University of Massachusetts Amherst

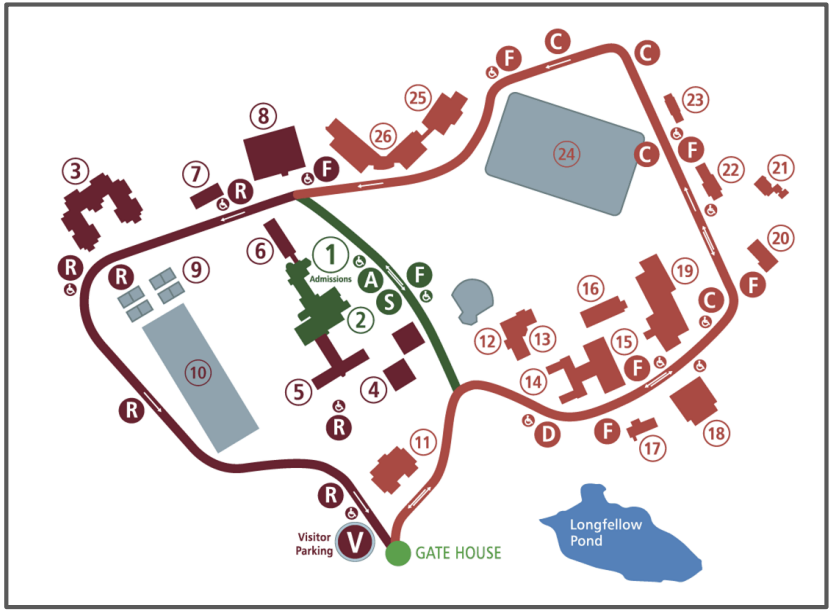
Clean Energy Extension

Mount Ida Campus Greenhouse Gas, Clean Energy, and Sustainability Planning

Created by the UMass Amherst Clean Energy Corps

Presentation Order:

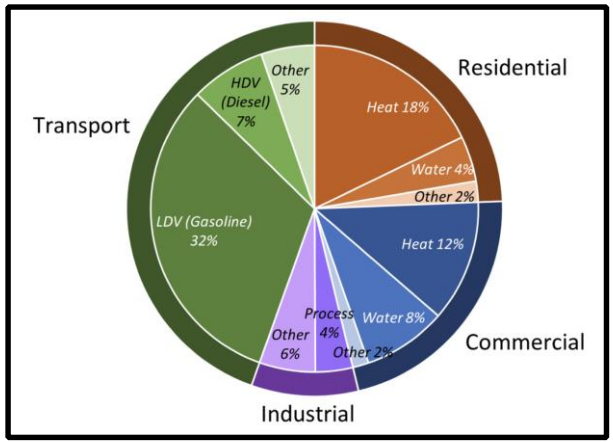
1. Introduction
2. Project Background
3. Emissions and Energy Analysis
4. Recommendations
   Buildings, Transportation, Sustainability
5. Working with Newton
6. Next Steps
7. Conclusion and Questions



Mount Ida Campus Map

Introduction:

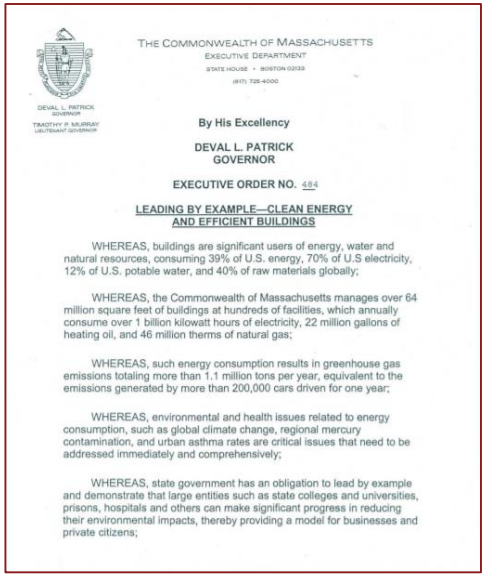
- Who are we?
  - CEE Interns interested in clean energy, emissions reduction and efficiency



- Project start: Jan 2019

Project Background:

- UMass Amherst purchased Mt. Ida College on May 17, 2018
- “Leading By Example” requires UMass to report and reduce its greenhouse gas emissions
- The UMass Commitment to Sustainability
- Going carbon neutral
- Significant increase to UMass emissions



THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE DEPARTMENT
STATE HOUSE • BOSTON 02133
(617) 725-4000

DEVAL L. PATRICK
GOVERNOR
TIMOTHY P. MURRAY
LIEUTENANT GOVERNOR

By His Excellency

DEVAL L. PATRICK
GOVERNOR

EXECUTIVE ORDER NO. 484

LEADING BY EXAMPLE—CLEAN ENERGY AND EFFICIENT BUILDINGS

WHEREAS, buildings are significant users of energy, water and natural resources, consuming 39% of U.S. energy, 70% of U.S electricity, 12% of U.S. potable water, and 40% of raw materials globally;

WHEREAS, the Commonwealth of Massachusetts manages over 64 million square feet of buildings at hundreds of facilities, which annually consume over 1 billion kilowatt hours of electricity, 22 million gallons of heating oil, and 46 million therms of natural gas;

WHEREAS, such energy consumption results in greenhouse gas emissions totaling more than 1.1 million tons per year, equivalent to the emissions generated by more than 200,000 cars driven for one year;

WHEREAS, environmental and health issues related to energy consumption, such as global climate change, regional mercury contamination, and urban asthma rates are critical issues that need to be addressed immediately and comprehensively;

WHEREAS, state government has an obligation to lead by example and demonstrate that large entities such as state colleges and universities, prisons, hospitals and others can make significant progress in reducing their environmental impacts, thereby providing a model for businesses and private citizens;

AASHE STARS Rating:

- Academics: Curriculum, Research
- Engagement: **Campus & Public**
- **Operations: Air & Climate**, **Buildings, Energy**
- Food & Dining, Grounds, Purchasing,
- **Transportation**, Waste, Water
- Planning & Administration: Coordination & Planning,
- Diversity & Affordability, Investment & Finance, Wellbeing & Work
- Innovation & Leadership

- Focusing on Aspects of the STARS Rating:
  - Building Operations
  - Emissions
  - Efficiency
  - Green Transportation
  - Sustainability

aashe
The Association for the Advancement of Sustainability in Higher Education

SUSTAINABILITY TRACKING, ASSESSMENT & RATING SYSTEM
stars
a program of aashe
GOLD ®

Our Goals:

1. Establish foundational energy and GHG emissions reporting data

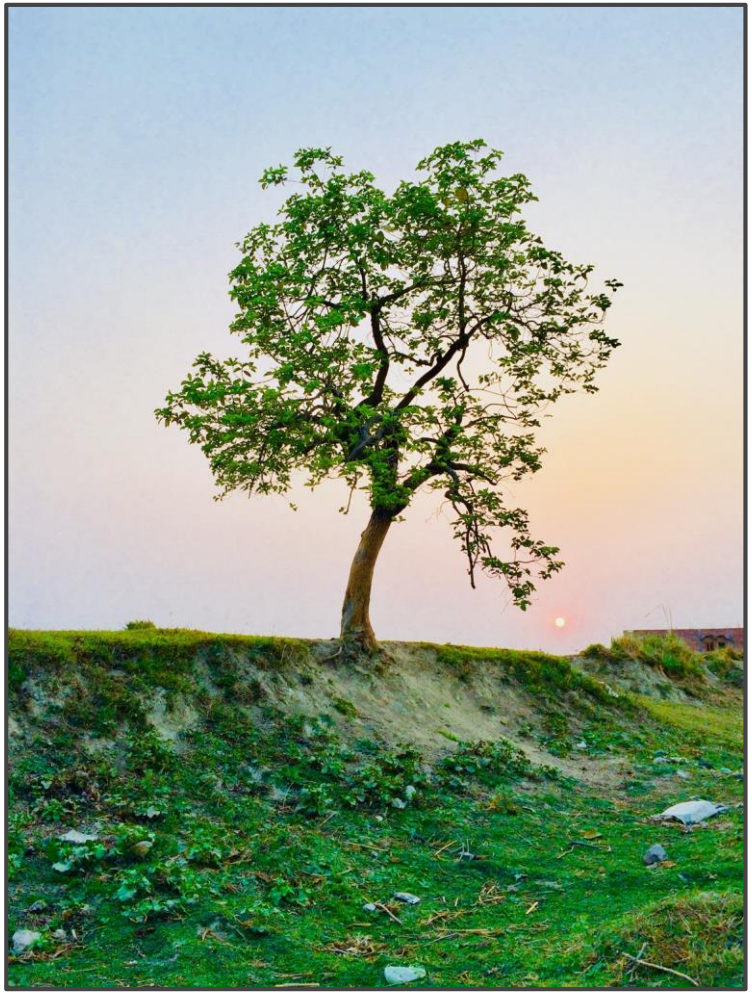
2. Identify focus areas and provide recommendations for low-cost energy efficiency

