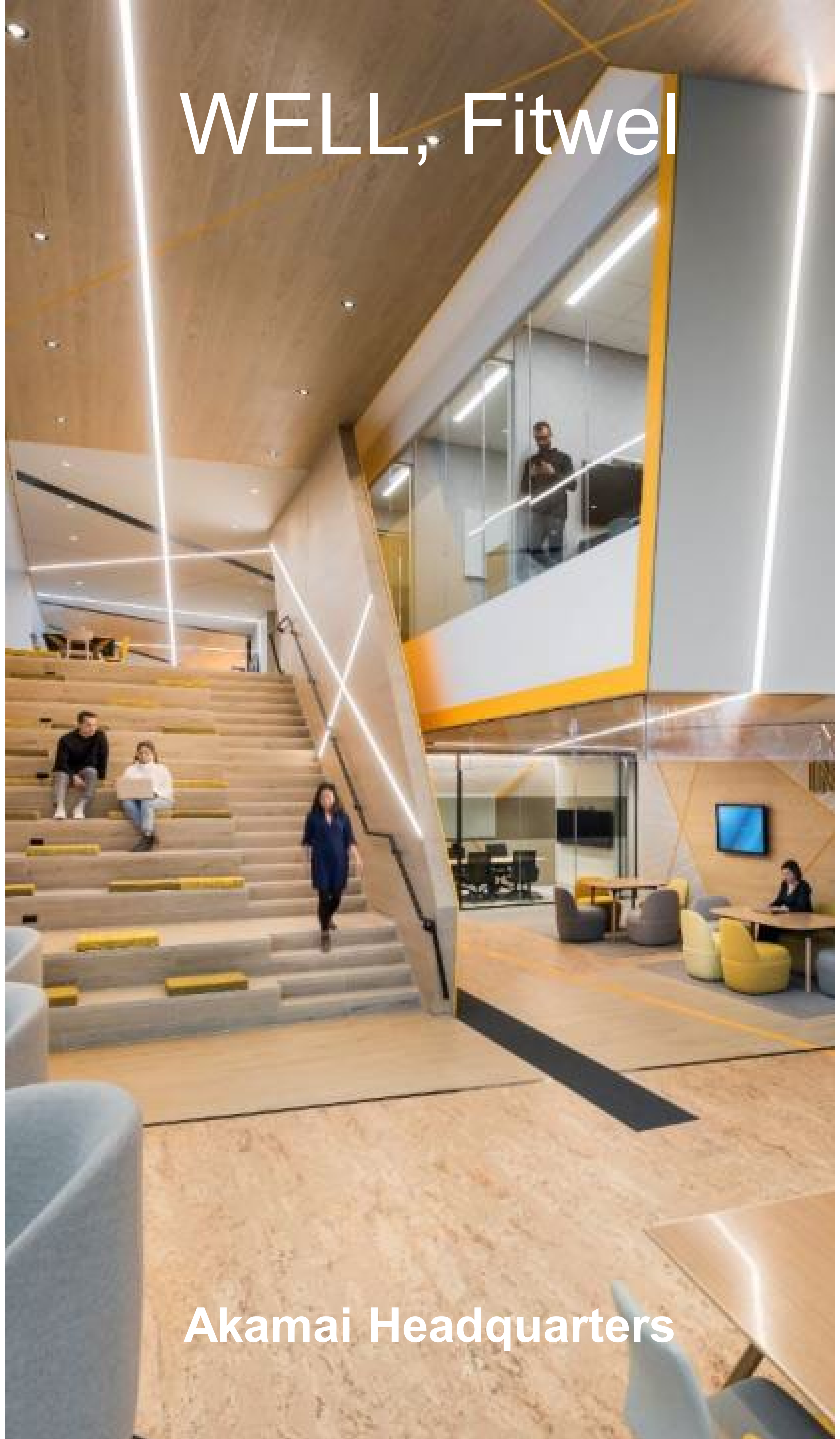


SCUP 2013 Honor Award
University of Pennsylvania Master Plan

SCUP 2019 Merit Award
Virginia Tech Campus Master Plan

We've received more than 900 design awards


Zero Energy
Bristol Health Sciences Center


WELL, Fitwel
Akamai Headquarters


Zero Carbon
ARTLAB
Harvard University Artlab

MASS MARITIME DECARBONIZATION PLAN

Carbon neutrality by 2035
100% renewable energy

How can the campus grow while eliminating GHGs?

Reduce energy use by 50%

All electric systems
Maximize onsite renewables

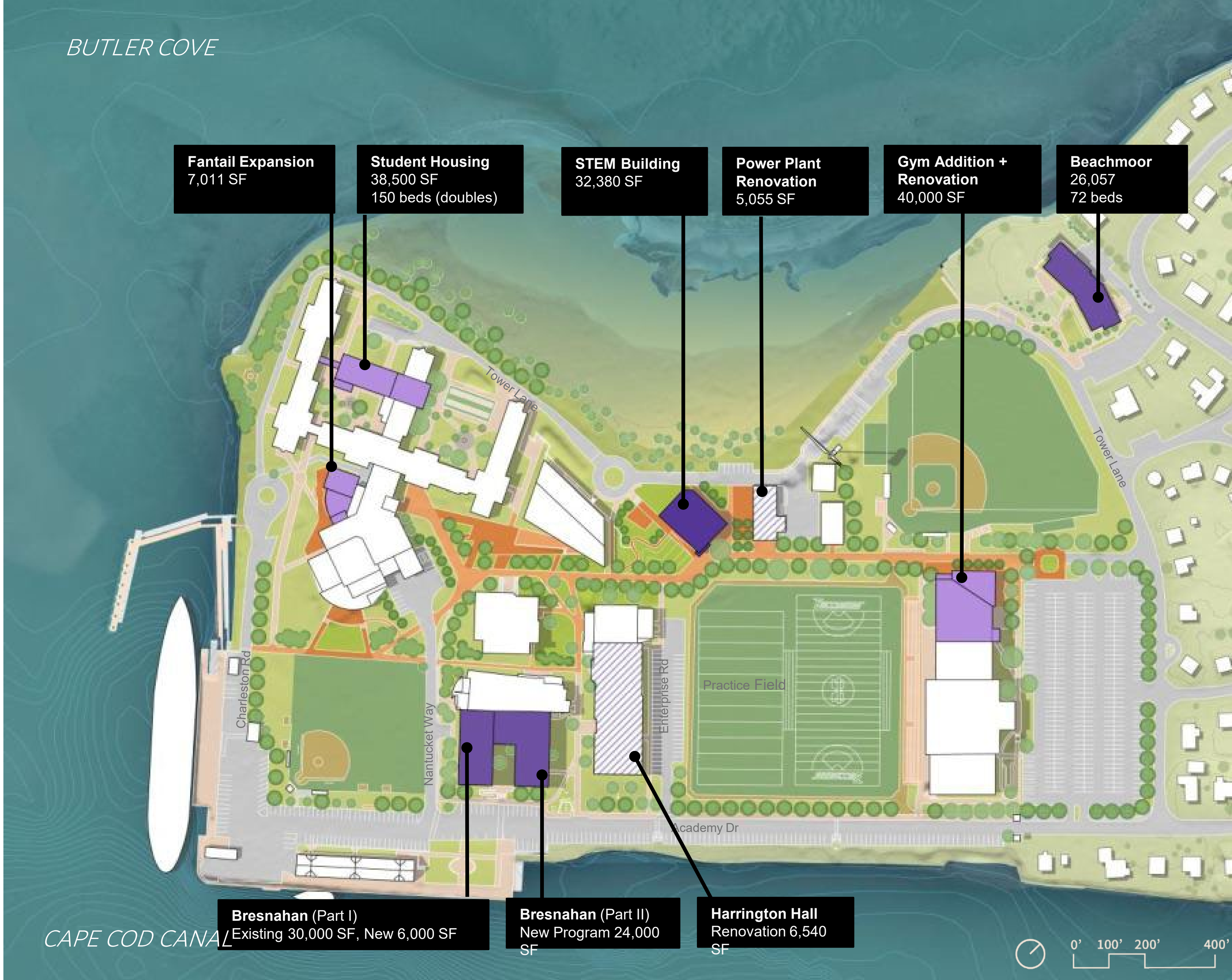
Reduce embodied carbon

Resilience planning to protect critical infrastructure

MASS MARITIME
MASTER PLAN VISION

20% Enrollment Growth Investments in academic, housing and student life spaces

How can the campus grow while reducing – and eliminating – carbon emissions?



- New Development
- Addition
- Renovation
- Existing Building
- Existing Trees
- New Trees
- Main Street
- Outdoor Plazas

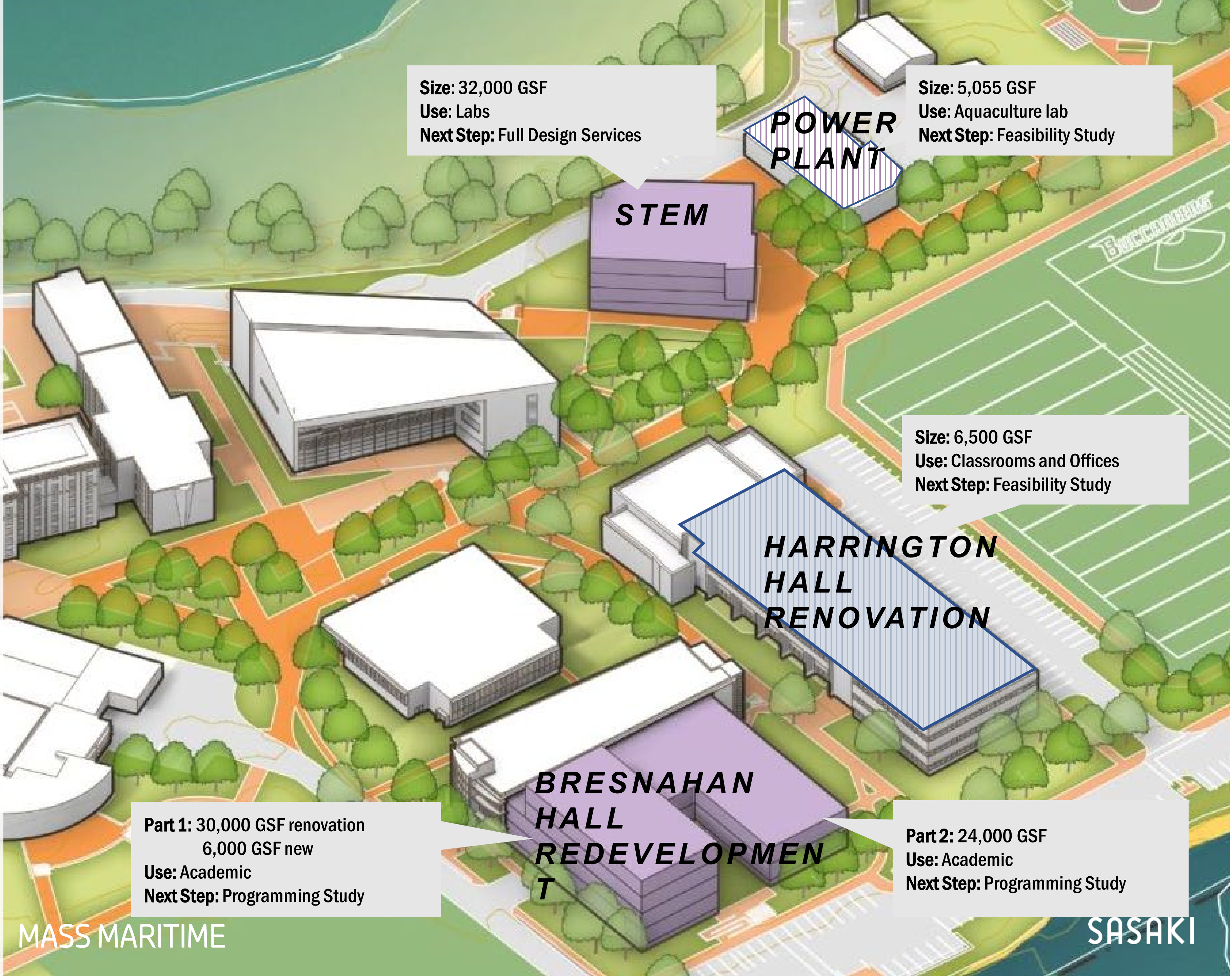
ACADEMIC PROJECTS

New STEM building with model sustainability and resilience priorities with 30,000 GSF of laboratory and classroom space.

Renovation of Harrington Hall to repurpose existing labs on the third floor.

Phased Bresnahan redevelopment to protect vulnerable infrastructure and add 60,000 GSF of academic space.

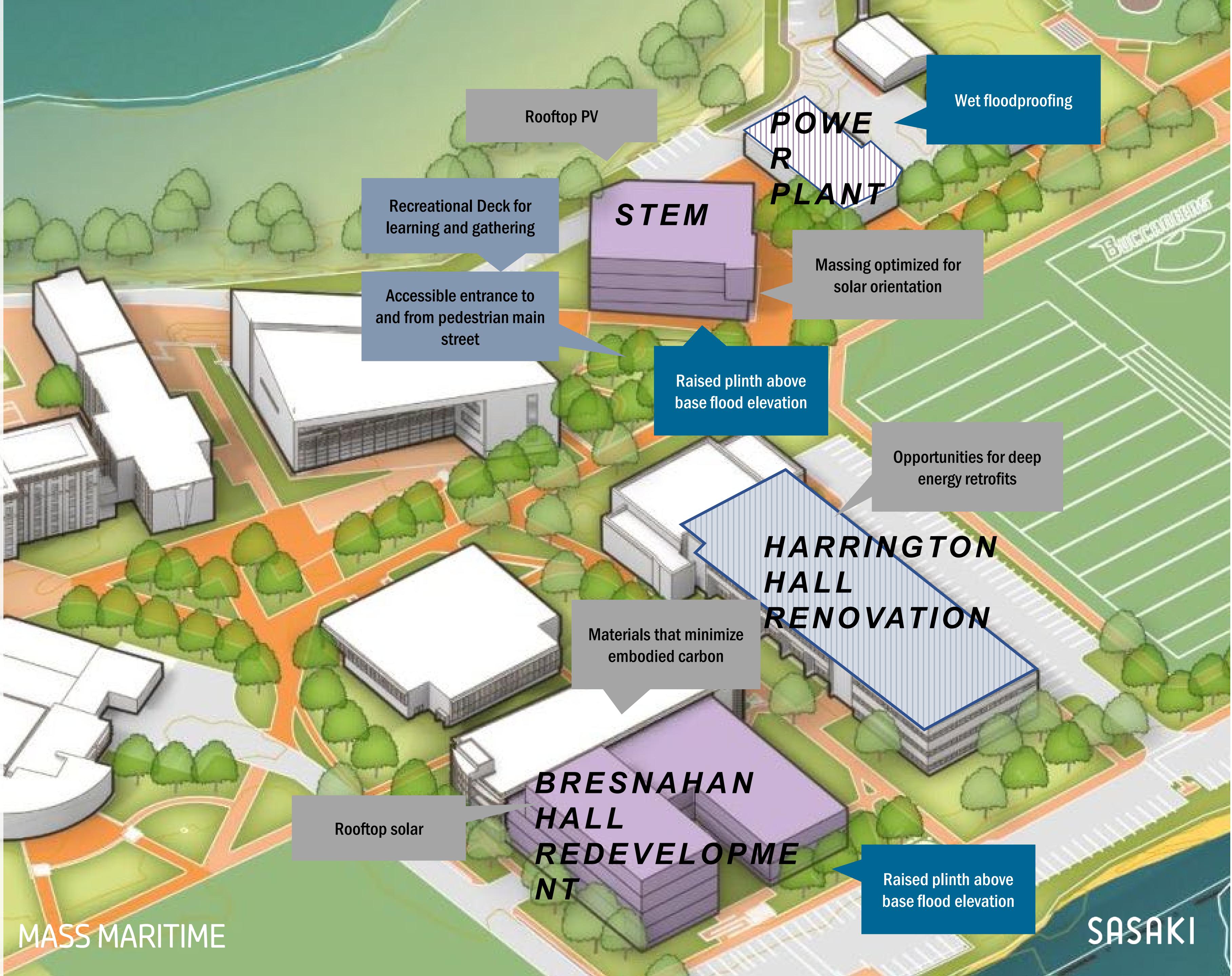
Power plant renovation of 5,055 GSF, reuse for aquaculture lab



ALIGNING GOALS

Capital improvement projects offer opportunities to address programming, resilience, and sustainability goals simultaneously.

Renovation projects are be paired with investments in energy and resilience infrastructure.



- Programming goal
- Decarbonization goal
- Resilience goal

SASAKI

LANDSCAPE

Learning, eating, and connecting can take place in multiple outdoor spaces along the new pedestrian main street.