3. Model possible deep-energy retrofit applications for high EUI/oil burning buildings

4. Review transportation options and current fleet vehicles and then provide options for increased efficiency

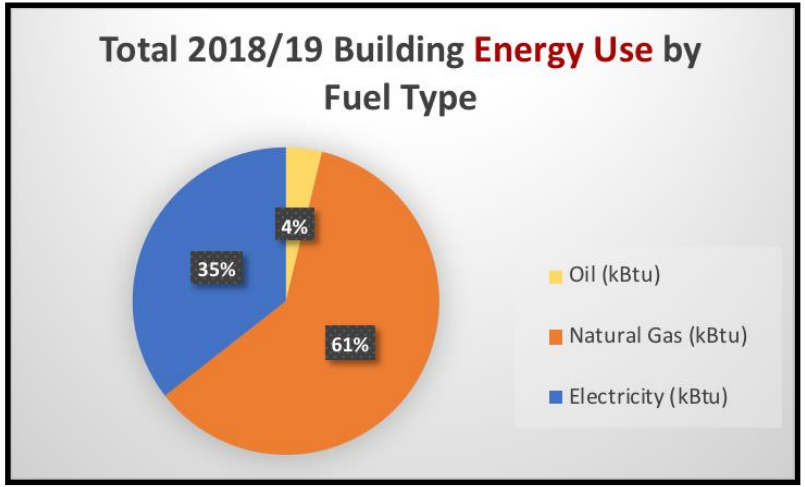
5. Provide an updateable building by building index and interactive GIS map to bring together all the sources of data

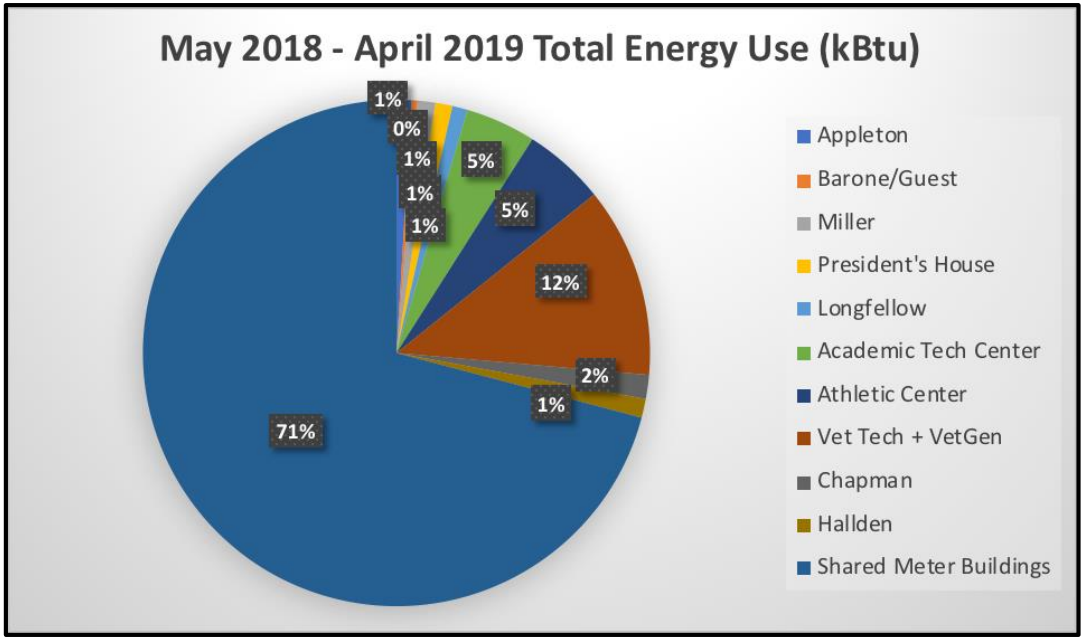
6. Identify overall sustainability opportunities through behavioral and operational changes