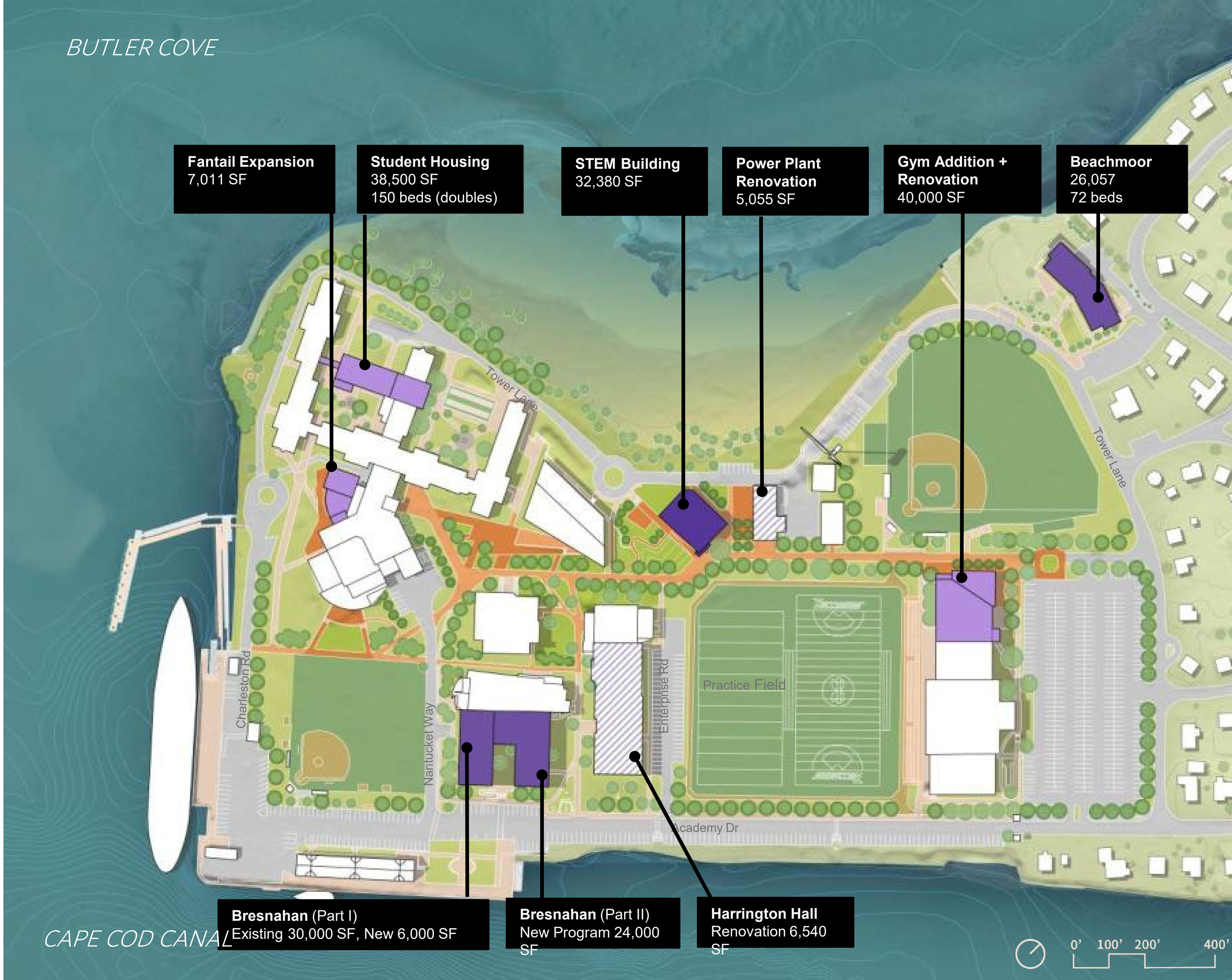
MASS MARITIME

SASAKI

MASS MARITIME
MASTER PLAN VISION

20% Enrollment Growth Investments in academic, housing and student life spaces

How can the campus grow while reducing – and eliminating – carbon emissions?



- New Development
- Addition
- Renovation
- Existing Building
- Existing Trees
- New Trees
- Main Street
- Outdoor Plazas

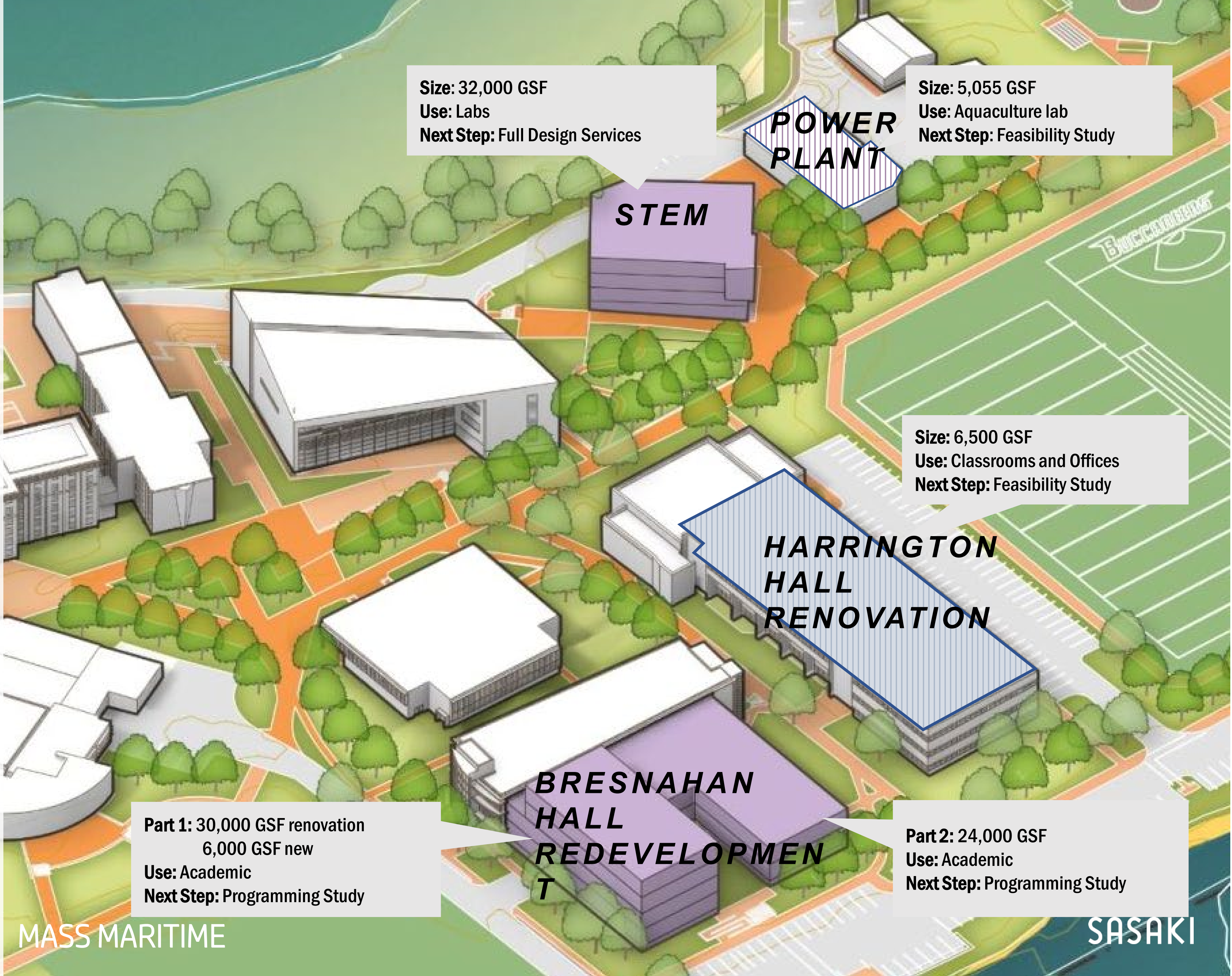
ACADEMIC PROJECTS

New STEM building with model sustainability and resilience priorities with 30,000 GSF of laboratory and classroom space.

Renovation of Harrington Hall to repurpose existing labs on the third floor.

Phased Bresnahan redevelopment to protect vulnerable infrastructure and add 60,000 GSF of academic space.

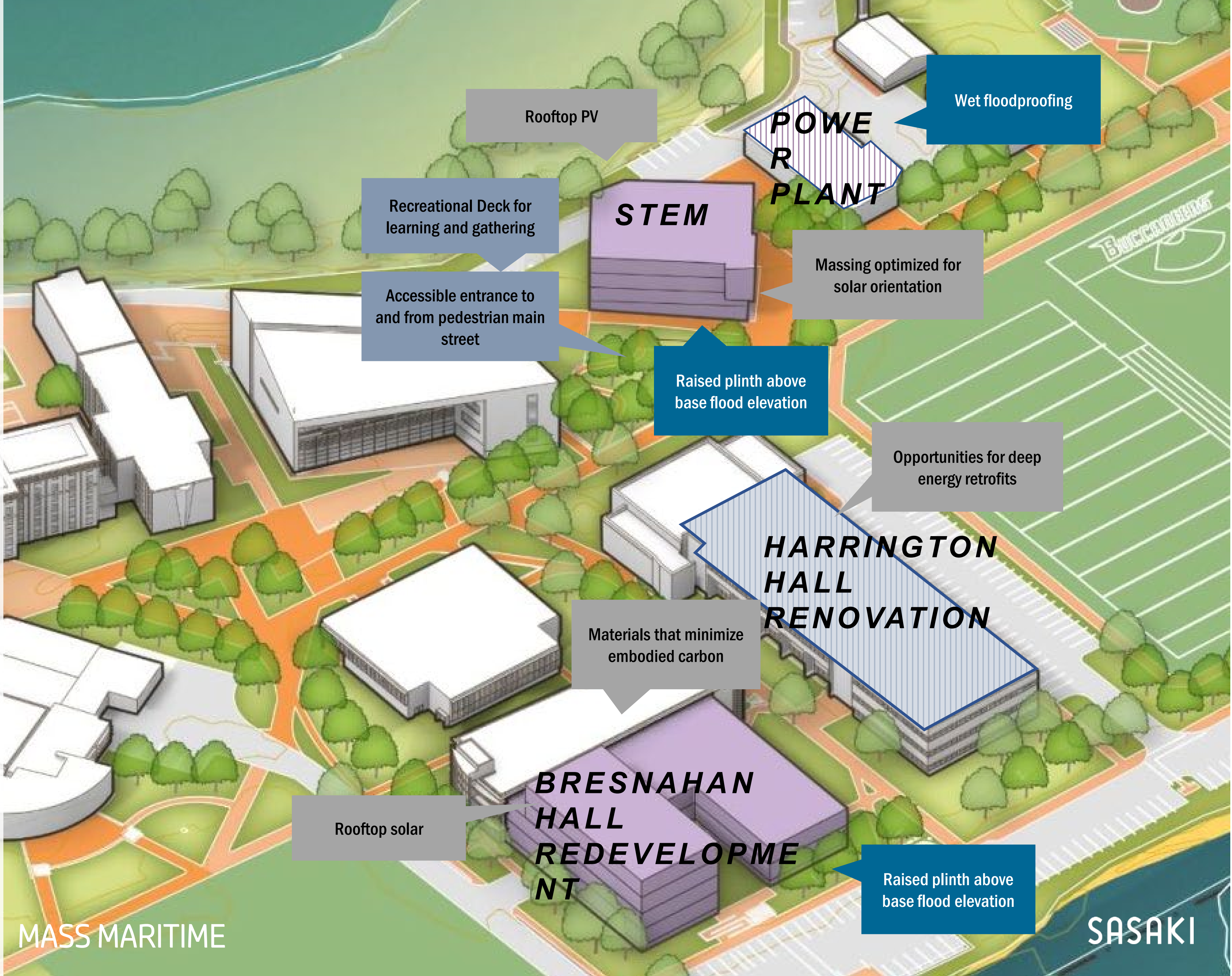
Power plant renovation of 5,055 GSF, reuse for aquaculture lab



ALIGNING GOALS

Capital improvement projects offer opportunities to address programming, resilience, and sustainability goals simultaneously.

Renovation projects are be paired with investments in energy and resilience infrastructure.

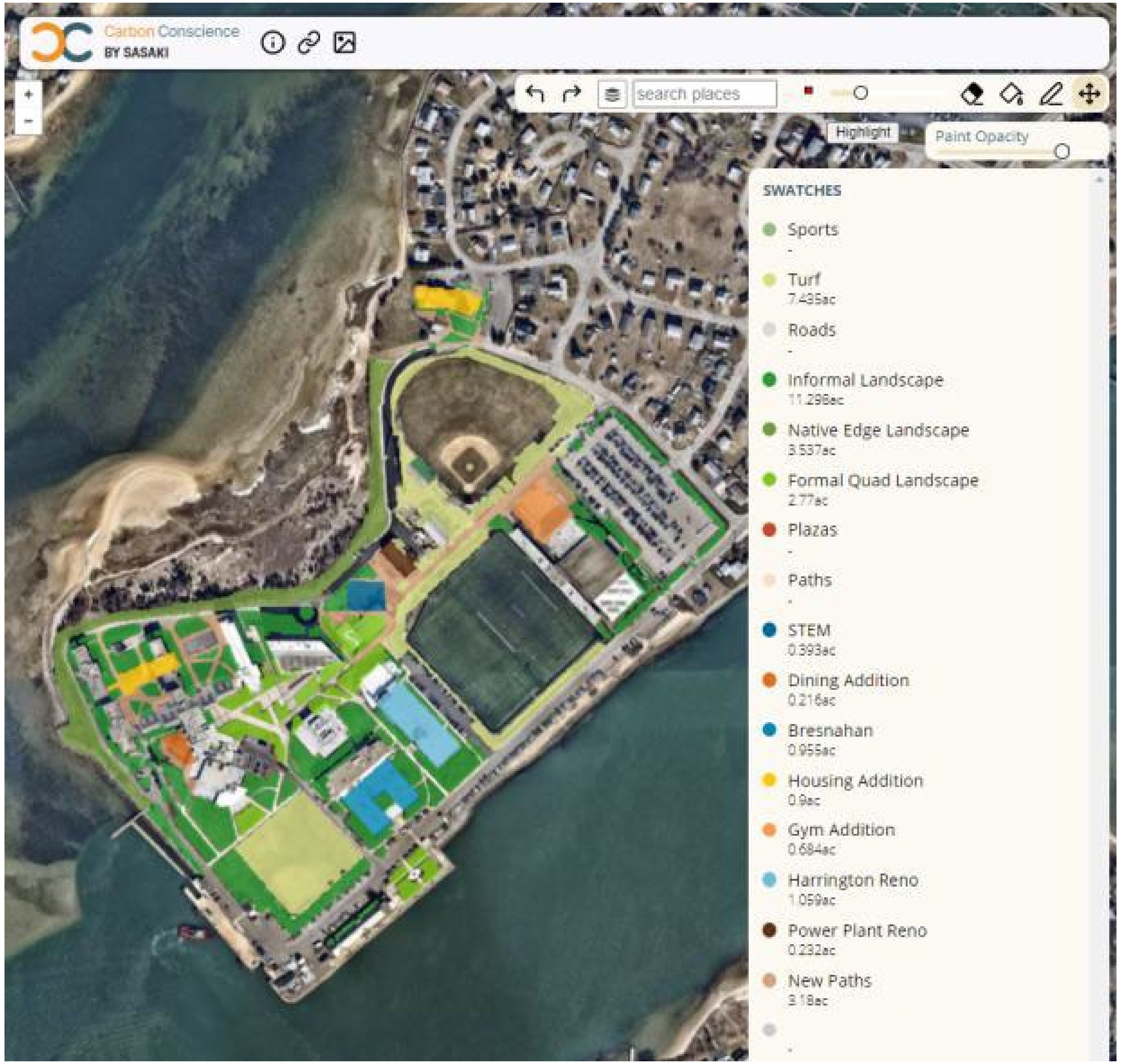


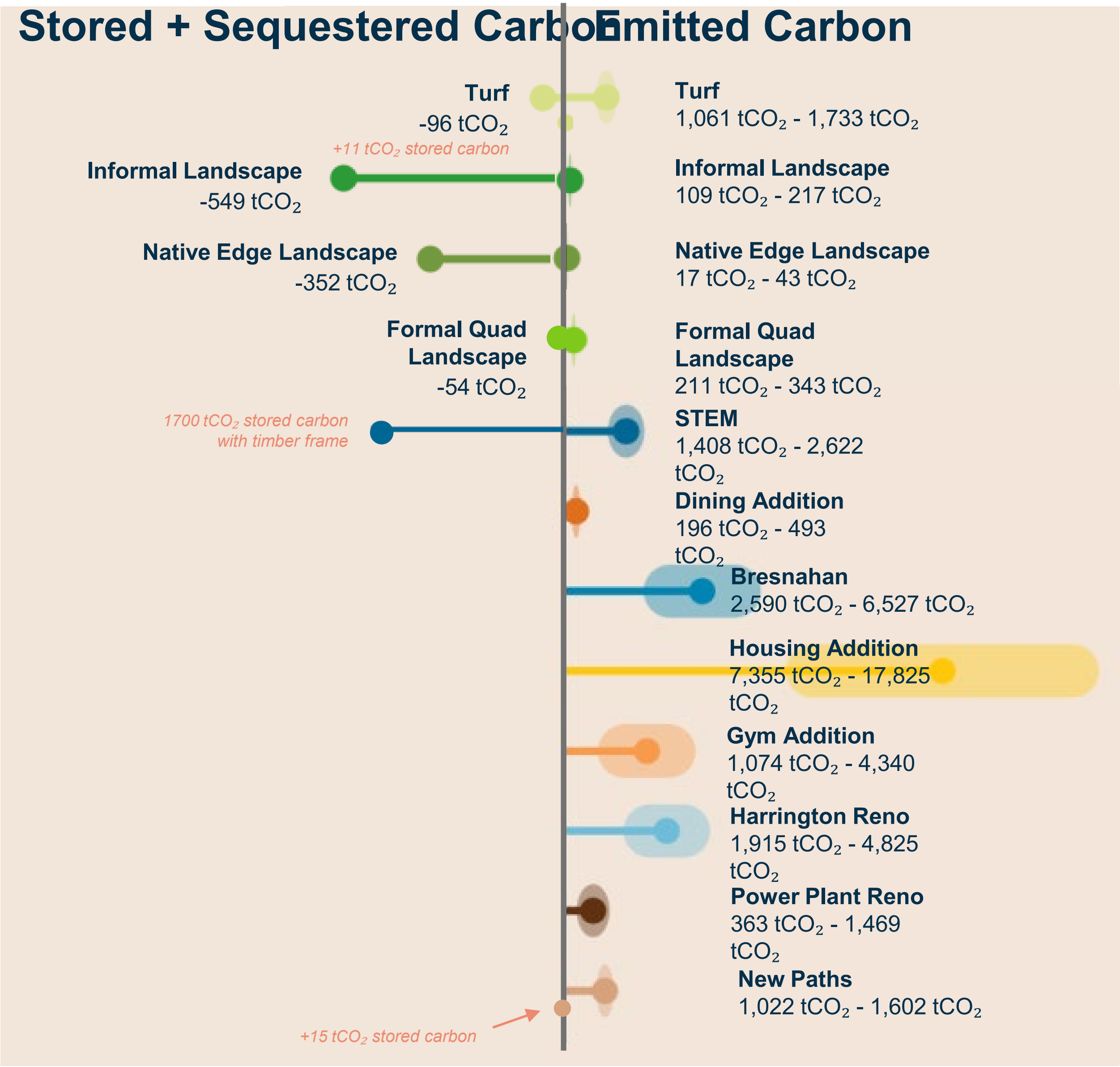
- Programming goal
- Decarbonization goal
- Resilience goal

LANDSCAPE

Learning, eating, and connecting can take place in multiple outdoor spaces along the new pedestrian main street.

SUSTAINABILITY ANALYSIS: EMBODIED CARBON

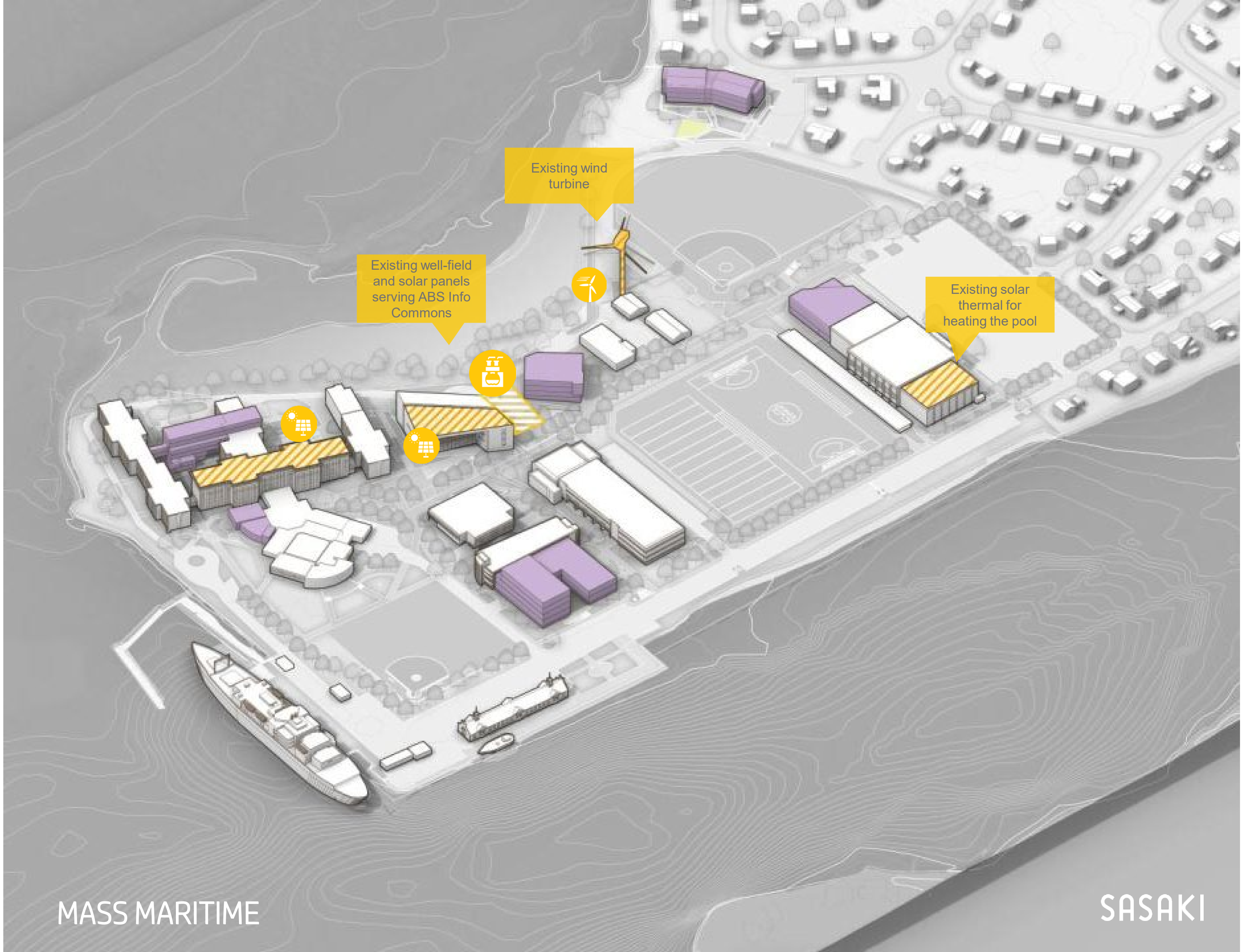




View of proposed STEM building and accessible pathway from pedestrian main street.

ELECTRIFICATION & ENERGY GENERATION

Existing Renewables



Wind turbine

Geothermal Wells

Rooftop PV

Existing geothermal well field

Existing rooftop PV/solar thermal

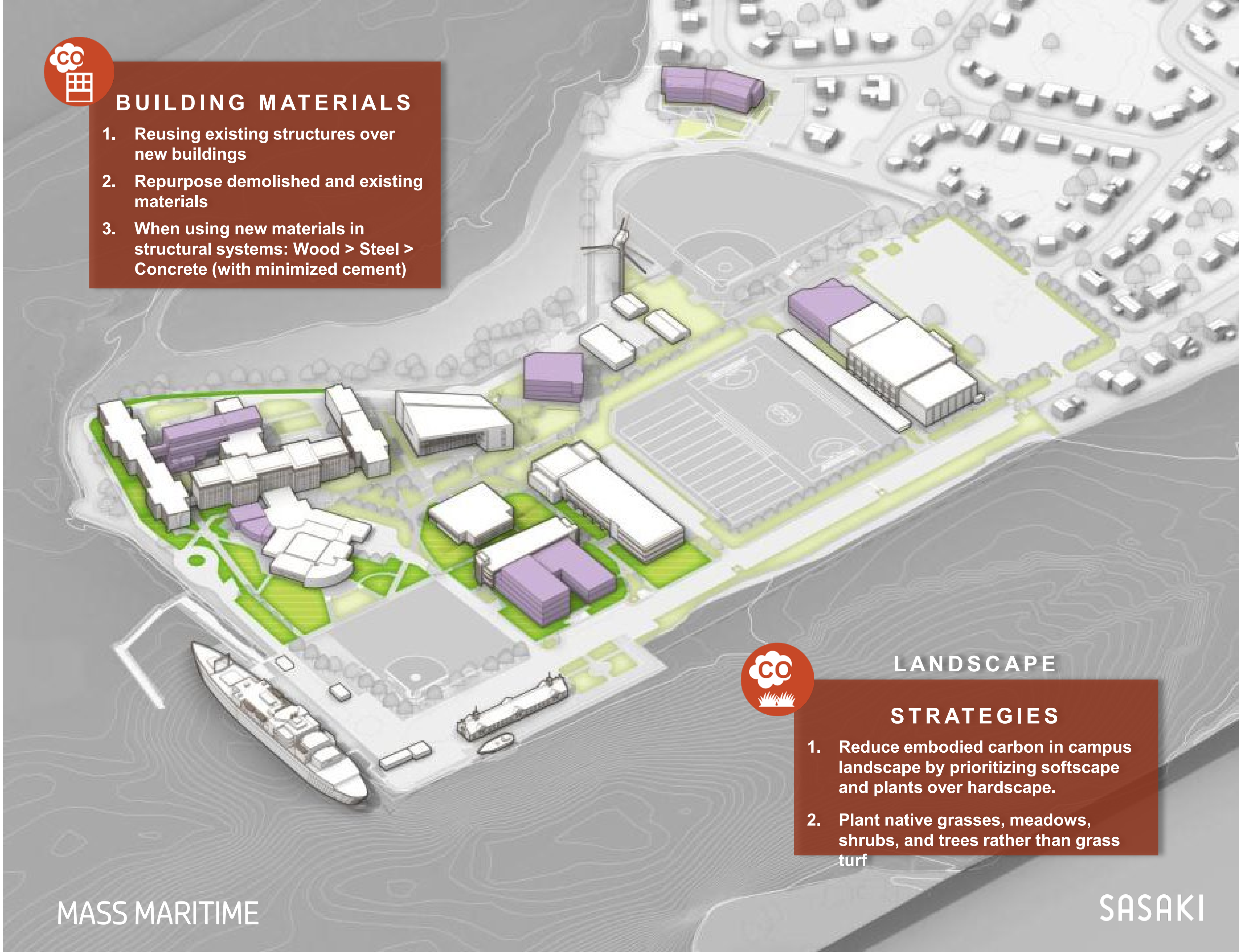
EMBODIED CARBON

GOALS:

20% Reduction for Building Materials

Mass Timber Feasibility for New Construction

Maximize Storage and Sequestration in Landscape Materials



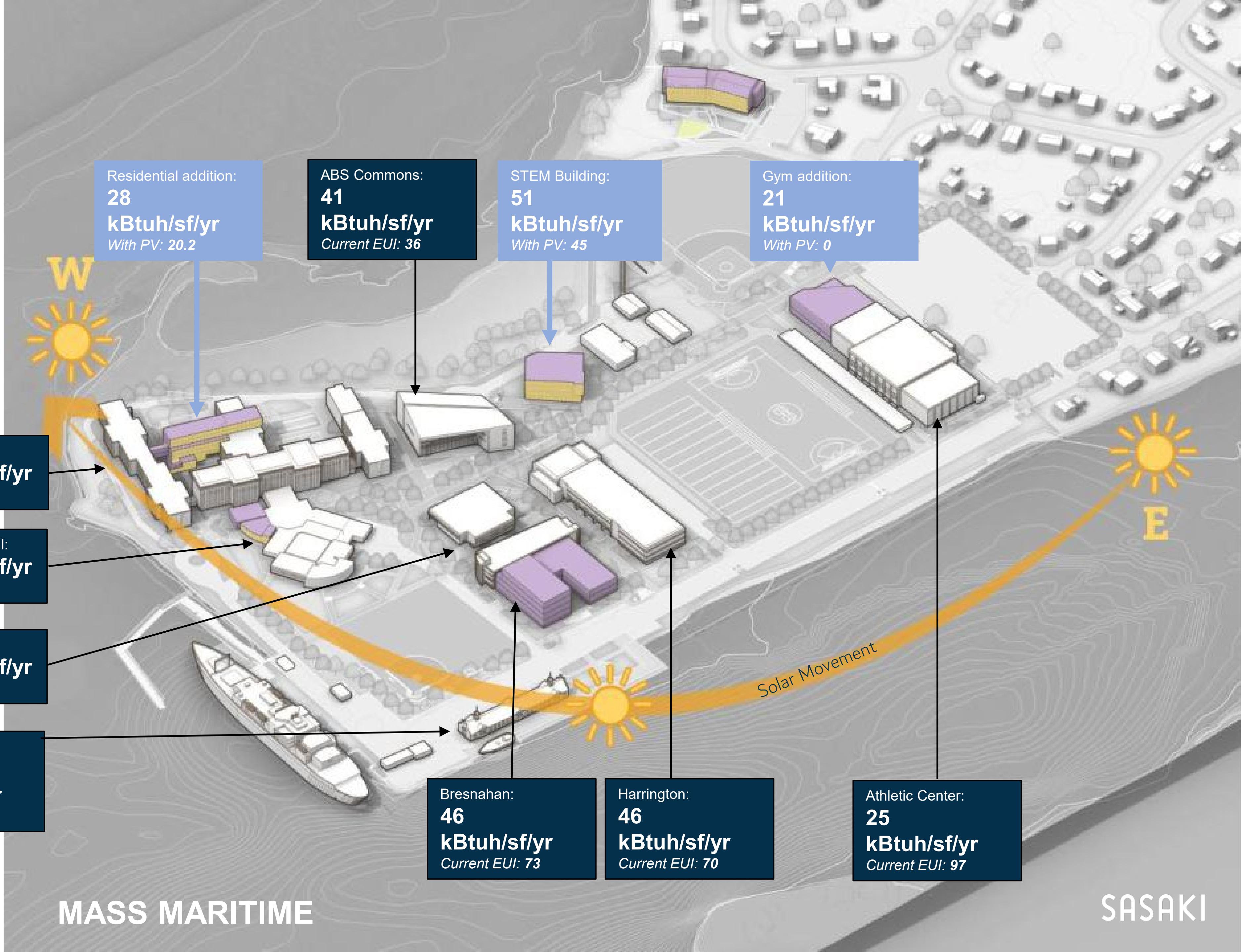
New Native Plantings

EUI (ENERGY USE INTENSITY)

Reduce campus energy use by 50%:

Existing Buildings:
Deep energy retrofits

New buildings:
EUI targets per energy modeling



Existing Building
Proposed Buildings

REDUCE ENERGY LOADS

SUSTAINABILITY GUIDELINES: EXISTING BUILDINGS

Performance Targets

- CBECS 25th percentile

Short-Term Strategies

- Retro-commissioning
- Demand control ventilation (DCV)
- Occupancy and CO2 sensors
- Lighting upgrades and controls
- Energy recovery

Deep Energy Retrofits

- High-efficiency heat pumps
- Hydronic heating and cooling
- Displacement ventilation
- Hight efficiency energy recovery
- Non-condensing cooling/radiant heating
- Natural and mixed-mode ventilation

REDUCE ENERGY LOADS

SUSTAINABILITY GUIDELINES: NEW CONSTRUCTION

Example: New Sciences Building

Performance Targets

- EUI = 45 kBtuh/sf/yr
- Utilize Campus Energy Loop
- All-electric systems

Prescriptive Targets

- Insulation 30% > code
- WWR = 35-40%
- HVAC = Energy Recovery, BMS
- DHW = Heat Pump or Solar Thermal
- Rooftop PV = > 50% of roof area