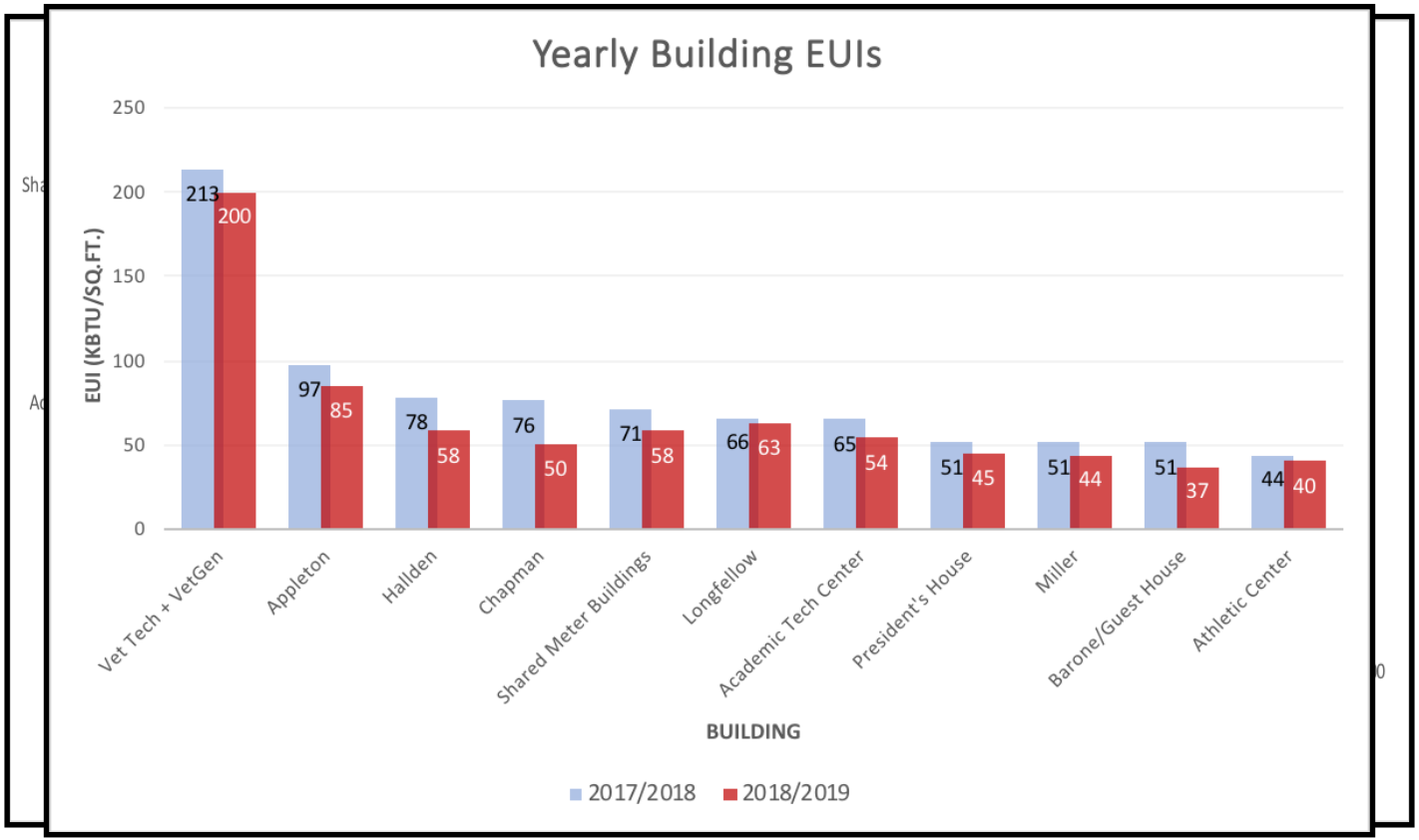
Energy and Emissions Findings

2018-2019 Energy Use

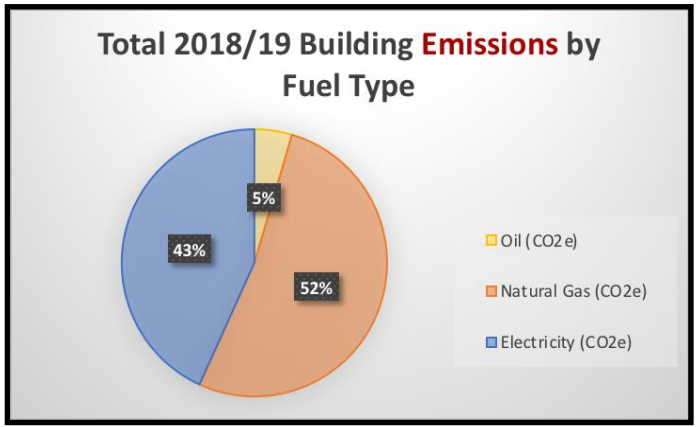


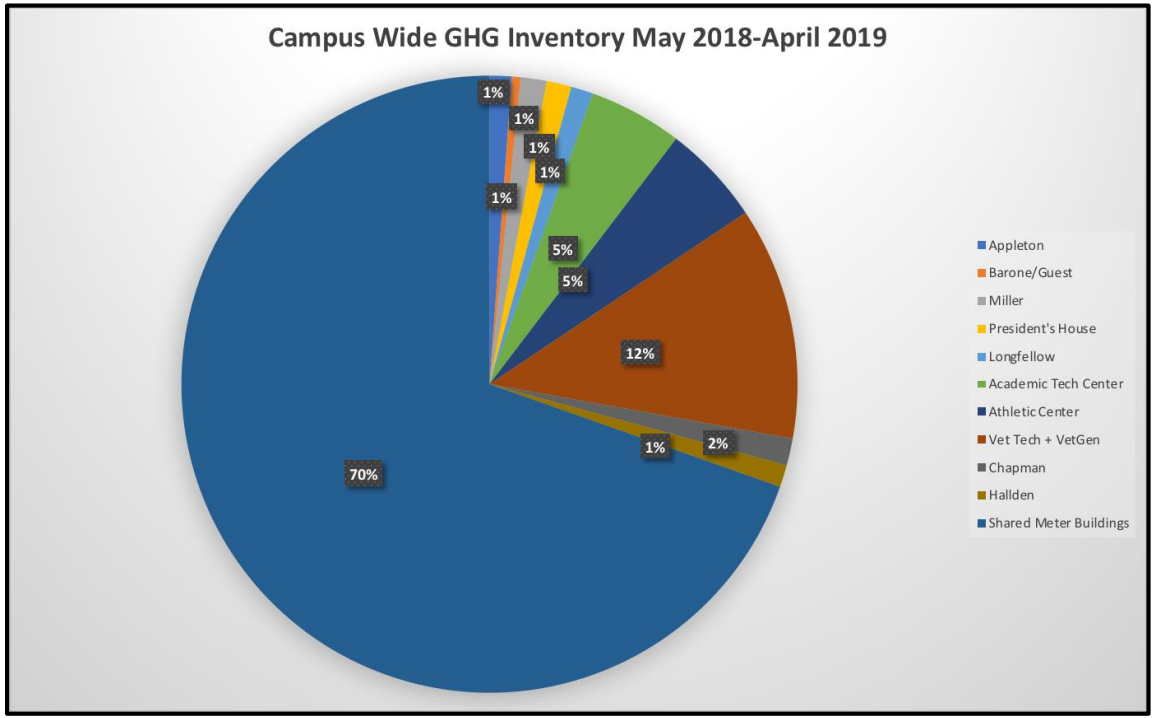


Yearly Building Energy Use

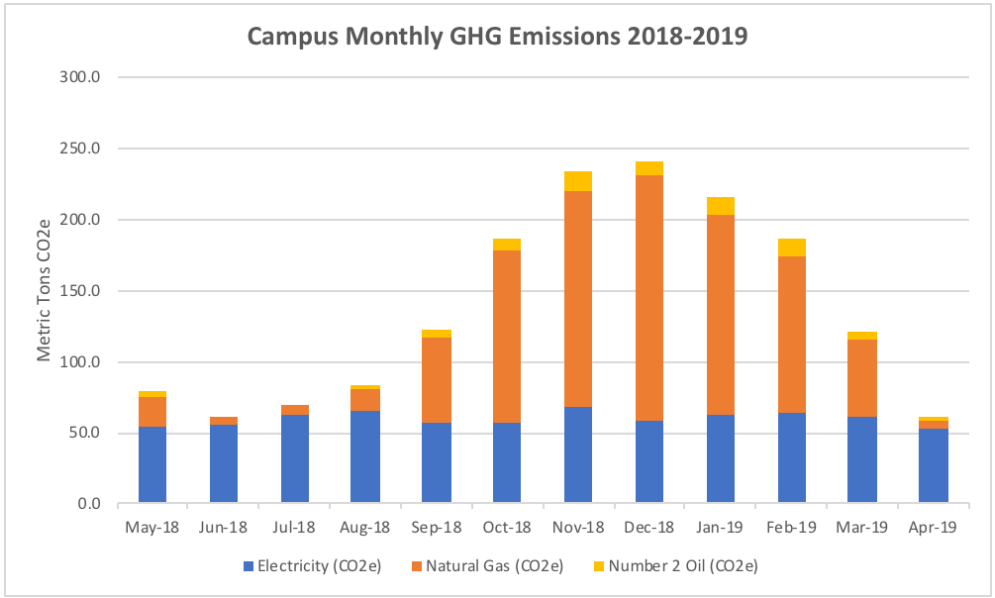


FY 2018 Mt Ida GHG Inventory:





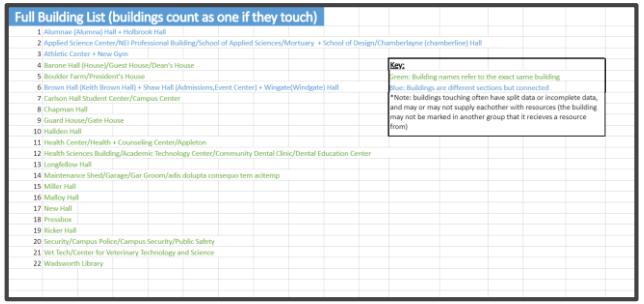
FY 2018 Mt Ida GHG Inventory:

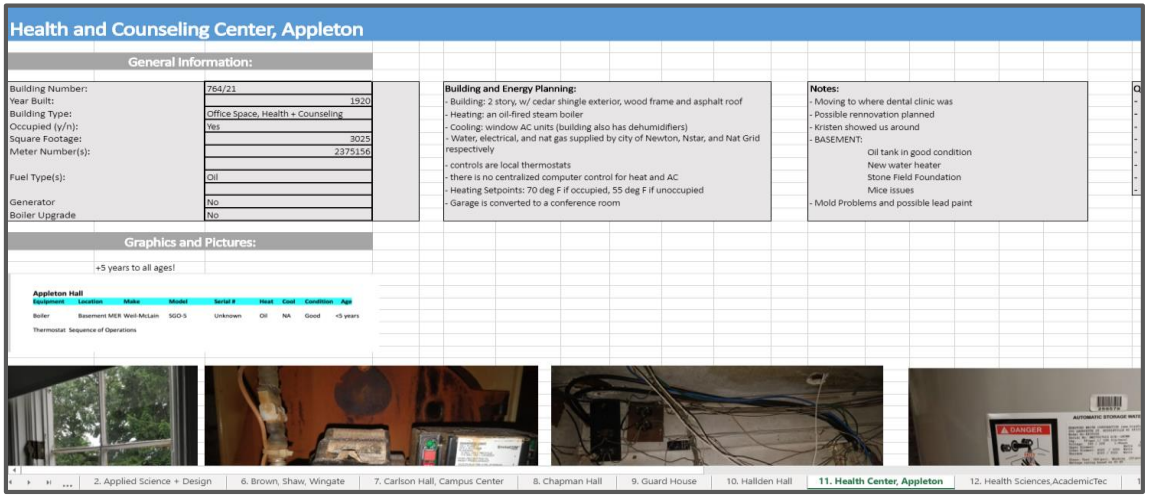


	Sum CO2e by Month											
	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19
Electricity (CO2e)	54.1	55.0	62.4	65.9	57.3	56.6	68.2	58.4	62.0	64.5	60.9	52.6
Natural Gas (CO2e)	21.2	6.8	6.7	14.9	59.9	122.0	151.9	172.6	140.7	110.0	54.6	6.4
Number 2 Oil (CO2e)	3.3	0.0	0.0	2.2	4.9	8.1	13.7	10.2	13.3	12.2	5.6	2.3
Sum CO2e (metric tons)	78.6	61.8	69.1	83.1	122.1	186.7	233.7	241.2	216.0	186.6	121.1	61.3