PROPOSED MICRODISTRICT
ALL ELECTRIC SYSTEMS
CARBON NEUTRAL

New Construction: PV on > 50% of roof area

Existing Buildings: PV incorporated into all renovations

Geothermal Wells

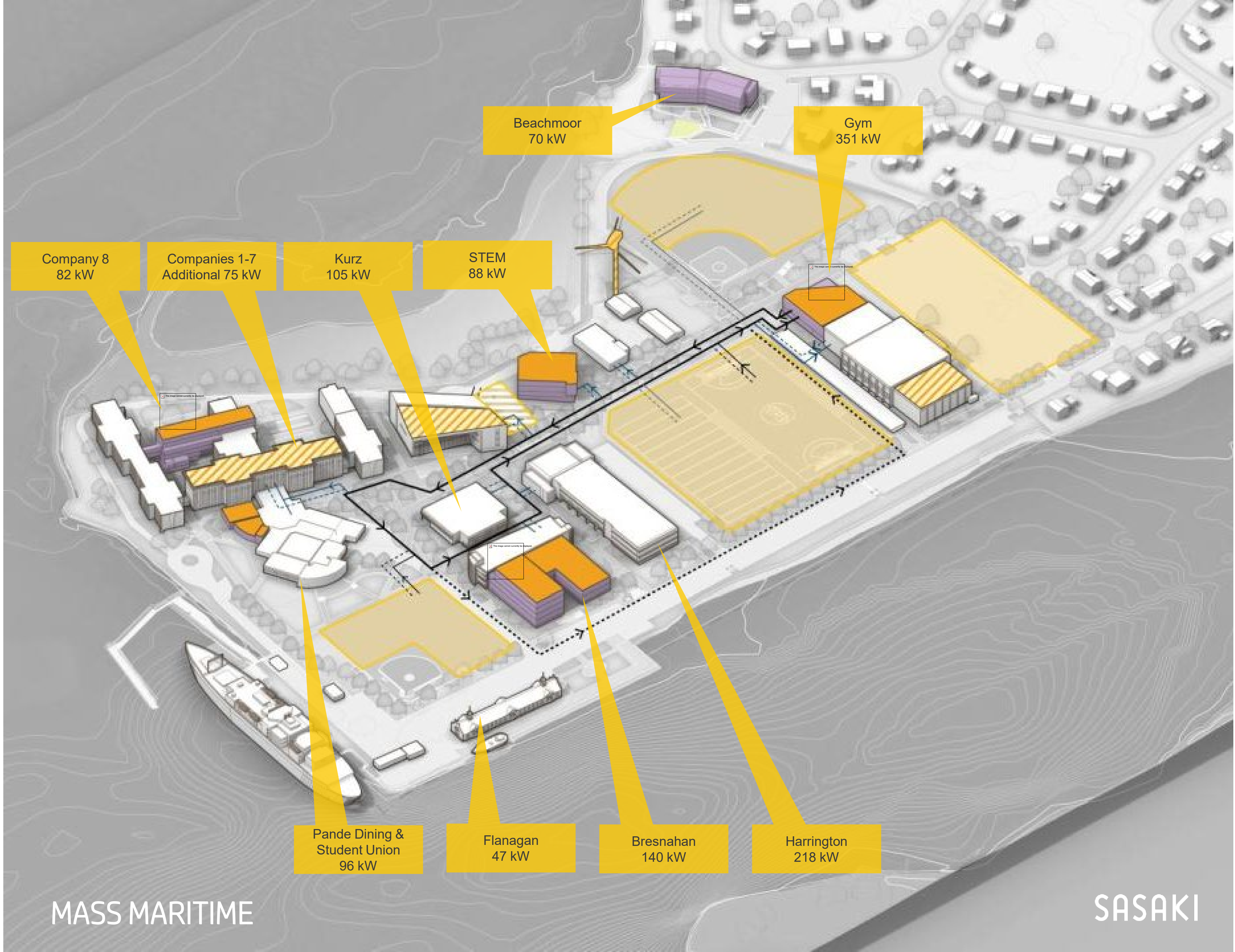
Rooftop PV

Existing geothermal well field

Potential geothermal well field

Existing rooftop PV/solar thermal

Potential rooftop PV

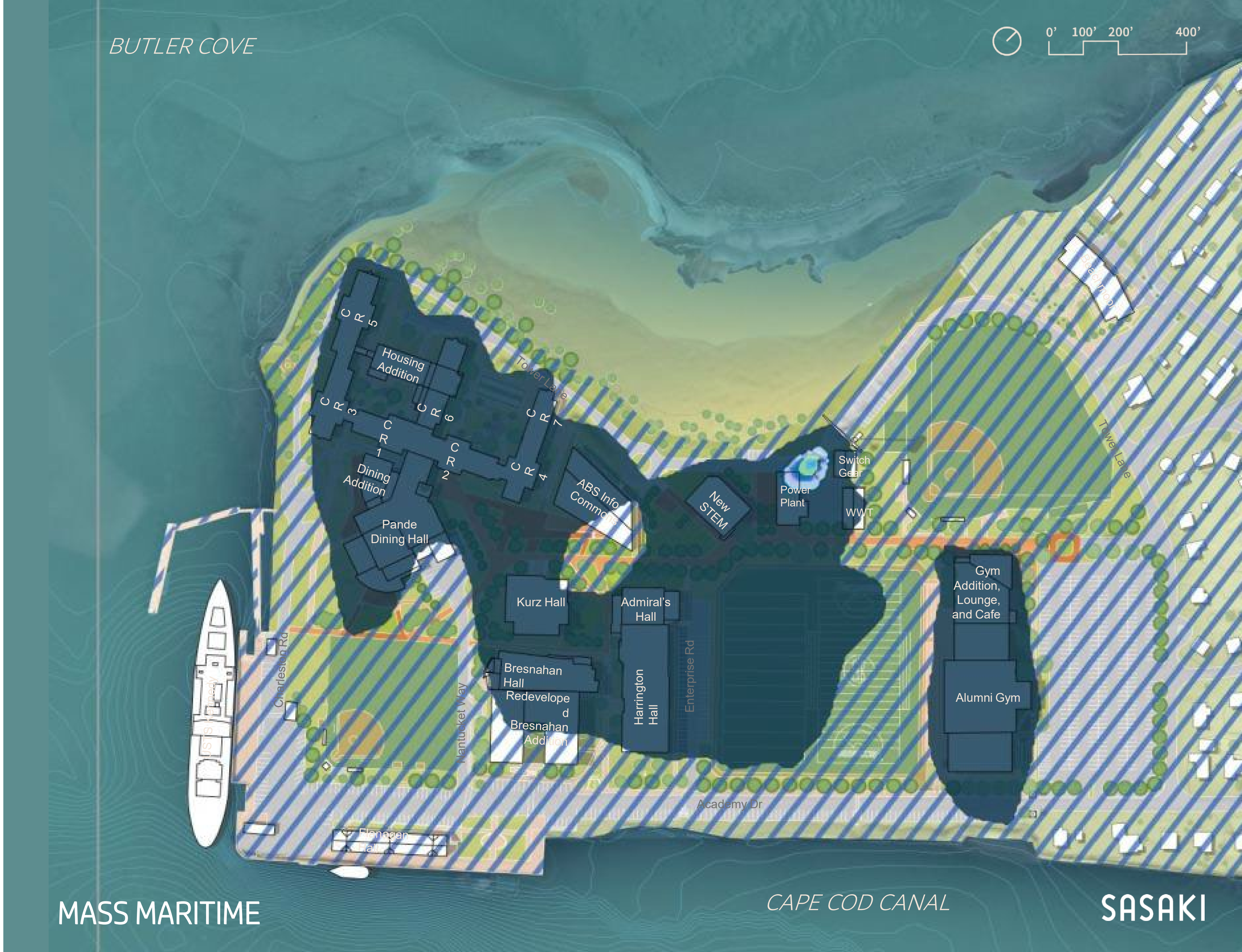


SASAKI

WOODS HOLE GROUP FLOOD ANALYSIS (FOR 2070)

Depth of flooding (above grade) during a 1% storm event

- 0.5 ft
- 1 ft
- 1.5 ft
- 2 ft
- 2.5 ft
- 3 ft
- 3.5 ft
- 4 ft
- 4.5 ft
- 5 ft
- 10 ft
- > 10 ft

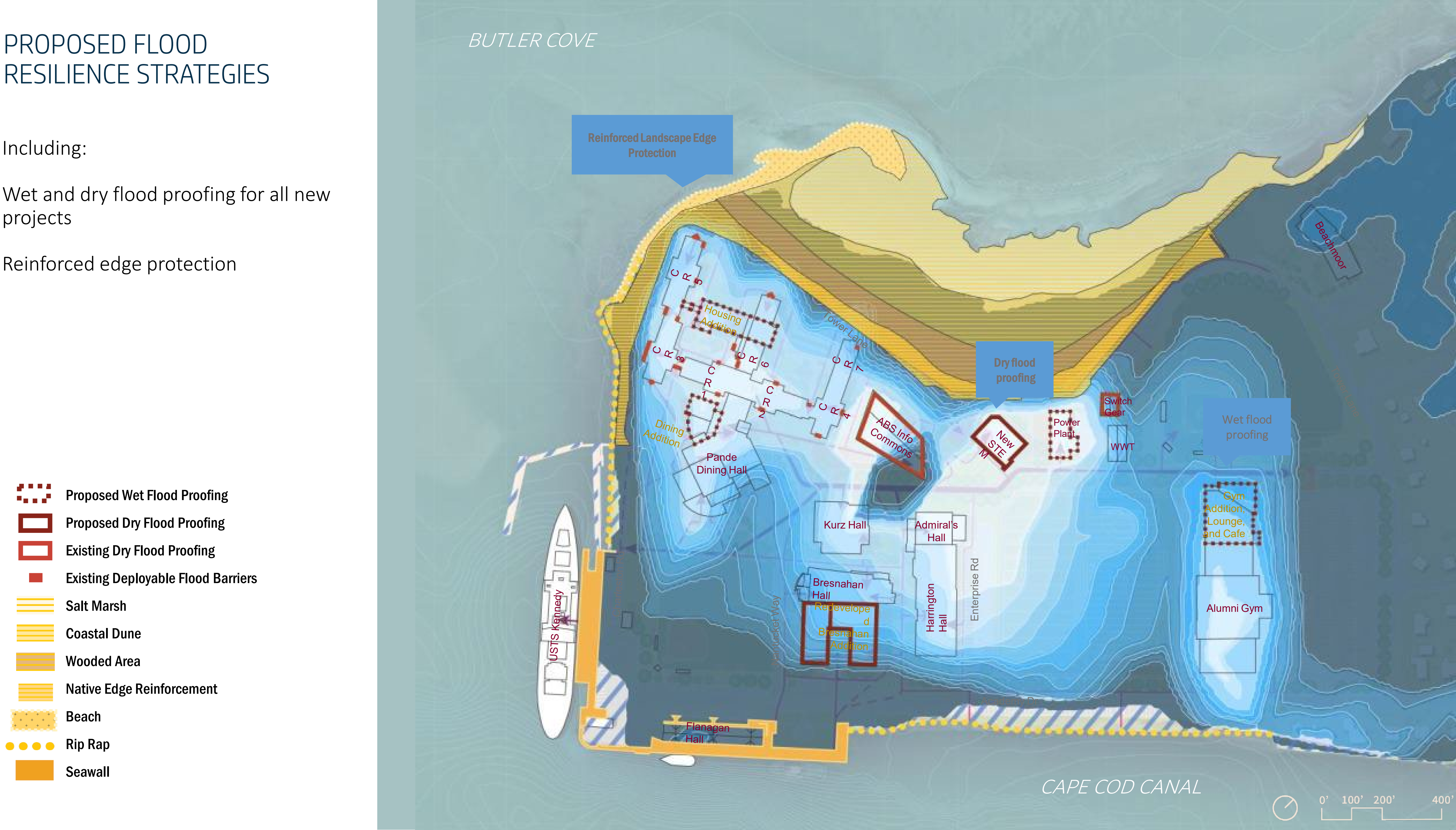


PROPOSED FLOOD RESILIENCE STRATEGIES

Including:

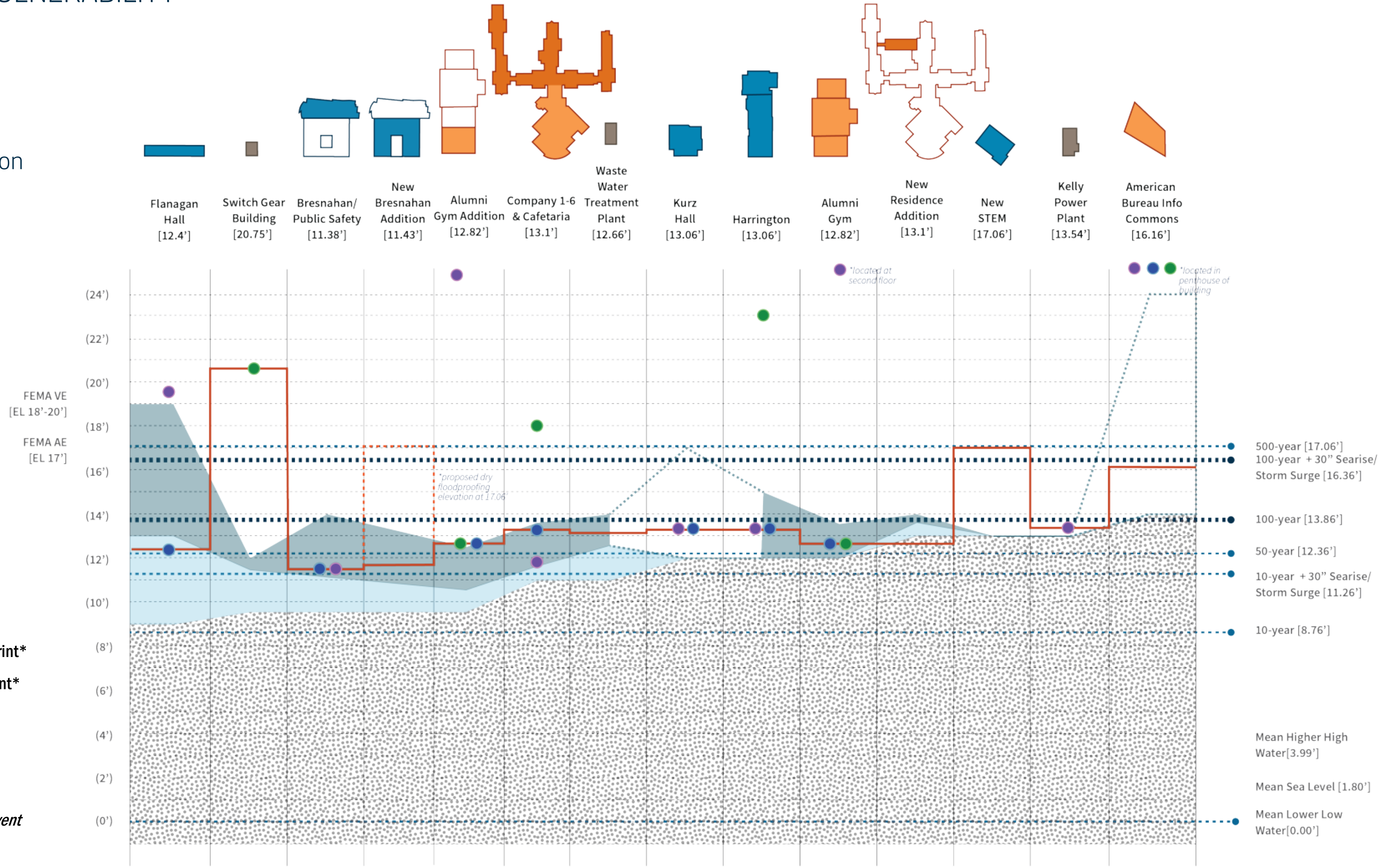
Wet and dry flood proofing for all new projects

Reinforced edge protection



BUILDING SYSTEMS VULNERABILITY

Identifying equipment location relative to flood modeling



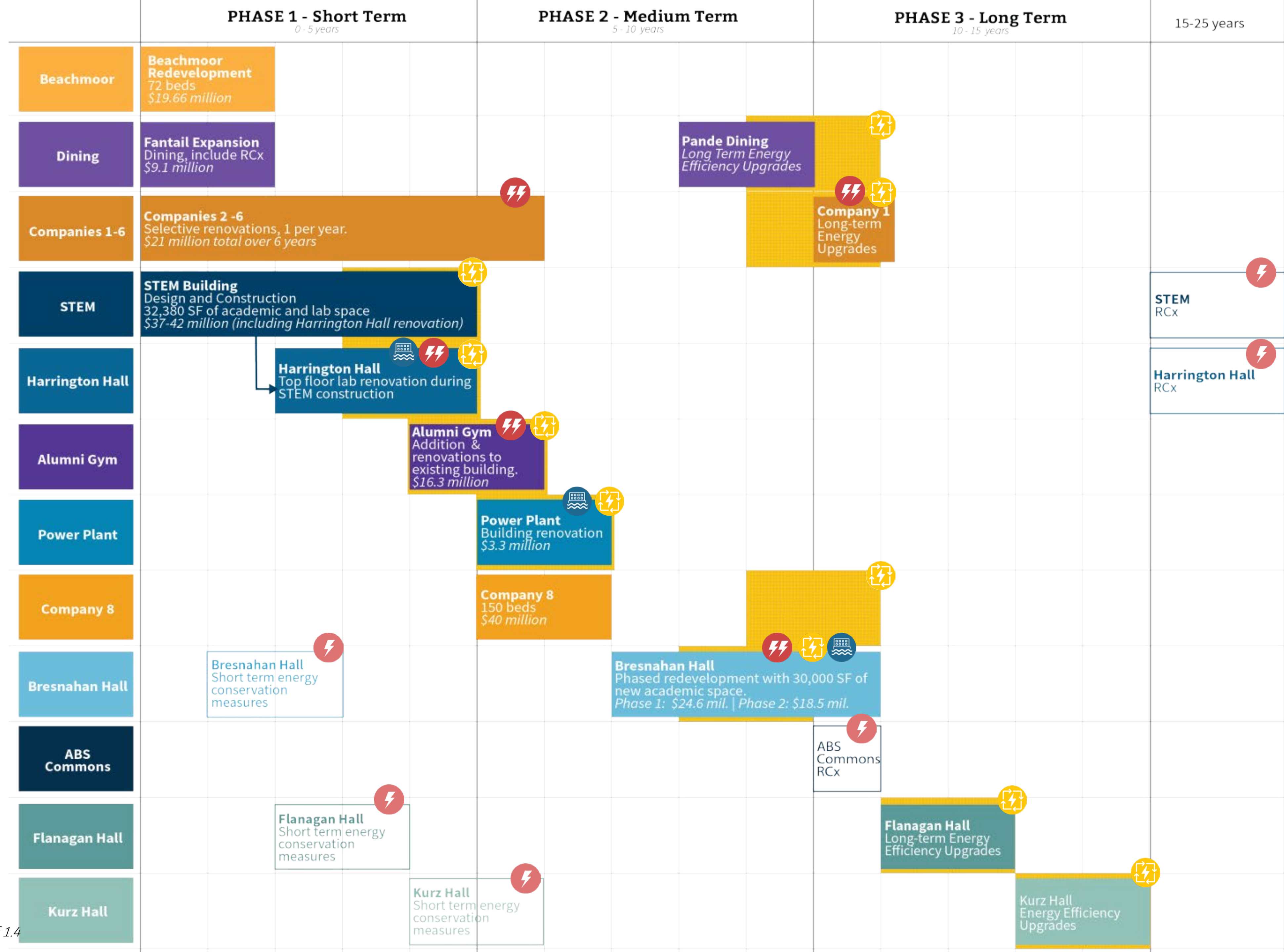
- Academic
- Residential
- Student Life
- Facilities
- First floor level
- Boiler Plant Location
- Switchgear Location
- Generator Location
- Max. flood depth below bldg. footprint*
- Min. flood depth below bldg footprint*
- Grade below building footprint

**Estimated flood depths based on Woods Hole Group modeling for 1% storm event*

PHASING

Decarbonization and resilience strategies will be incorporated into all renovations and new construction projects.

Projects connect to the campus energy loop following energy upgrades.



Floodproofing during renovation

Short term energy upgrade during renovation

Long term energy upgrade during renovation

Connection to energy loop

Project costs are high level estimates from Sasaki. TPC assumption of 1.4

LESSONS LEARNED

CARBON NEUTRALITY BY 2035

CAMPUS GROWTH WHILE ELIMINATING GHGS

MASS MARITIME

SASAKI

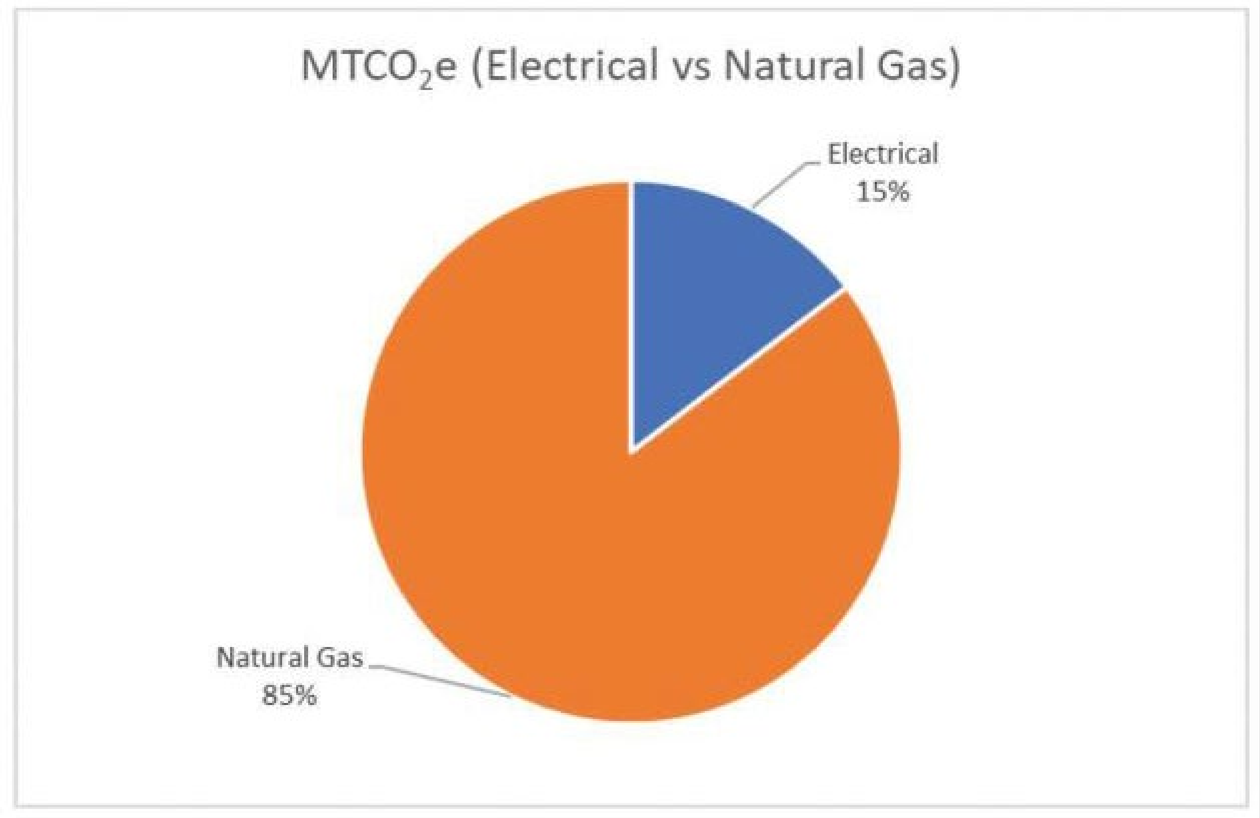
Existing Campus Energy Systems

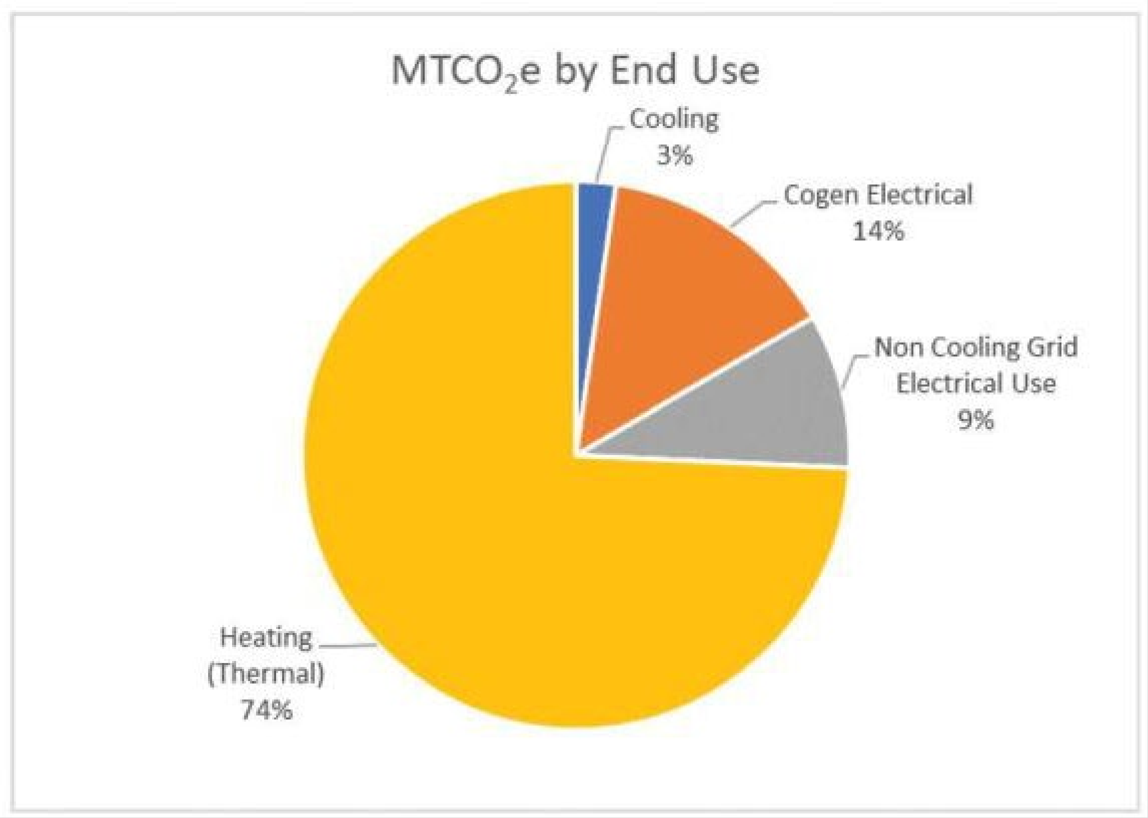
- Electrical Systems
  - Campus served from a Single Underground Feeder at 25kv from Eversource
  - 2,500KVA Service Transformer steps down to 4160V
  - New Campus 4160V Switchgear in Elevated Building
  - 5 Radial 4160 Feeders Distribute across the Campus
  - Mostly Indoor Unit Substations for Individual Building Services
  - Wind Turbine Interconnection
  - 3 Microturbines & PV Generation
- Electrical Generation Systems
  - 660 kW Wind Turbine
  - Solar PV
    - 81 kW on First/Second Company
    - 103 on ABS Commons
  - Cogeneration
    - 3-65 kW Capstone Microturbines serving dorms

Existing Campus Energy Systems

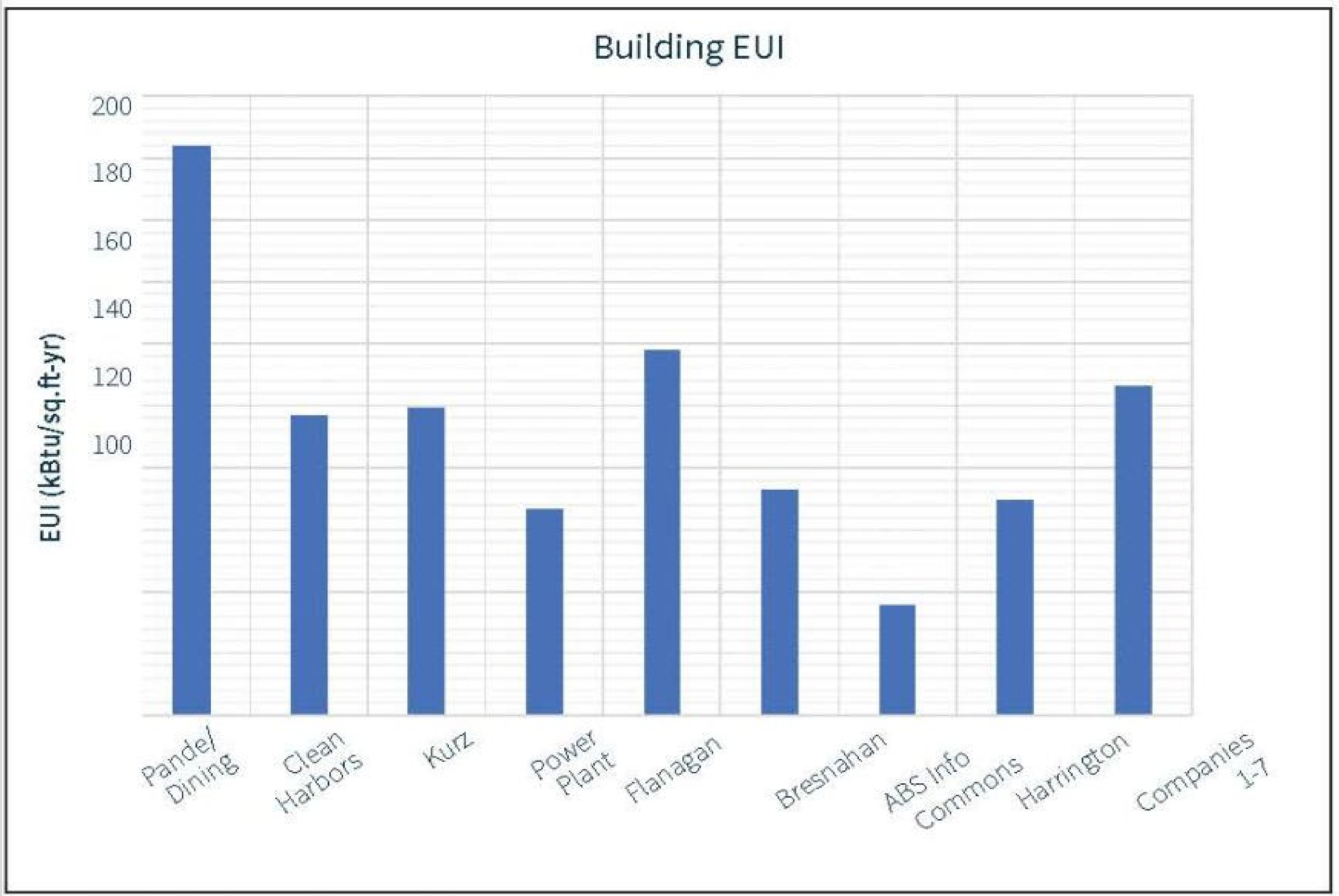
- Heating Systems
  - Original Campus Steam Heating System Removed / Abandoned
  - Individual Hot Water Plants Installed in Various Buildings – Gas Fired
- Cooling Systems
  - Most Campus Buildings not Fully Air Conditioned at Present
  - All Campus Cooling – Direct Expansion
  - No Campus Chilled Water Systems
  - All Existing Cooling Electrically Generated

Existing Campus Energy Use / Carbon Emissions

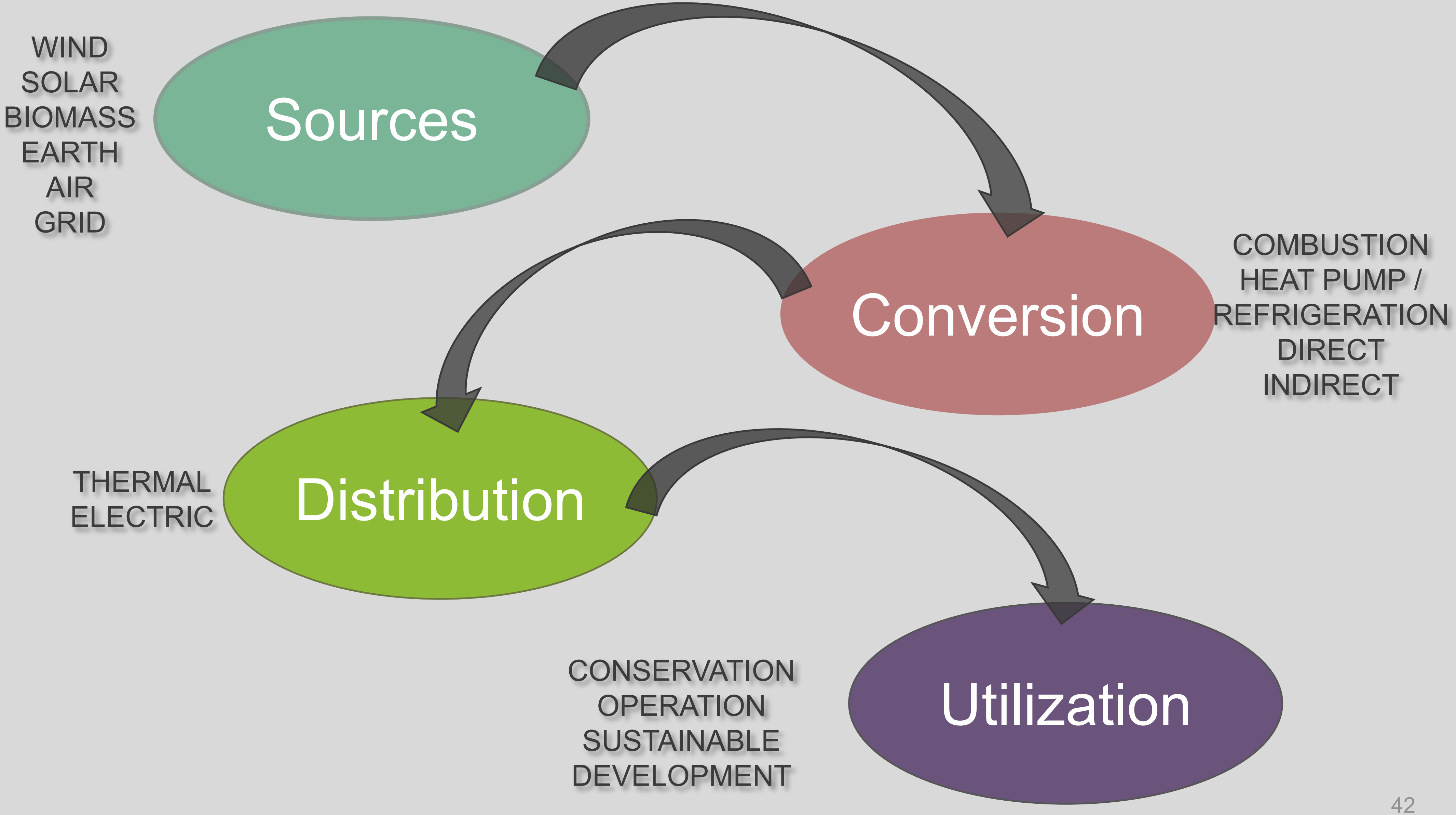




Building Energy Use / EUI



Energy Transformation Elements

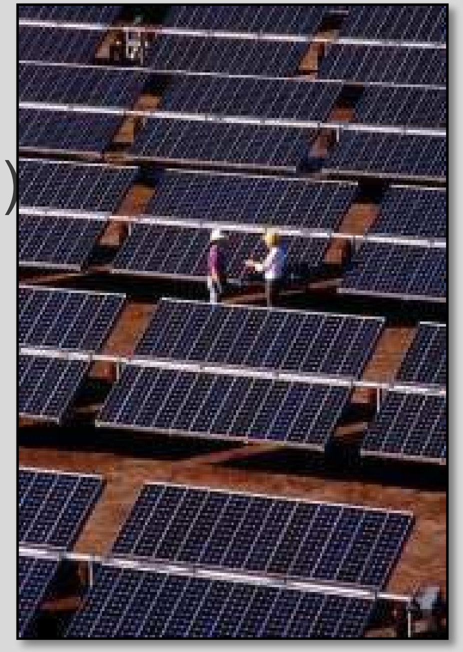


Renewable Energy Options

- Solar
  - Solar Thermal
  - Solar Electric (Photovoltaic)
- Wind
- Hydro
- Biomass
  - Wood Chips / Pellets
  - Liquid Biofuels (Biodiesel, RFO, Ethanol)
  - Biogas (landfill, agricultural)
  - Hydrogen
- Conservation (Negawatts)

Wind

Biomass



Photovoltaics

Ocean/Tidal Energy

Heating / Cooling Technologies for Carbon Neutrality

- Electrical
  - Air Source Heat Pumps
  - Ground Source Heat Pumps
  - Seawater Source Heat Pumps
  - VRF or Hydronic

- Biomass
  - Wood Chip or Wood Pellet
  - Biodiesel, Yellow Grease or RFO
  - Bio-Gas
  - Bio-fueled Cogeneration

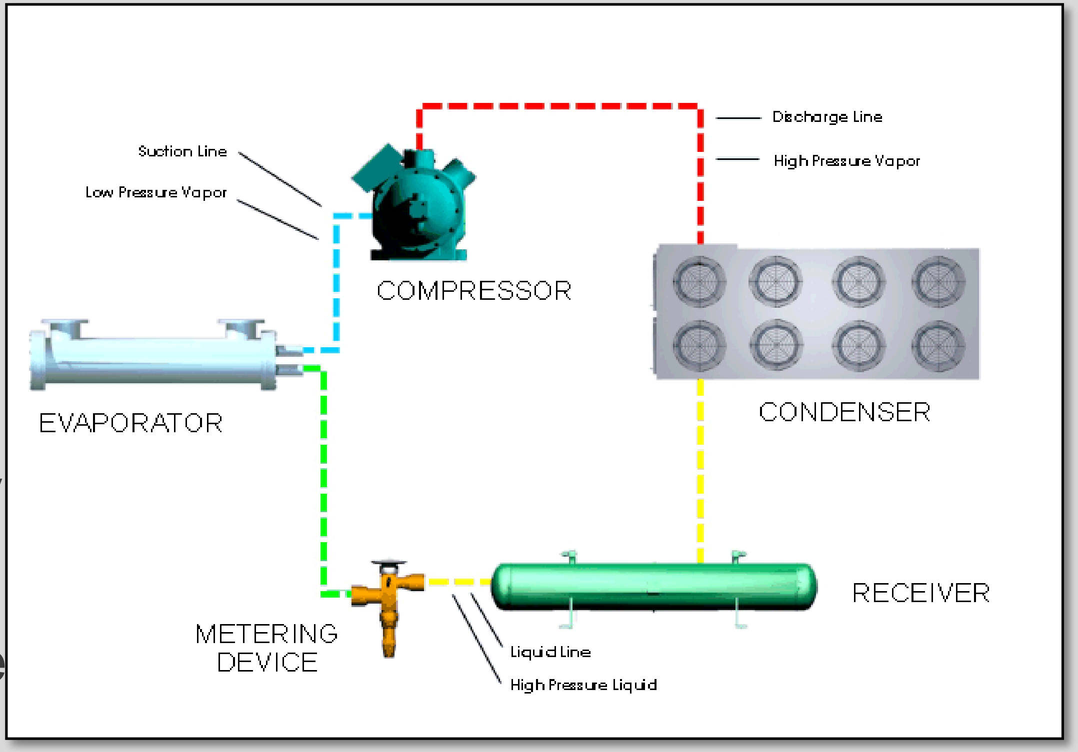
- Solar Thermal
  - Solar Thermal Heating/DHW
  - Solar Driven Absorption Cooling
  - Solar/Heat Pump Hybrid