Analysis Tools: Building Atlas

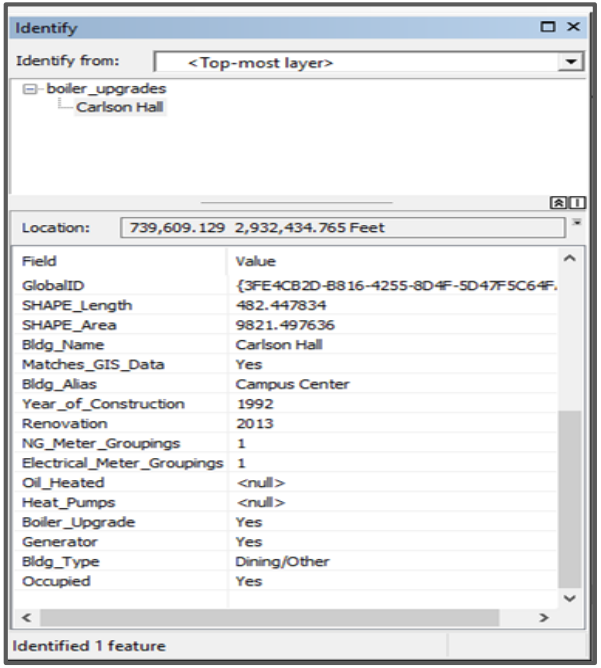
- All-in-one building by building data organization
- Meter numbers, year built, building aliases, generators, mechanical systems, emissions, issues, etc
- Previous upgrades
- Building recommendations
- Future organization and tracking

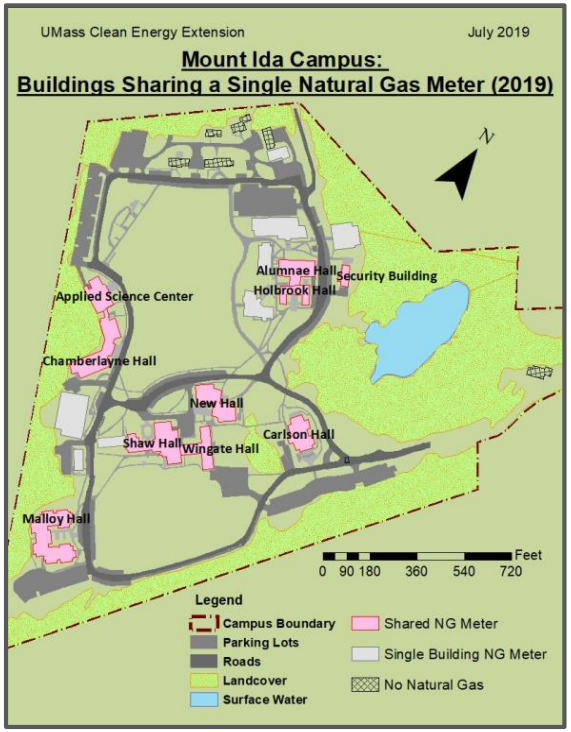


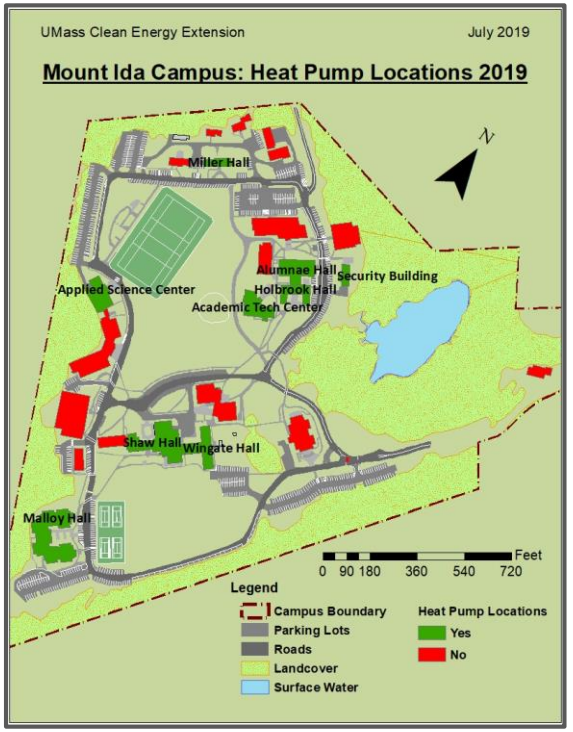


Analysis Tools: GIS

- Visualize the key findings of our research
- Establish a malleable tool to be utilized in future campus planning efforts

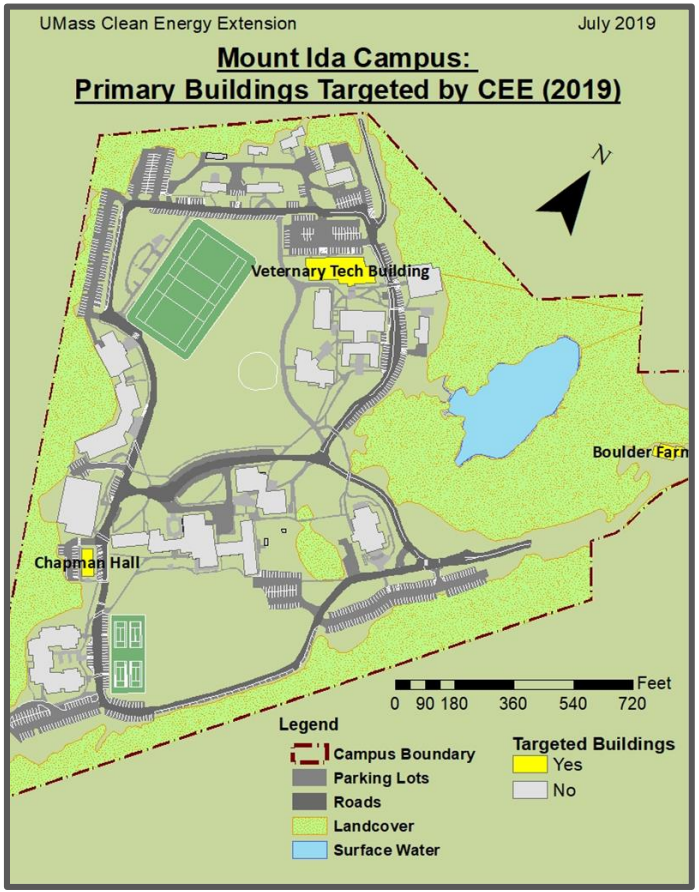







Building Recommendations
Beckett
ELYRIA,
O U.S.A

Building Prioritization:

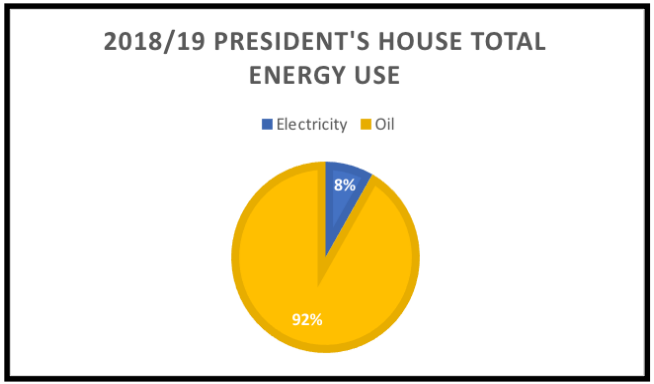


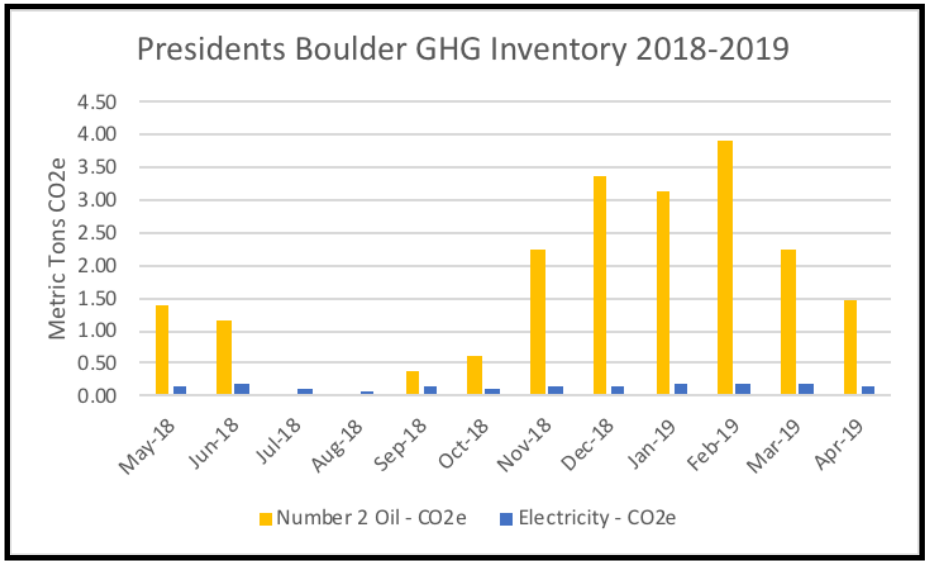
Building Priority:

1. TARGET BUILDINGS
   - President's House/Boulder Farm
   - Chapman Hall
   - Veterinary Technology Center
1. Increase Efficiency of Remaining Buildings
2. Buildings with No Future Use

Target Buildings: President's House/Boulder Farm

- Heavy oil use, high emissions
- Poor thermal insulation
- Roof needs replacement
- Stormwater management
- Very low baseline of electricity
- Propane used for cooking



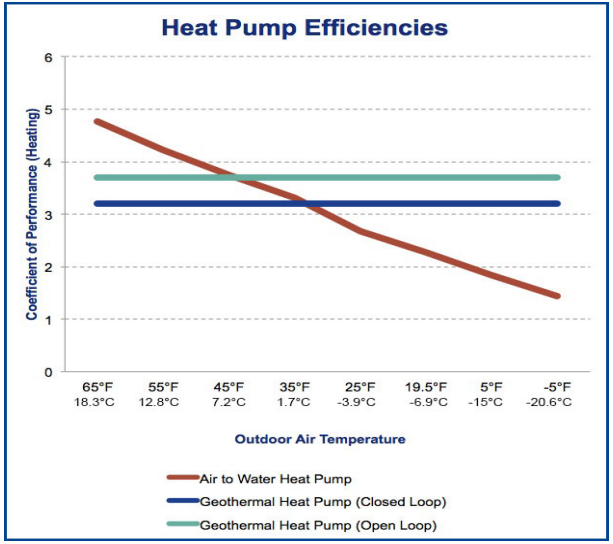


President's House: Recommendations

- New well insulated roof
- Insulate and air seal attic, replace Sin pane windows
- Install LEDs and smart plugs
- Replace the boiler with a GSHP

Estimated Heating Improvements for a Ground Source Heat Pump (COP 4)							
Building	Oil Heating Energy Use (kBtu) (2018-2019)	Estimated Operational Savings (kBtu)	CO2e from Oil (metric tons) (2018-2019)	Estimated CO2e from GSHP Electricity (metric tons)	Estimated CO2e Saved (metric tons)	Estimated Percent CO2e Saved for Heating	Estimated Percent CO2e saved for Total Energy
Boulder Farm	267,692	200,769	19.94	5.02	14.92	74.8 %	68.8 %

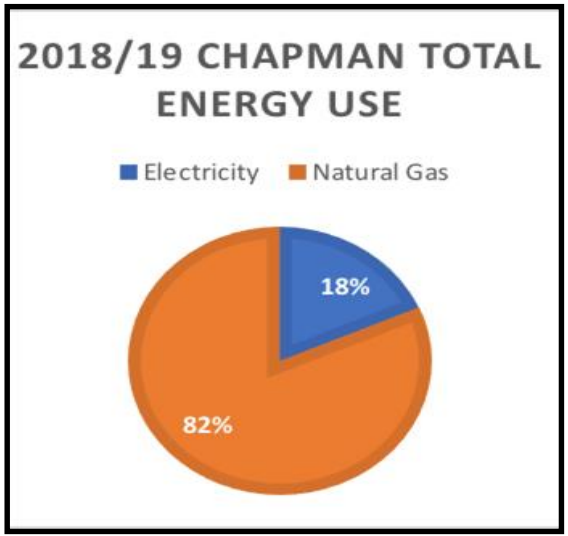
Table 4.1: *Estimated emissions savings by installing a GSHP to provide all of Boulder Farm's heating load.*

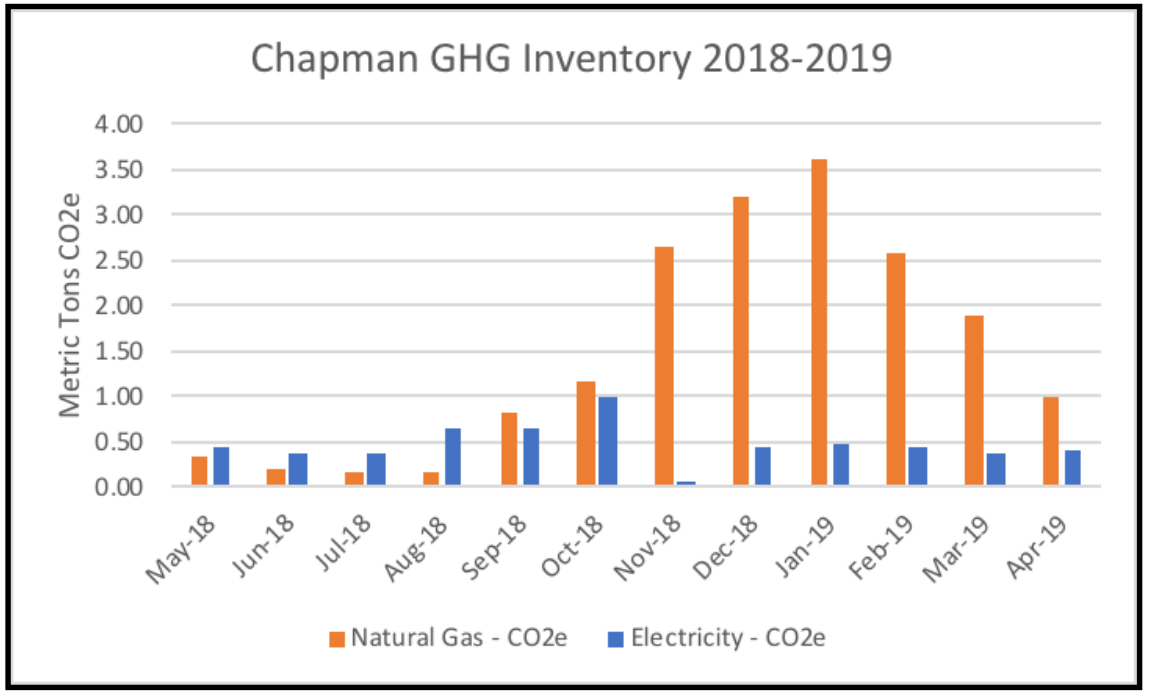


- GSHPs have a higher avg COP vs ASHPs
- Unaffected by weather
- Greater temperature control
- Integrative, non-intrusive design
- Chimney stove insert

Target Buildings: Chapman Hall

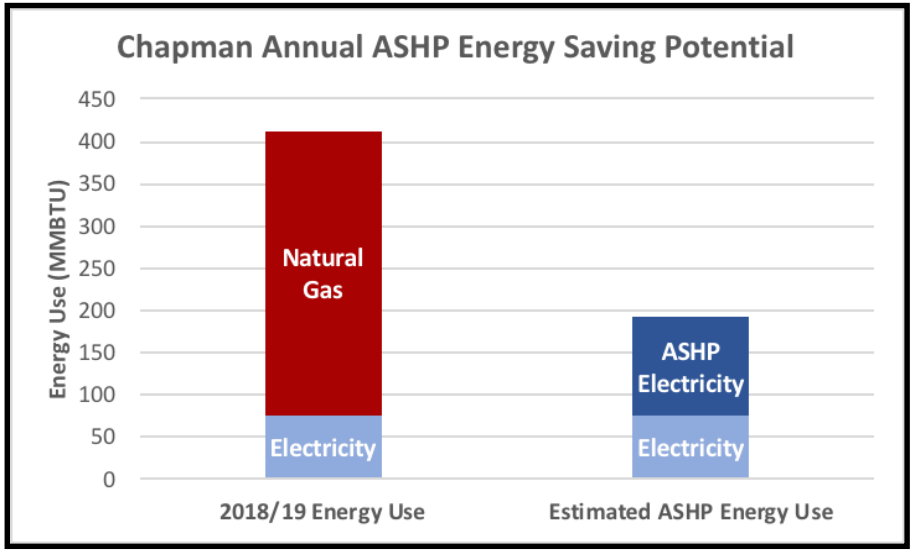
- Small residents hall with no AC
- Only baseboard heating
- Model for conventional building