- Hydrogen
  - Boilers
  - Cogeneration

- Deep well thermal

Technology / Fuel Source	Further Consideratio n	Comments
Ground Source Heat Pumps	Yes	Highest Efficiency, but High Cost, Site Disruption
Air Source Heat Pumps	Yes	Ongoing Advances in Technology/Efficiency
Wastewater Source Heat Pumps	Possible	Has Potential, but Application Challenges, Need More Information
Seawater Source Heat Pumps	Possible	Water Temp may be too cold in Winter, Application Challenges
Solar PV	Yes	Consider On & Off Campus Deployment, Power Purchase
Solar Thermal – DHW/Pool Heating	Yes	Consider for Facilities with Significant DHW Loads or Pool Heating
Solar Thermal – Space Heating/Cooling	No	Energy Storage Requirements, Complexity, Poor Economics
Wind Energy	Yes	Consider on & Off Campus Deployment, Power Purchase
Biomass – Wood Chips/Pellets	No	Material Handling, Space Requirements, Resiliency Issues
Biomass – Liquid BioFuels	No	Equipment Compatibility, Availability, Cost
Biomass – Gaseous BioFuels	Possible	May Investigate Remote Gas Purchase, but High Cost at present
Hydropower - Remote	Yes	Potential Remote Source of Green Power
Hydropower - Tidal	Possible	Investigate Potential for Future Local Development
Hydrogen	No	High Cost, Limited Availability
Fuel Cell Based Cogeneration	No	High Equipment Cost, Limited and Costly Renewable Fuels
Microturbine Based Cogeneration	Possible	Retain/Replace existing, evaluate Bio-gas Availability

Air Source Heat Pumps



- Pros
  - Lower Cost than GSHP Systems
  - All Electric – No Fossil Fuel Required
  - Recent Improvements in Efficiency
  - Low Ambient Temperature Operation Availability
  - Simpler Installation, No Site Disruption
  - No Issues with Heating/Cooling Load Imbalance
- Cons
  - Lower Efficiency than GSHP Systems, Particularly in Colder Climates
  - Requires Outdoor Heat Rejection Equipment, Issues of Space, Weight, Noise, Aesthetics
  - Higher Peak Electrical Loads than GSHP Systems
  - Heating/Cooling Electronically Dependent – Resiliency Issues
  - Limited Availability of Air to Water Heat Pumps

Ground Source Heat Pumps

- Pros
  - Highest Operating Efficiency, Lowest Operating Cost
  - All Electric – No Fossil Fuel Required (assuming green power utilized)
  - Peak Electrical Loads and Source Capacity Minimized
  - No Issues with Operating at Low Ambient Temperatures
  - External Heat Rejection Device may not be Required
  - Perceived as very “Green”
- Cons
  - First Cost is High – Well Fields Expensive
  - Underground Piping & Wells – Significant Site Disruption, Space Required
  - Heating / Cooling Electrically Dependent – Resiliency Concerns
  - Heating / Cooling Imbalance may Require Larger Well Field or Supplementary Equipment
  - Heating Dominated Applications may Require Glycol fill

Considerations for Campus Heating/Cooling Systems

- Energy Efficiency
  - Use minimum of fuel resource to address heating/cooling load
- Carbon Neutrality
  - Ability to use renewable/carbon neutral fuel sources
- Flexibility
  - Ability to utilize new technologies and equipment when available
- Phased Implementation
  - Can be implemented in a phased manner as buildings are constructed or renovated
- Resiliency
- Minimum Aesthetic or Acoustical Impacts to Campus
- Minimum Physical Space Requirements in Buildings or on Campus
- Low Initial and Total Developed Cost

Campus Energy Systems

Concept Approaches & Technologies
Central vs. Distributed

Fully Centralized

- Low Temperature Hot Water and Chilled Water Distribution
- Central Chillers / Heat Pumps
- Central GSHP Well Field(s) / ASHP's
- Supplementary Heating/Cooling as required

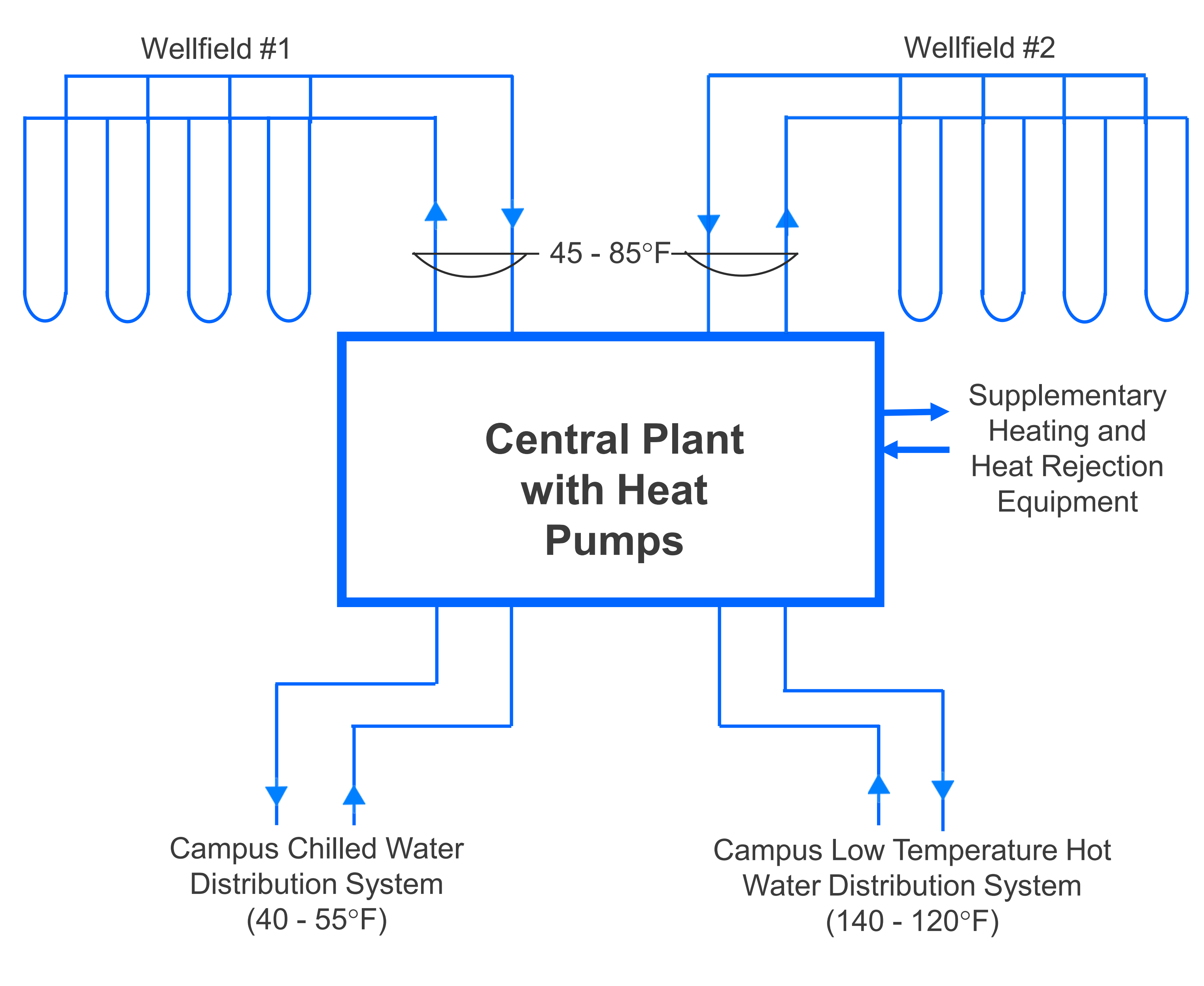
Fully Distributed

- No Central Thermal Distribution
- Air and/or Ground Source Heat Pumps and Well Fields for Each Building
- No Ability to Share Loads between Buildings

Semi-Distributed

- No Central Plant/Heating/Cooling Equipment
- Distributed Well Fields connected by a "neutral temperature loop"
- Local Heat Pumps in each Building or Group of Buildings
- Energy can be shared/transferred among Buildings

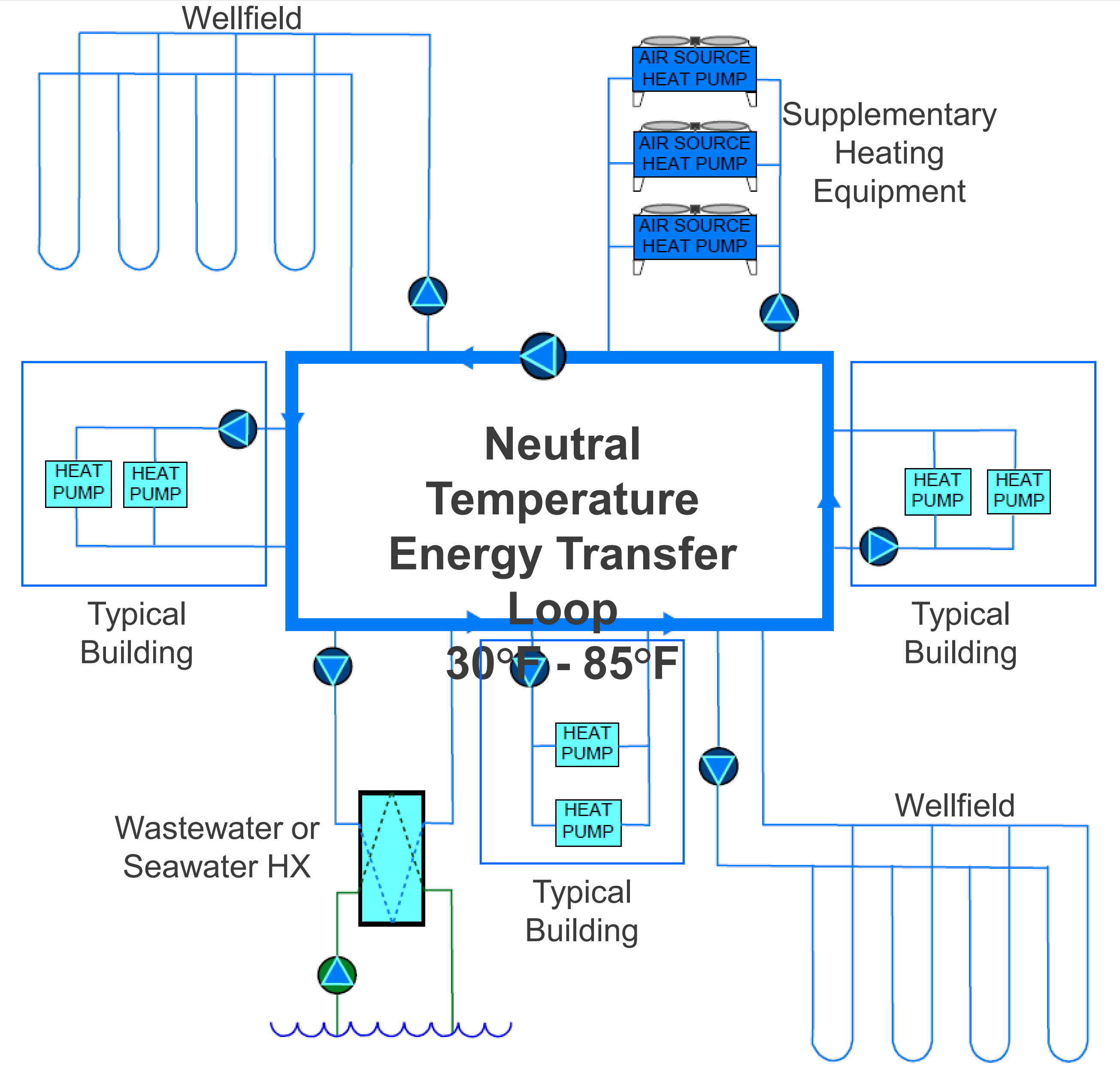
Campus Energy Systems



Central Energy System Disadvantages

- Central Plant Development can be Capital Intensive in Early Stages of Campus Development
- A Central Plant Facility with Issues of Aesthetics, Acoustics, Service, and Environmental Discharge Required on Campus
- Buried Distribution System Required – Site Disruption Issues, High Cost
- Not Conducive to Remote of Distributed Borefields

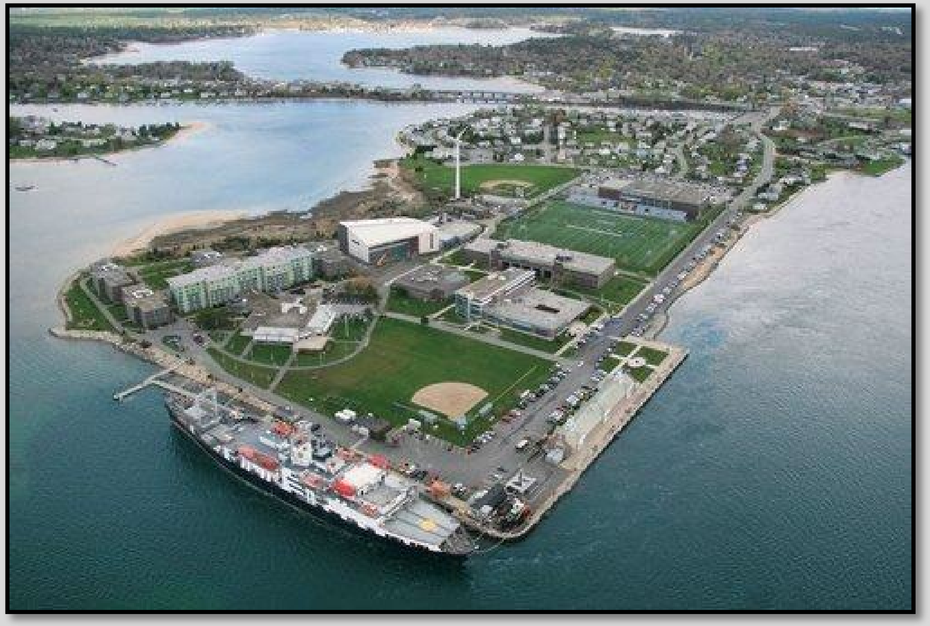
Semi-Distributed – Neutral Temperature Loop



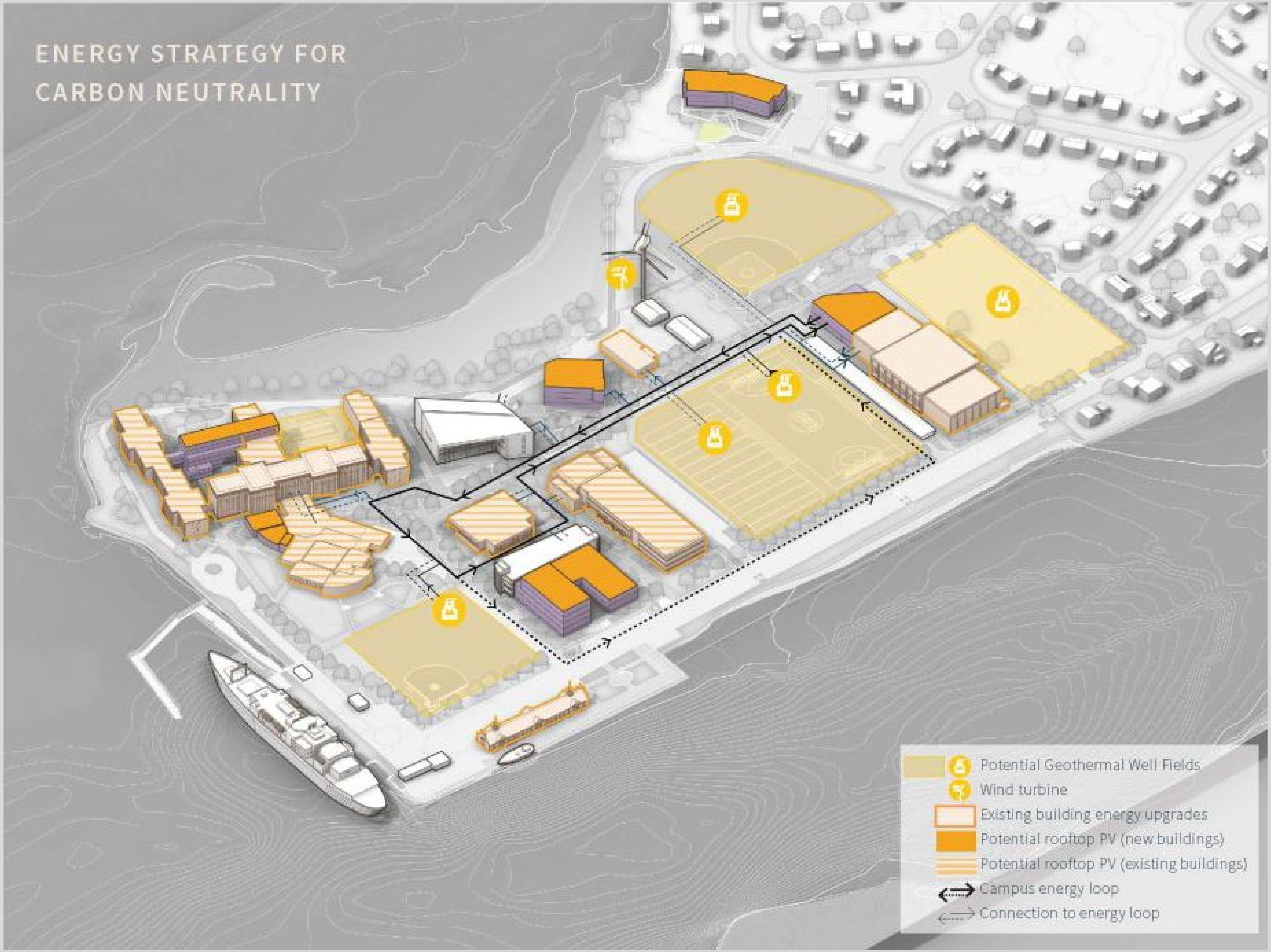
WSHP / Energy Transfer Loop Benefits

- High Energy Efficiency
  - Energy Transfer between Buildings
  - Heat Pumps Optimized to respond to Specific Building Loads
- Carbon Neutral
  - All Electric Heating/Cooling System except for Back-up Boilers
- Highly Flexible
  - New Energy Sources can be “Plugged into” Loop at anytime (such as wastewater or seawater heat exchangers)
  - Loop Energy Sources can be located anywhere on Campus
- Easily Phased
  - Can be Implemented on a Building-by-Building Basis with Limited Associated Central Infrastructure
- Resilient
  - Building Plants elevated to address Flooding Concerns
  - Local HW Boilers in the event of Power Outage or Equipment Failure
  - Lower Cost than Central Plant and Distribution System
  - No Additional Campus Space Required
- Low-Cost Distribution System

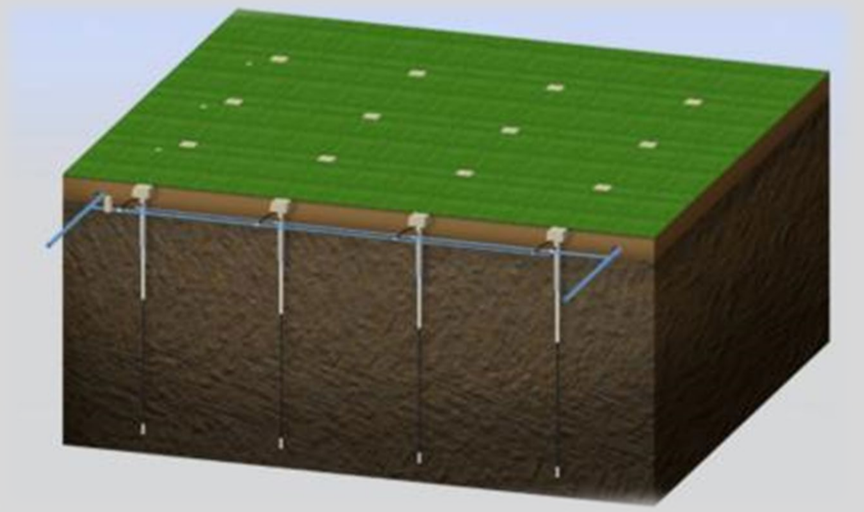
Mass Maritime Recommendations:



- Maximize Building Energy Conservation
- Utilize Existing Electrical Distribution System
- Continue Implementation of Solar and Wind Based Electrical Generation
- Develop all-Electric Campus Heating/Cooling System(s) using Air Source and Ground Source Heat Pump Systems.
- Maintain Existing Boiler Plants for Back-up Purposes.
- Utilize Semi-Distributed Heating/Cooling Approach
- Utilize Off-Campus Renewably Generated Electricity
- Investigate Bio-gas “wheeling” Options (landfill or agricultural) for short term Carbon Emission Reductions


ENERGY STRATEGY FOR
CARBON NEUTRALITY
Potential Geothermal Well Fields
Wind turbine
Existing building energy upgrades
Potential rooftop PV (new buildings)
Potential rooftop PV (existing buildings)
Campus energy loop
Connection to energy loop

Impact of Conservation - Number of Wells Required



Building Name	Number of Wells BAU/Existing	Number of Wells at 25th Percentile
Pande Dining Hall	51	21
Clean Harbors	110	54
Kurz Hall	29	11
Power Plant	4	2
Flanagan Hall	9	4
Bresnahan Building	45	36
Harrington Building	62	36
Company 1 - 6	373	84
Company 7	54	10
New Science Building	40	25
Total	**775**	**283**

Required Borefield Area	310,000

115,000

RENEWABLE ENERGY
PROPOSED GEOTHERMAL

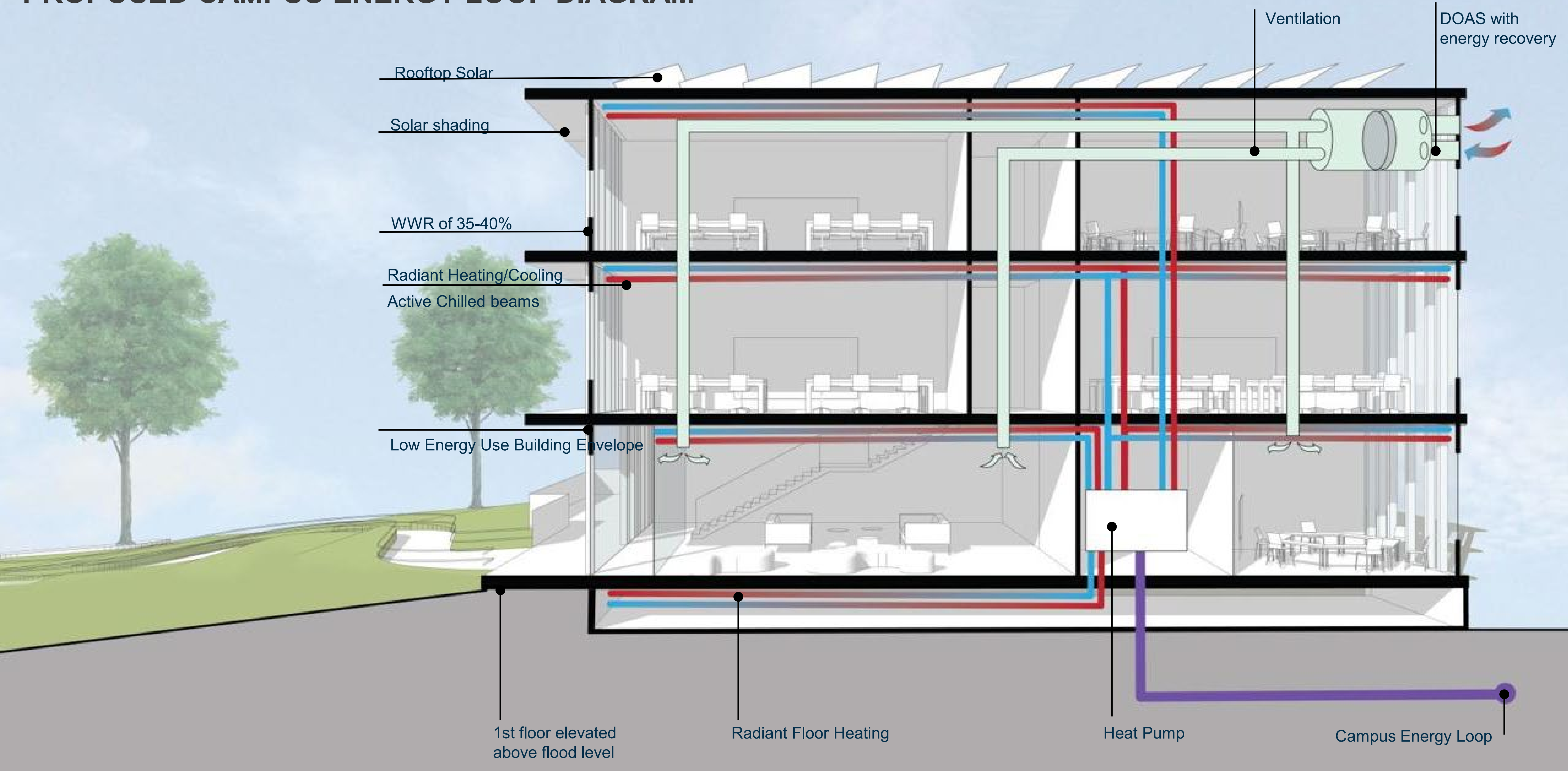
1205 GeoWells x
Area / Well: 400 SF

Total Area: 482,000 SF

- New Development
- Addition
- Renovation
- Existing Building
- Existing Trees
- New Trees
- Main Street
- Outdoor Plazas

MASS MARITIME SASAKI

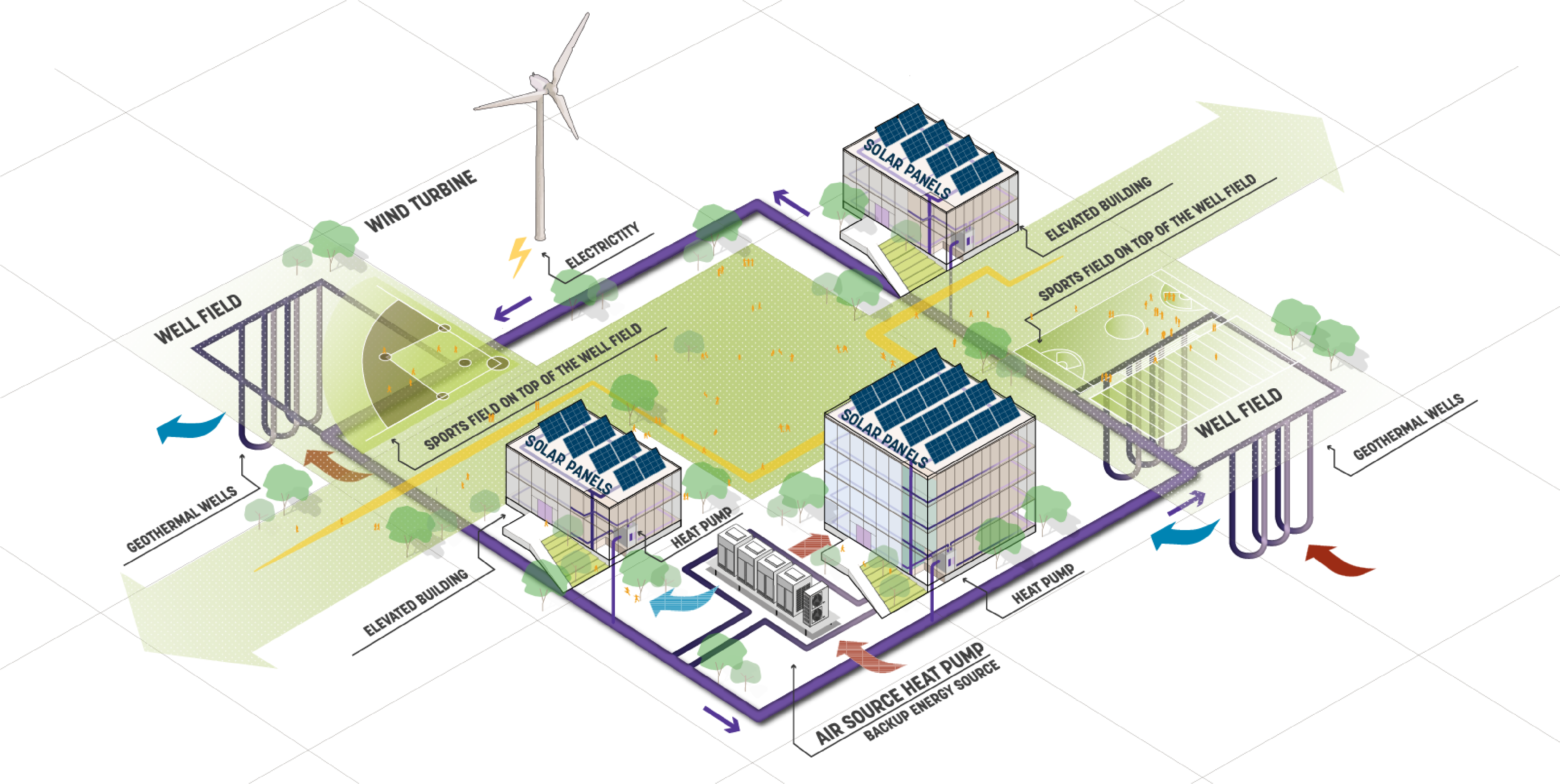
PROPOSED CAMPUS ENERGY LOOP DIAGRAM



MASS MARITIME

SASAKI

CAMPUS ENERGY LOOP

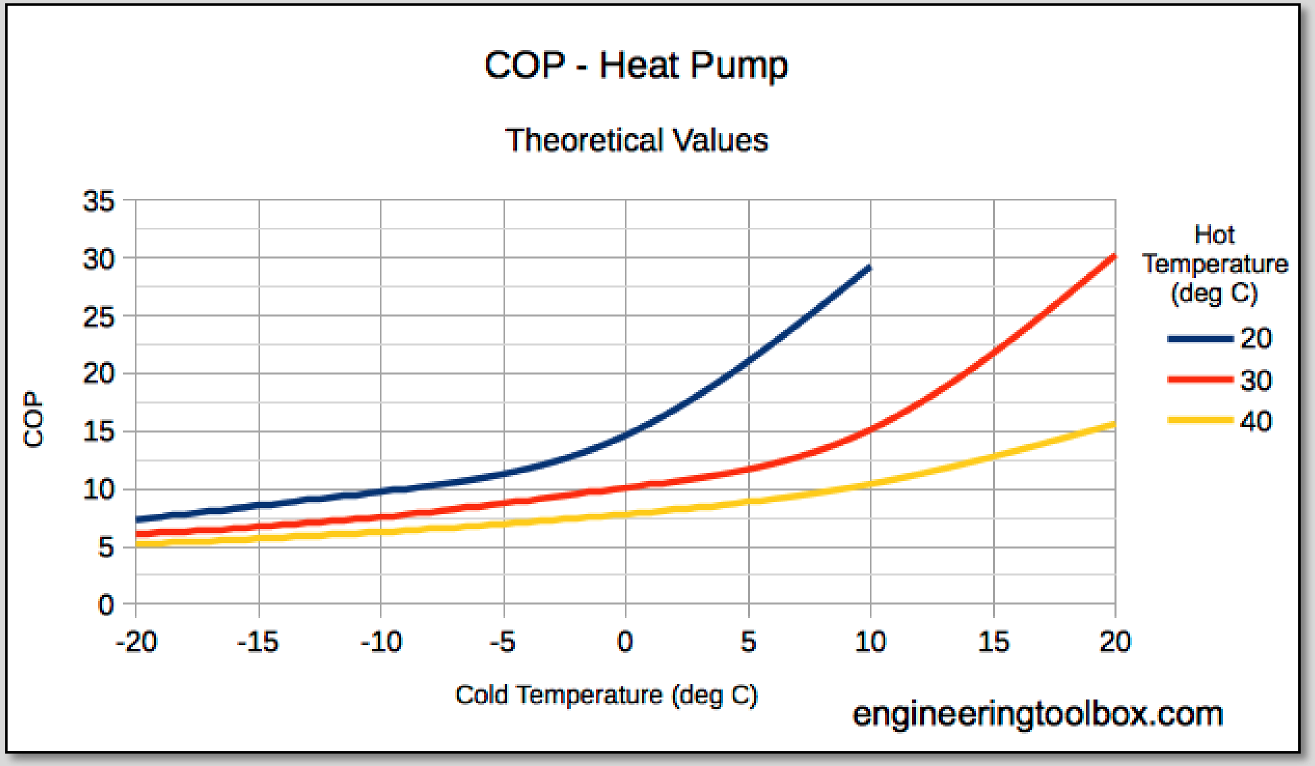


Low Temperature Hot Water & Its Significance

- Commercially available heat pumps will not operate over 150°F supply water temperature
- Large scale, two stage heat pumps can provide higher water temperatures, but efficiency is compromised, availability limited

Low Temperature Hot Water Benefits

- Higher heat pump efficiency
- Lower cost distribution system
- Reduced maintenance costs
- Higher distribution efficiency (reduced losses)
- Safer for maintenance staff
- Reduced plant staffing requirements
- Lower life cycle cost



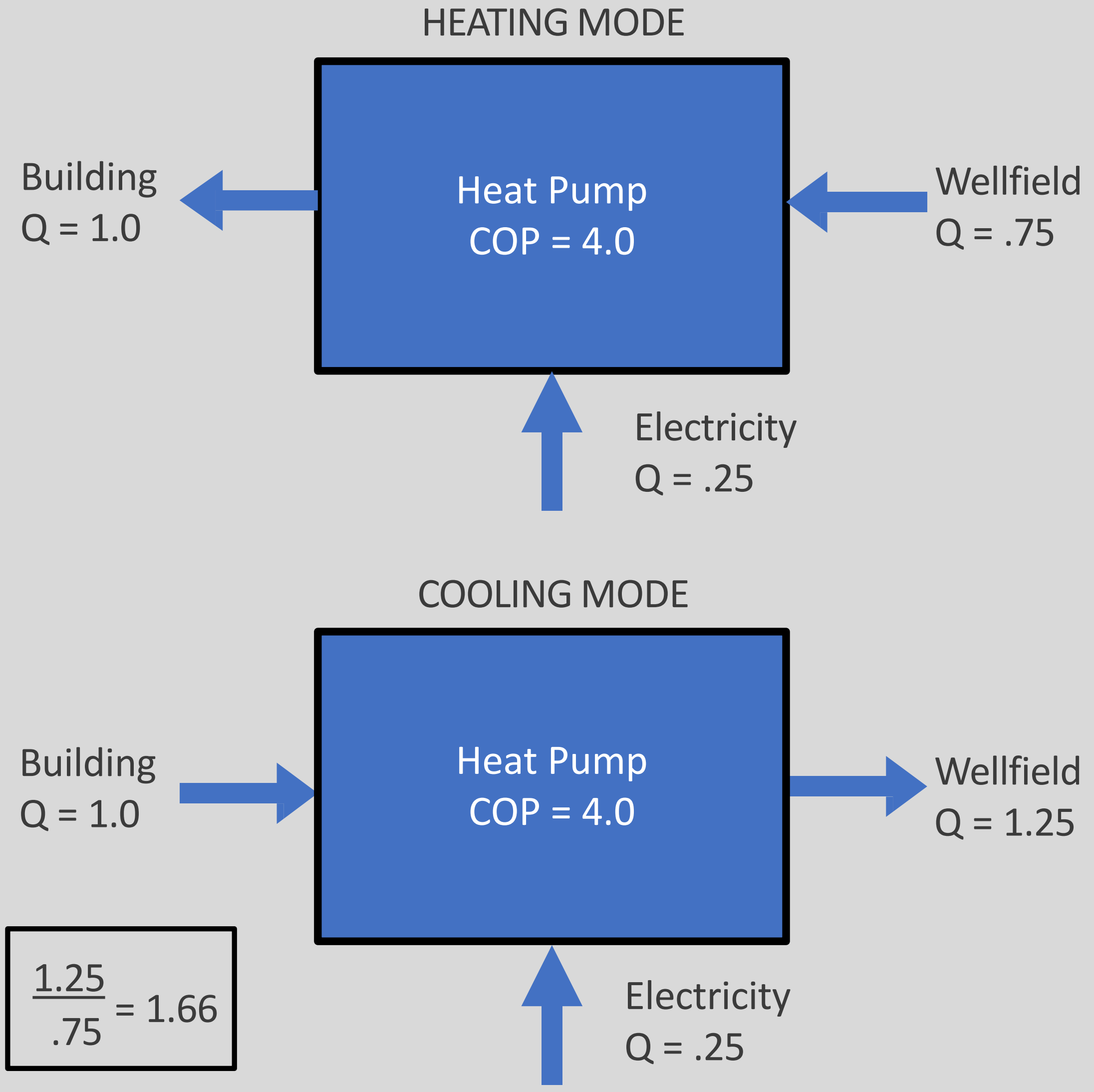
Building Accommodations for Low Temperature Hot Water