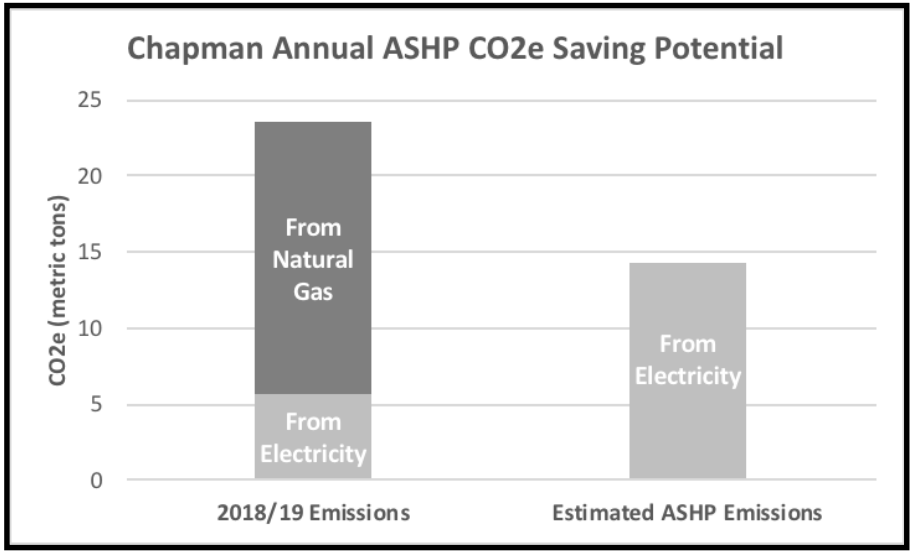




Chapman Hall: Recommendations

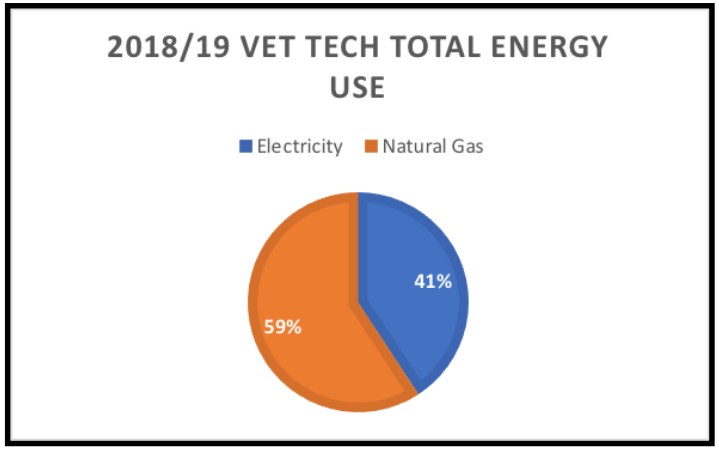
- Install ASHPs
- Air seal and insulate
- LEDs and controls

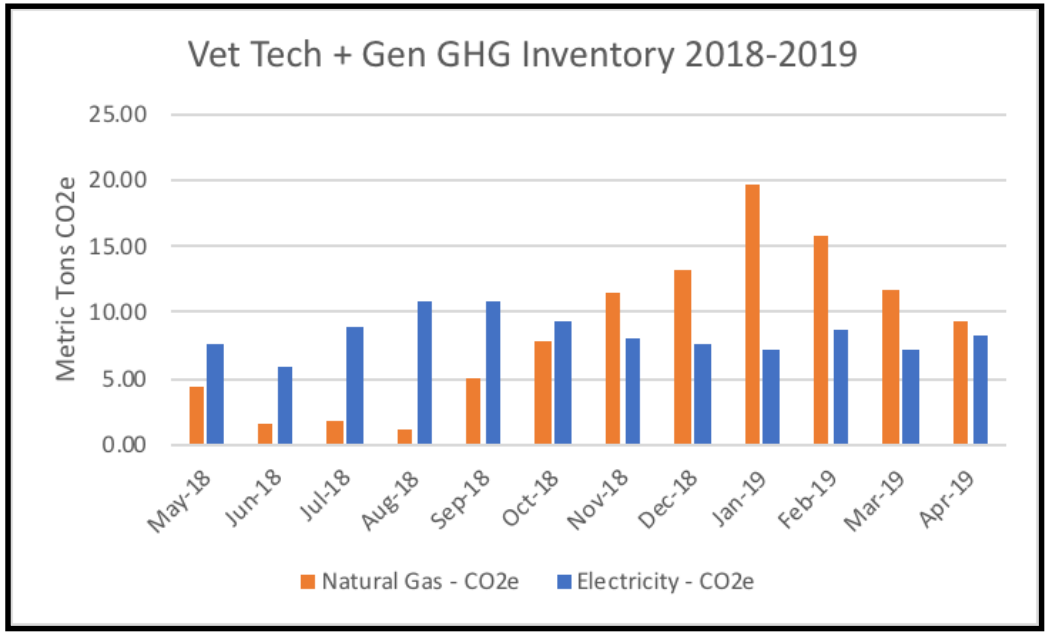




Target Buildings: Veterinary Technology Center

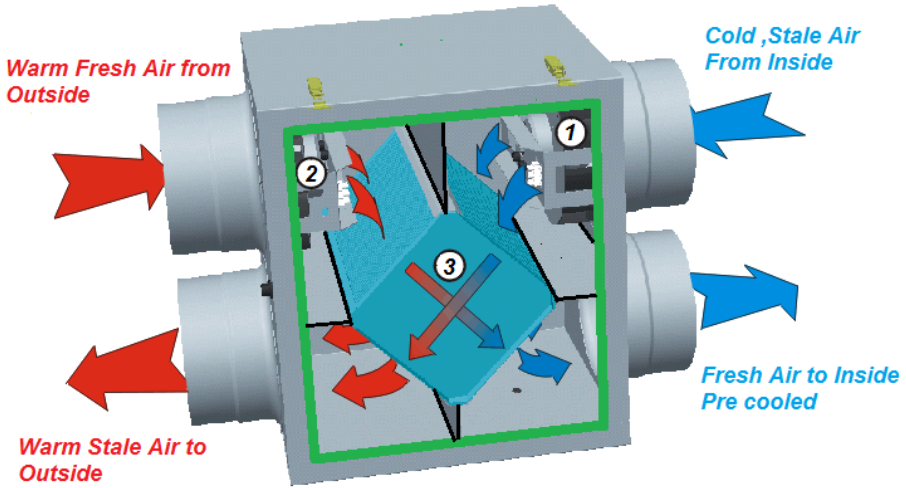
- **Largest energy user on campus**
- Lab-type construction and high glazing
- High ventilation requirements

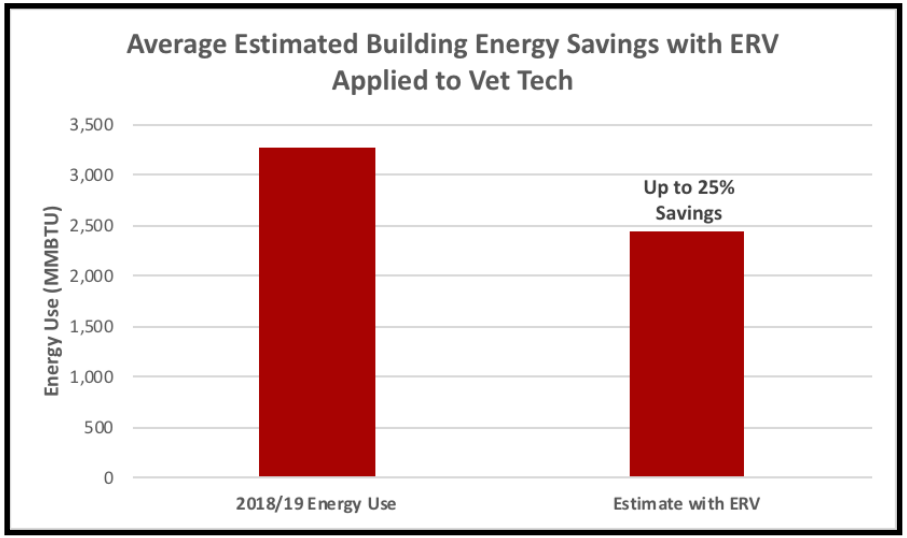




Veterinary Technology Center: Recommendations

Energy Recovery Ventilation:





Target Buildings: Air Source Heat Pumps

Electrifying with ASHPs:

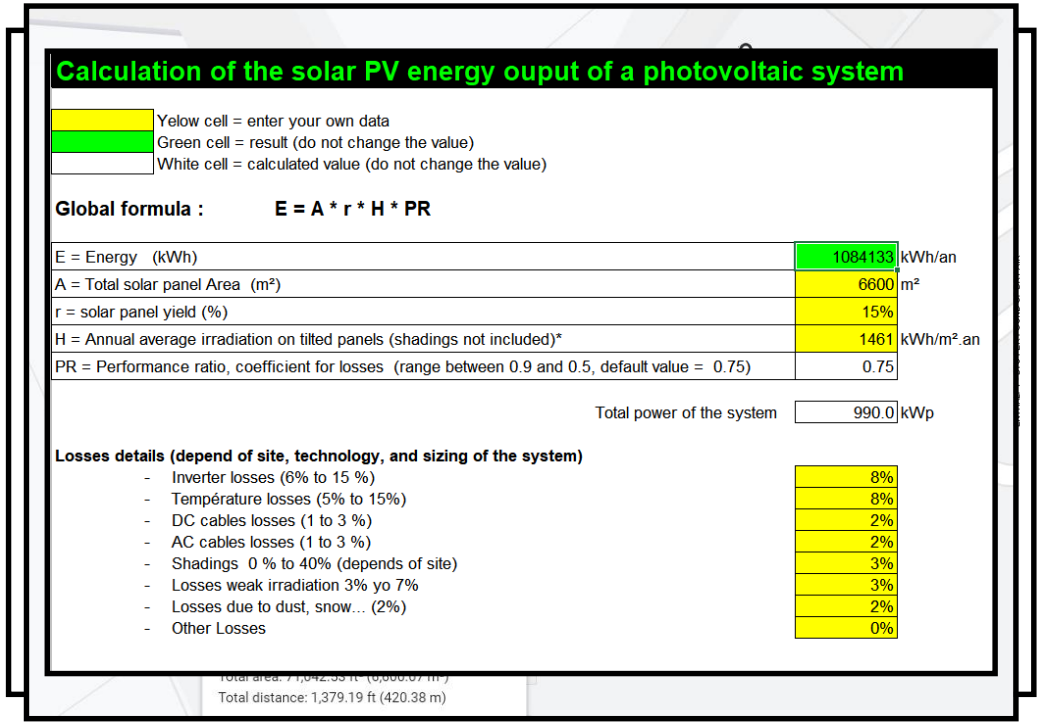
- Estimated avg COP of 2.9 vs .91 efficiency
- Replacing heating systems and adding cooling capability
- Fuel switching to electricity
- Similar emission but potential to be green

Potential Carbon Saving Benefits of Air-Source Heat Pumps

Building	2018/19 Total Energy Use from Electricity + NG or Oil (kBtu)	Estimated Total Energy Use from ASHPs and Electricity (kBtu)	2018/19 CO2e (metric tons)	Estimated ASHP CO2e (metric tons)	Estimated CO2e Saved (metric tons)	Estimated Percent CO2e Saved
President's	291,924	115,908	21.8	8.7	13.1	60%
Chapman	411,434	190,831	23.5	14.3	9.2	39%
Vet Tech	3,269,692	1,996,968	202.8	149.7	53.1	26%

General Buildings: Recommendations

- Improve Efficiency Through Temperature Control
  - Schedules based on occupancy
  - Set Points for Occupied Buildings:
    - 68 °F to 72 °F for heating, 68 °F to 70 °F for cooling
  - Comfort
- Condemn Oil buildings and Malloy
- Renewable Energy
- BMS: sensors and controls



Calculation of the solar PV energy ouput of a photovoltaic system

Yelow cell = enter your own data
Green cell = result (do not change the value)
White cell = calculated value (do not change the value)

Global formula : **E = A * r * H * PR**

E = Energy (kWh)	1084133	kWh/an
A = Total solar panel Area (m²)	6600	m²
r = solar panel yield (%)	15%	
H = Annual average irradiation on tilted panels (shadings not included)*	1461	kWh/m².an
PR = Performance ratio, coefficient for losses (range between 0.9 and 0.5, default value = 0.75)	0.75	

Total power of the system 990.0 kWp

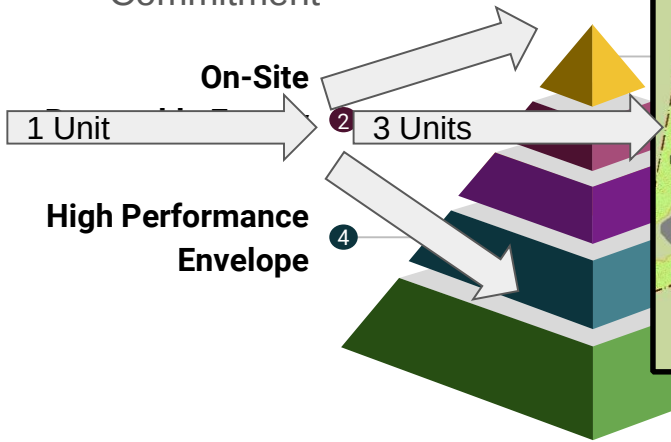
Losses details (depend of site, technology, and sizing of the system)

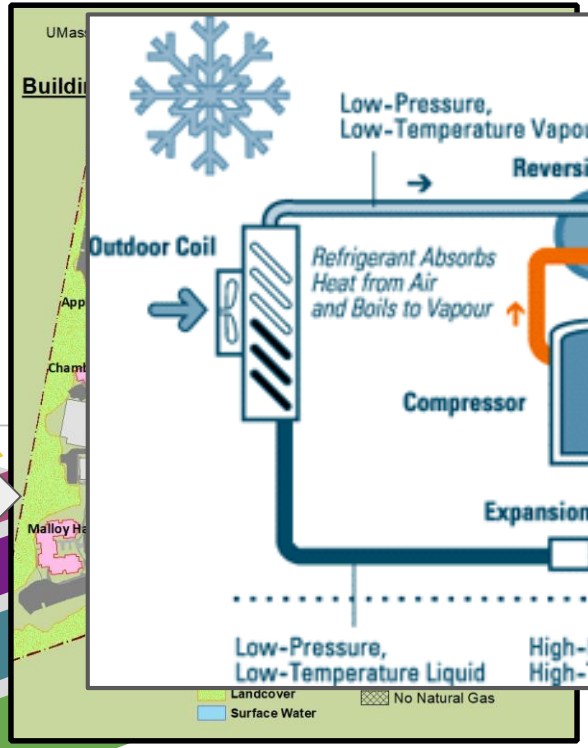
- Inverter losses (6% to 15 %)	8%
- Température losses (5% to 15%)	8%
- DC cables losses (1 to 3 %)	2%
- AC cables losses (1 to 3 %)	2%
- Shadings 0 % to 40% (depends of site)	3%
- Losses weak irradiation 3% yo 7%	3%
- Losses due to dust, snow… (2%)	2%
- Other Losses	0%

Total distance: 1,379.19 ft (420.38 m)

General Buildings: Recommendations Cont.

- Building Metering
- Electrification: Consider ASHP
  - 100% switch saves ~27% emissions
- Future Building Standards Commitment



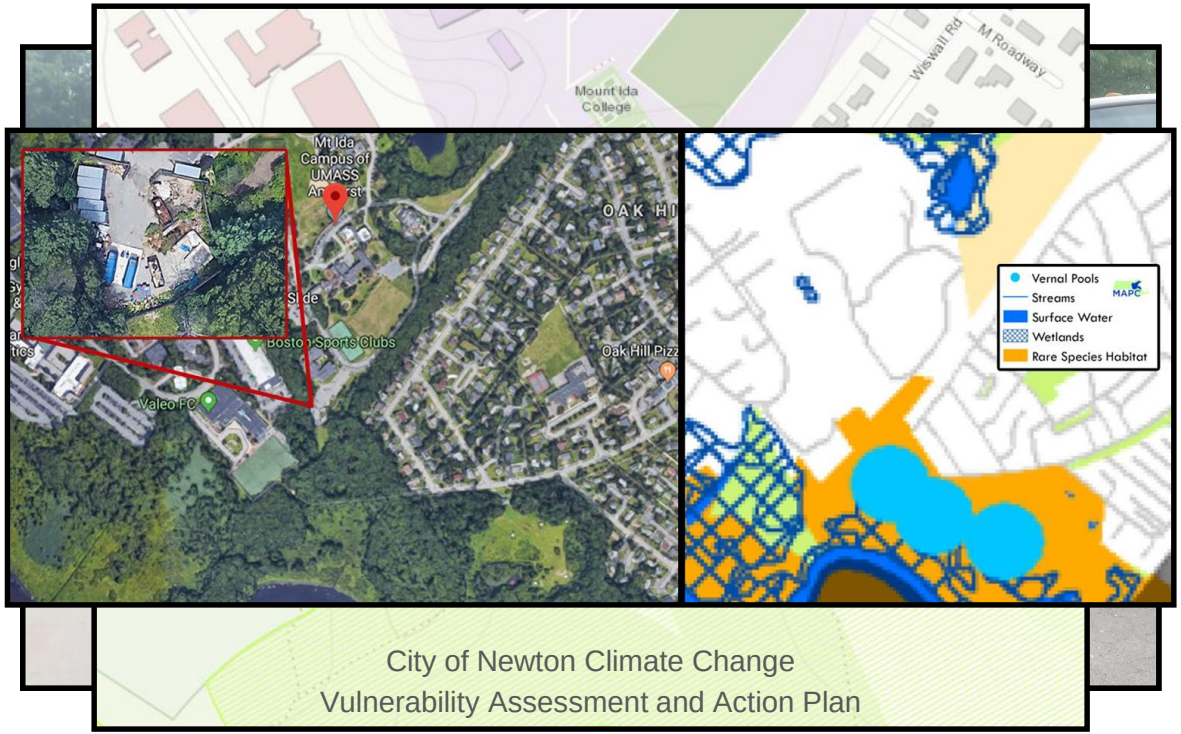


Campus Sustainability Recommendations

Environmental Sustainability:

Environmental Sustainability:

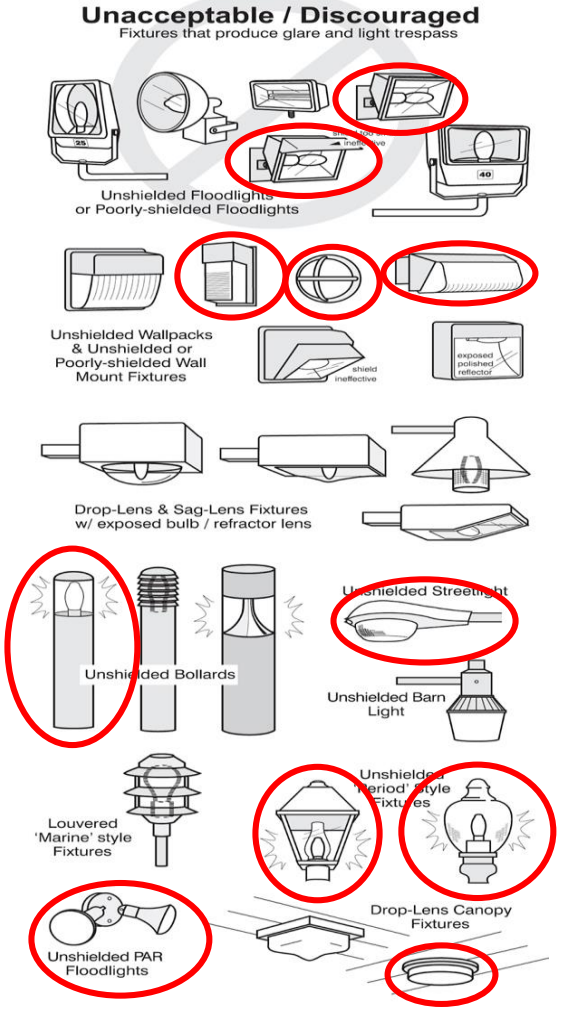
- Rare Species Habitat and Vernal Pools
- Uncovered Road Salt
    - Harm native species (ex. spotted salamander which use vernal pools as their only breeding ground), kill trees, change stream chemistry, and more
- ClogBusters
    - “Stormwater picks up potential pollutants that may include sediment, nutrients, bacteria, pesticides, metals, and petroleum by-products” -U.S. Geological Survey



Natural Heritage & Endangered Species Program (NHESP)

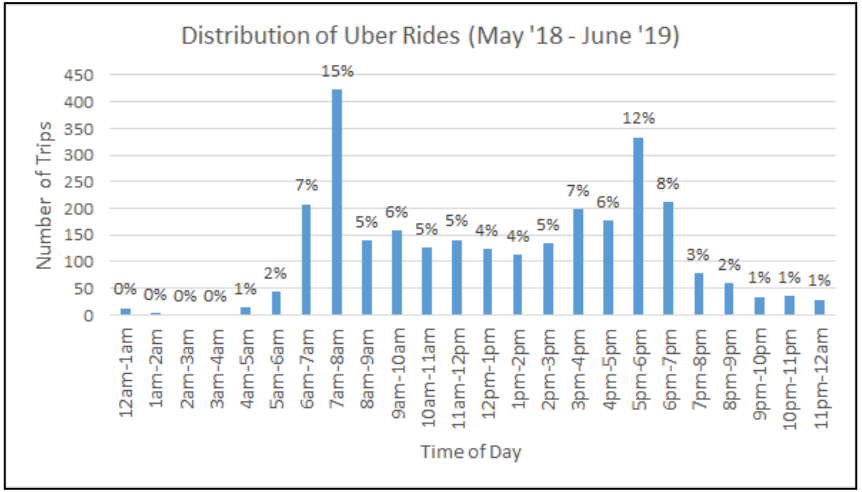
Environmental Sustainability:

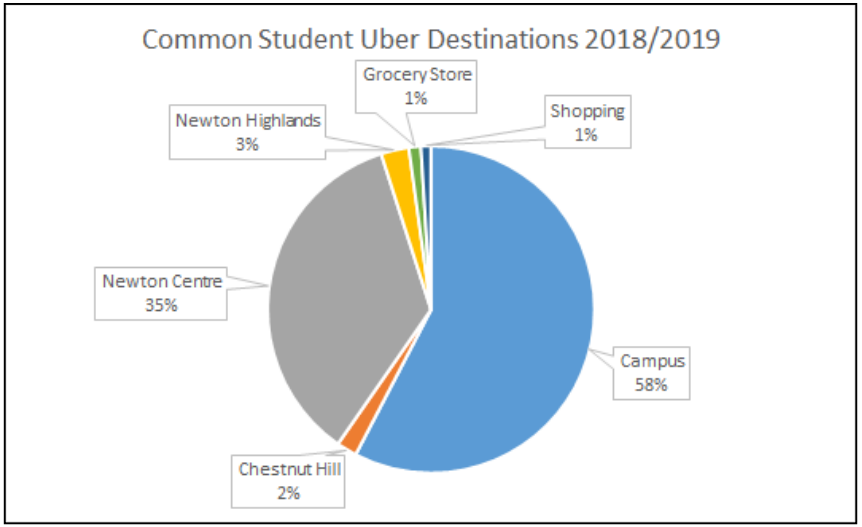
- Inefficient and environmentally harmful outdoor light fixtures across campus
- Poorly sited solar compactors
- Lack of composting



Transportation:

- Highlight existing student commuting trends
- Explore opportunities for campus transportation systems
- Investigate the potential for electrification of the campus fleet

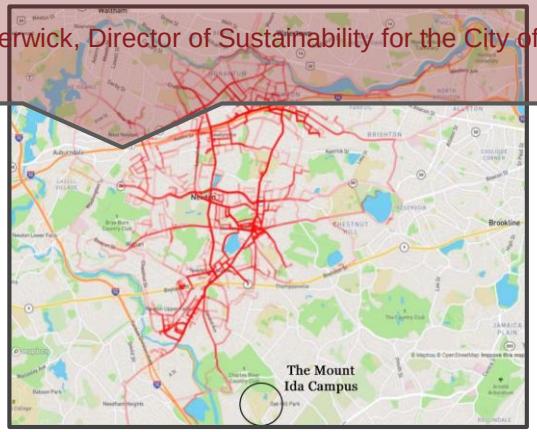




Working with Newton:

"The City of Newton is excited about the opportunities for the Mt. Ida Campus to reduce its greenhouse gas emissions, and for Mt. Ida to serve as a leader in Newton's anticipated Green Ribbon Commission. We expect that many of Mt. Ida's "leading by example" initiatives will contribute momentum to the City's climate programs."

- Ann Berwick, Director of Sustainability for the City of Newton



- 40% of large commercial buildings in Newton are used for academic purposes
- Green Ribbon Commission
- Align emissions reduction and clean energy goals
  - On-site renewables
  - EV transit
  - High Efficiency Buildings
- Integrate sustainable actions with Newton's goals and ongoing projects
  - e.g. Limebike bike share

Next Steps:

Action Items:

- Increase Building Efficiency
- Operational/Behavioral Modifications and Retrofits
- Implement Campus-wide Sustainability Measures
- Transform Mt. Ida's Transportation Sector

Future Goals:

- Set future campus specific emissions goals
- Develop detailed HVAC schedules
- Investigate more renewable options
- Retrofit cost analyses
- Further develop transportation plan
- Investigate energy storage

Thank You!