- New buildings can easily be designed for low temperature hot water (LTHW)
- Adapting existing buildings can be challenging/costly
  - All direct/indirect steam use eliminated
    - Air handler heating coils
    - Humidification
  - Most hot water heating systems designed for 180°F+ temperatures, but often oversized
  - Energy conservation measures can both save energy and allow for reduced operating temperatures
  - Every existing building has a unique solution – must be evaluated individually
  - Building load reduction measures to accommodate LTHW operation can also produce substantial savings in infrastructure

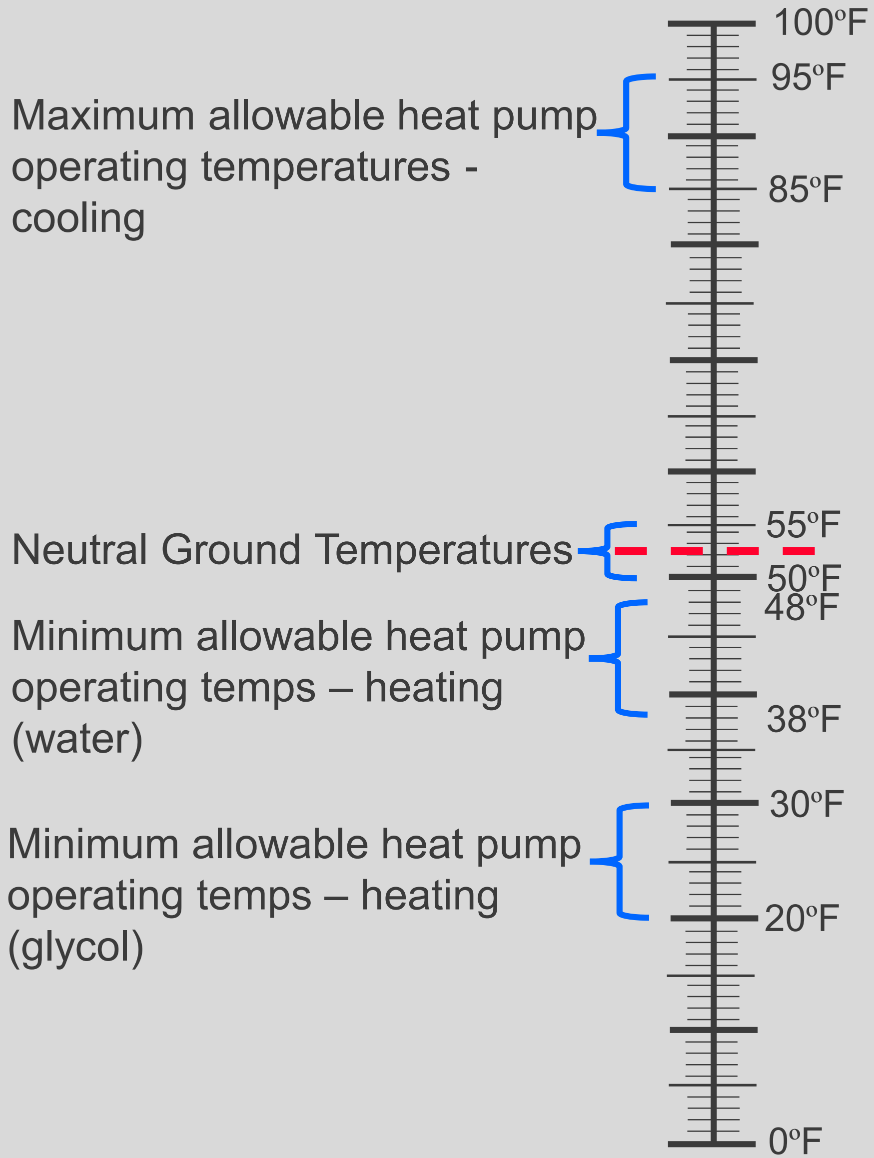
Balancing Heating/Cooling Loads in GeoExchange Systems

- Balancing loads in GeoExchange systems important to minimize size/cost of GeoExchange systems and allow high operating efficiency.
- Methodologies to balance loads
  - Modify building loads
  - Cooling imbalance
    - Heat rejection equipment
  - Heating imbalance
    - Glycol/Water solution
    - Air source heat pump(s)
    - Solar Thermal
    - Biomass
    - Fossil fuel/carbon offsets

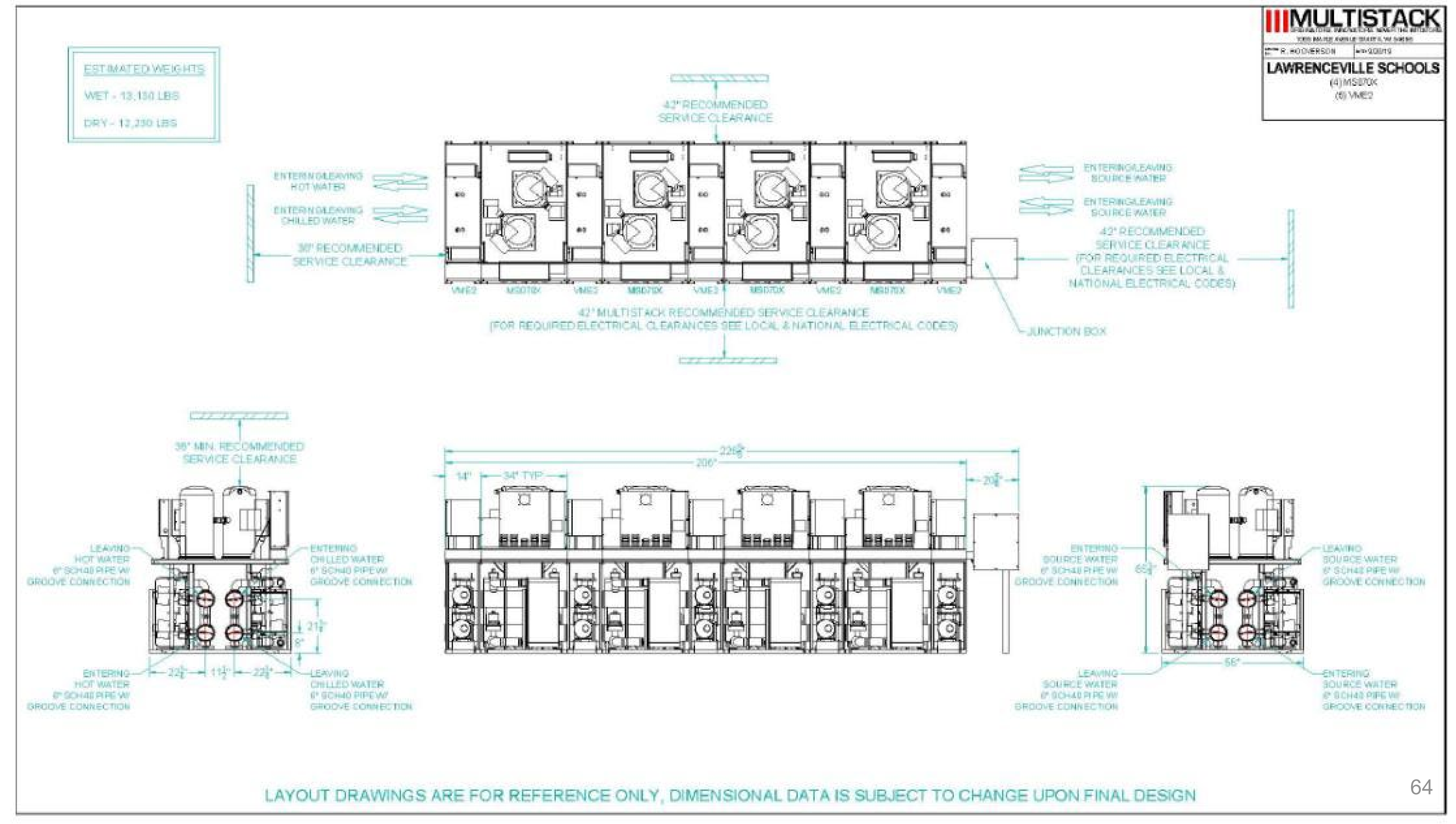
Borefield vs. Building Heating/Cooling Imbalance



For equal building heating/cooling loads, Wellfield loads 66% higher in cooling



Sample Modular Heat Pump Systems



Domestic Hot Water Options

- Domestic Hot Water a significant load on Campuses
  - Residence Halls, Dining, Athletic Centers
- Domestic Hot Water must be maintained above 135ºF to prevent Legionella
- Options to Produce Domestic Hot Water:
  - Hot Water Source Domestic Hot Water Heaters
    - Keep Hot Water temp > 140ºF or
    - Provide Supplemental Electric Heat
  - Dedicated Water Source Heat Pump Domestic Hot Water Heaters
  - Dedicated Air Source Heat Pump Domestic Hot Water Heaters
  - Electric Domestic Hot Water Heaters (small loads)

Sample Heat Pump Water Heaters

CxW WATER SOURCE HEAT PUMP WATER HEATER

STANDARD FEATURES INCLUDE:

- 10, 15, 20, 25, & 30 HP compressor options
- Stackable for reduced footprint
- Expandable in arrays of up to eight, with zero clearance book end spacing
- Electrical available in 460/60/3 (all models) and 208-230/60/3 (<25HP)
- Industrial PLC color touchscreen with internal controls including lead-lag, staging, temperature output
- BACnet and Modbus via MSTP or Ethernet built in
- 140°F to 160°F (60°C to 71°C) output temperatures
- Machine suitable for outdoor applications
- 304L stainless steel frame and enclosure
- Integrated stainless steel circulator pump
- Double wall 316L stainless steel condenser
- Massachusetts Board of State Examiners of Plumbers and Gas Fitters approved
- NSF/ANSI 61 potable circuit rated, UL 1995 machine rating

AVAILABLE OPTIONS INCLUDE:

- Compressor VFD for improved efficiency and control
- Remote Monitoring via ethernet, Wi-Fi, or cellular
- Header assemblies for multiple modules
- Single point electrical distribution for multiple modules
- High source circuit for soure water temperatures over 110°F (43.3°C)
- Double wall 316L stainless steel evaporator to protect source water (ground water sources or domestic water cooling)

Made In the USA

LEAD FREE NSF/ANSI 61 IAPMO R&T

c UL us LISTED

COLMAC WATERHEAT
A division of Colmac Industries

sales@colmacwaterheat.com / colmacwaterheat.com / 401 N Lincoln • PO Box 72, Colville, WA 99114 USA
Tel: (509) 684-4505 / Toll Free: (800) 926-5622 / FAX: (509) 684-4500

Sample Air Source DHW Heat Pump

Commercial Heating | Product Information

MITSUBISHI ELECTRIC

CAHV-R450YA-HPB

Ecodan Air Source Heat Pump

The Mitsubishi Electric Ecodan **CAHV air source heat pump** uses low GWP R454C refrigerant, offering a robust, low carbon system for the provision of sanitary hot water and space heating. This innovative heat pump solution can operate as a single system or form part of a multiple unit system, making it suitable for most commercial applications.

The multiple unit system has the ability to cascade available units to both on and off mode to meet the load from a building. As an example of this unique modulation, a 16 unit system allows 0.5kW increments of capacity, from 7.8kW all the way up to 640kW*. With cascade and rotation built in as standard, the Ecodan CAHV system is perfectly suited to commercial applications including schools and hospitals.

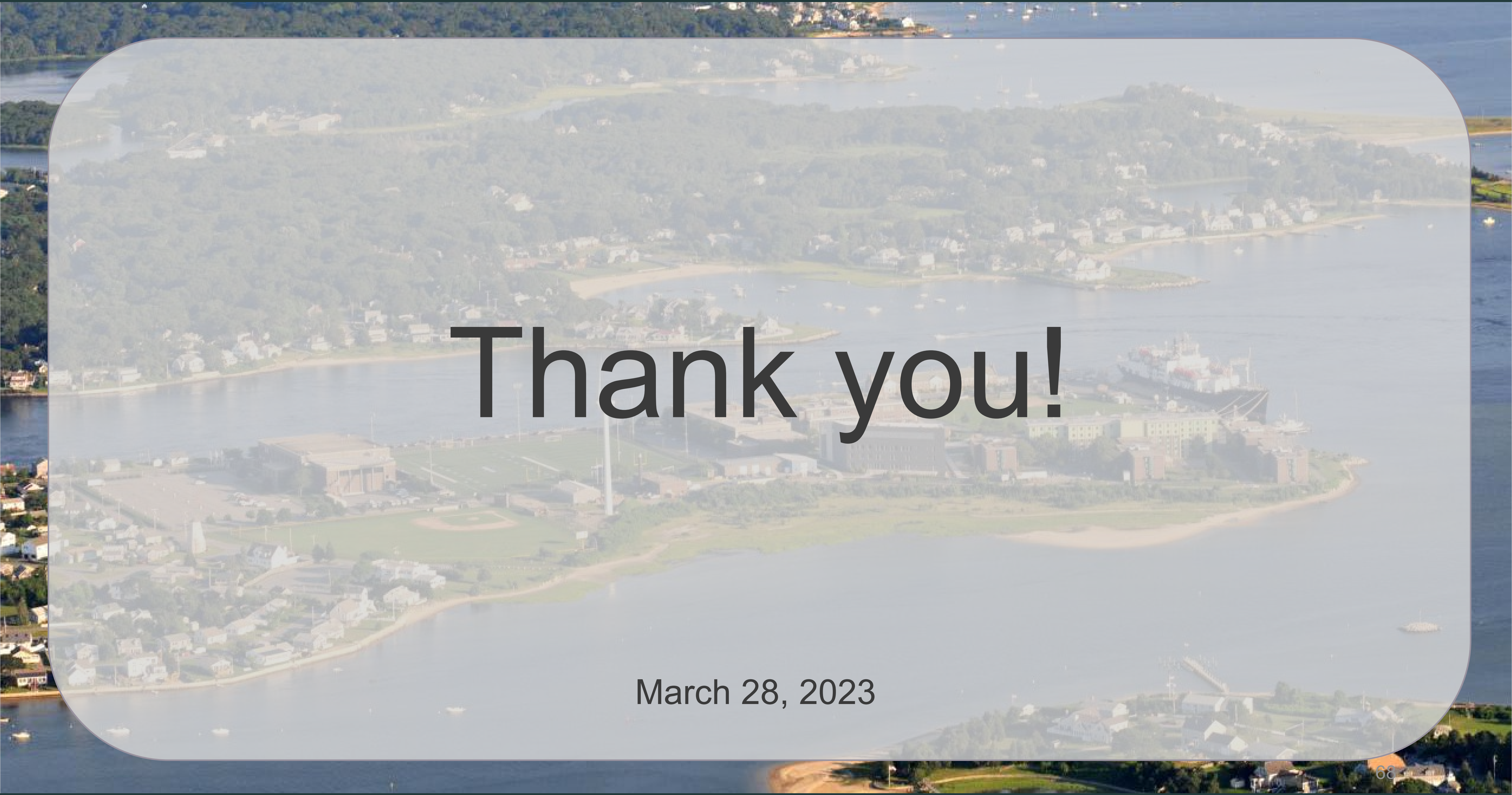
*At nominal conditions A7W35

Key Features & Benefits:

- Low GWP R454C refrigerant and reduced embodied carbon helps achieve CSR targets
- Achieves 70°C outlet temperature down to -20°C ambient temperature for continuous heating provision
- Multiple unit cascade control from 7.8kW to 640kW capacity provides design flexibility for a wide range of commercial applications
- Water flow temperatures from 24°C to 70°C without boost heaters results in cost and energy savings
- Advanced heat exchange design combined with the properties of R454C refrigerant enables a shorter defrost time
- Low frequency compressor control improves energy efficiency and product operation
- Ability to rotate units based on accumulated run hours offers extended product life
- Requires only water and electrical connections, for ease of installation
- Hermetically sealed monobloc design, requiring low maintenance

ecodan®
Renewable Heating Technology

les.mitsubishielectric.co.uk



Thank you!

March 28, 2023