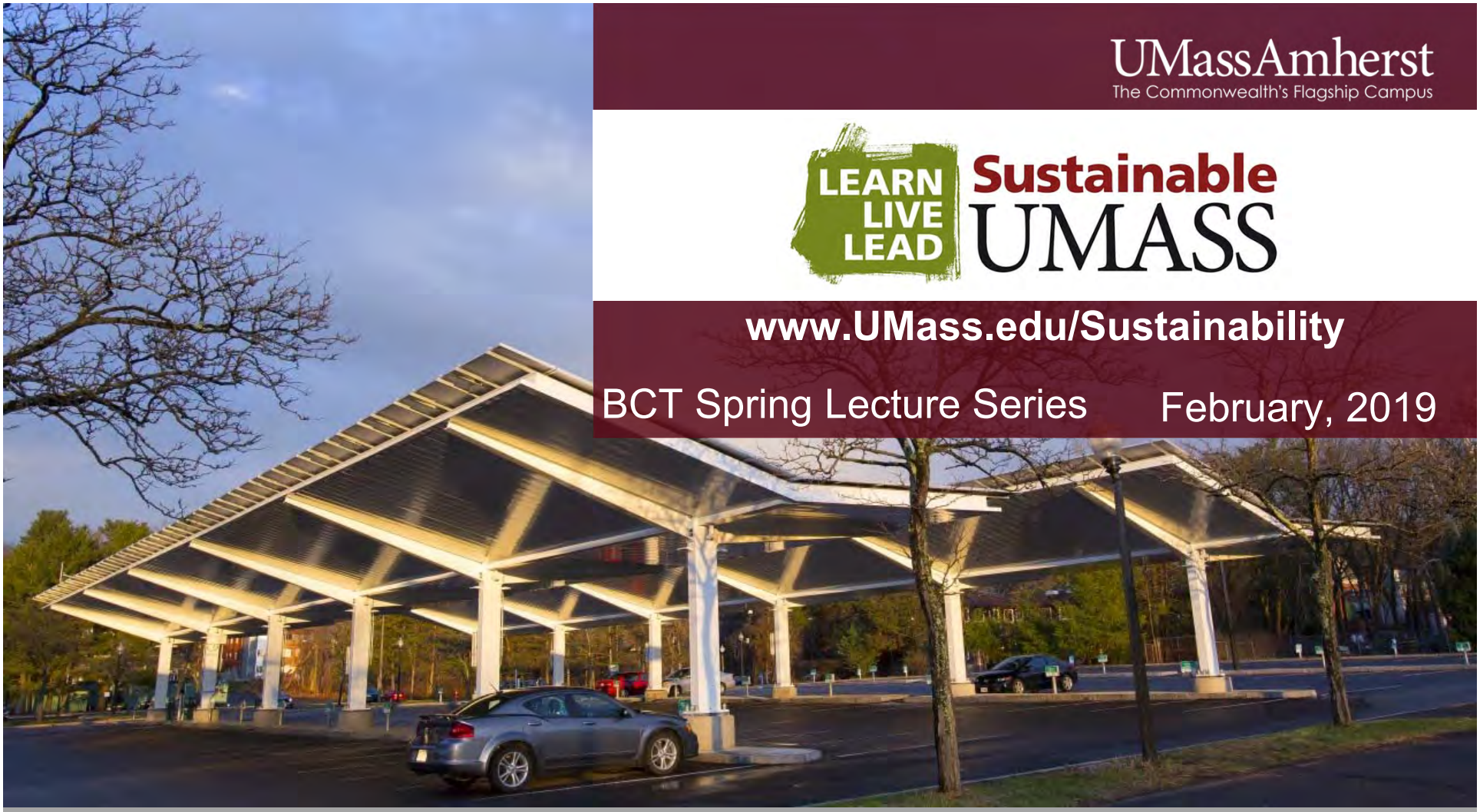


UMassAmherst
The Commonwealth's Flagship Campus

LEARN LIVE LEAD

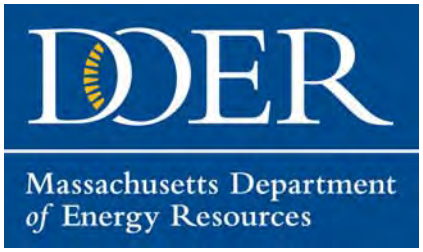
Sustainable UMASS

www.UMass.edu/Sustainability

BCT Spring Lecture Series February, 2019


LEADING BY EXAMPLE
RANKINGS AND AWARDS

UMassAmherst



What's behind the Gold Star?

UMassAmherst

- Reports: 2011, 2014, 2015, 2018
- **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**

aashe
The Association for the Advancement of Sustainability in Higher Education

UMass Sustainability Rankings

AASHE STARS

2015 – 68.18 (Gold)

2018 – 75.77 (Gold)*

*9th in US Doctorate Granting Institutions

Need 85 for Platinum

Sierra Magazine Cool Schools

2017 – 58th in US

2018 – 7th in US

Princeton Review Green Colleges

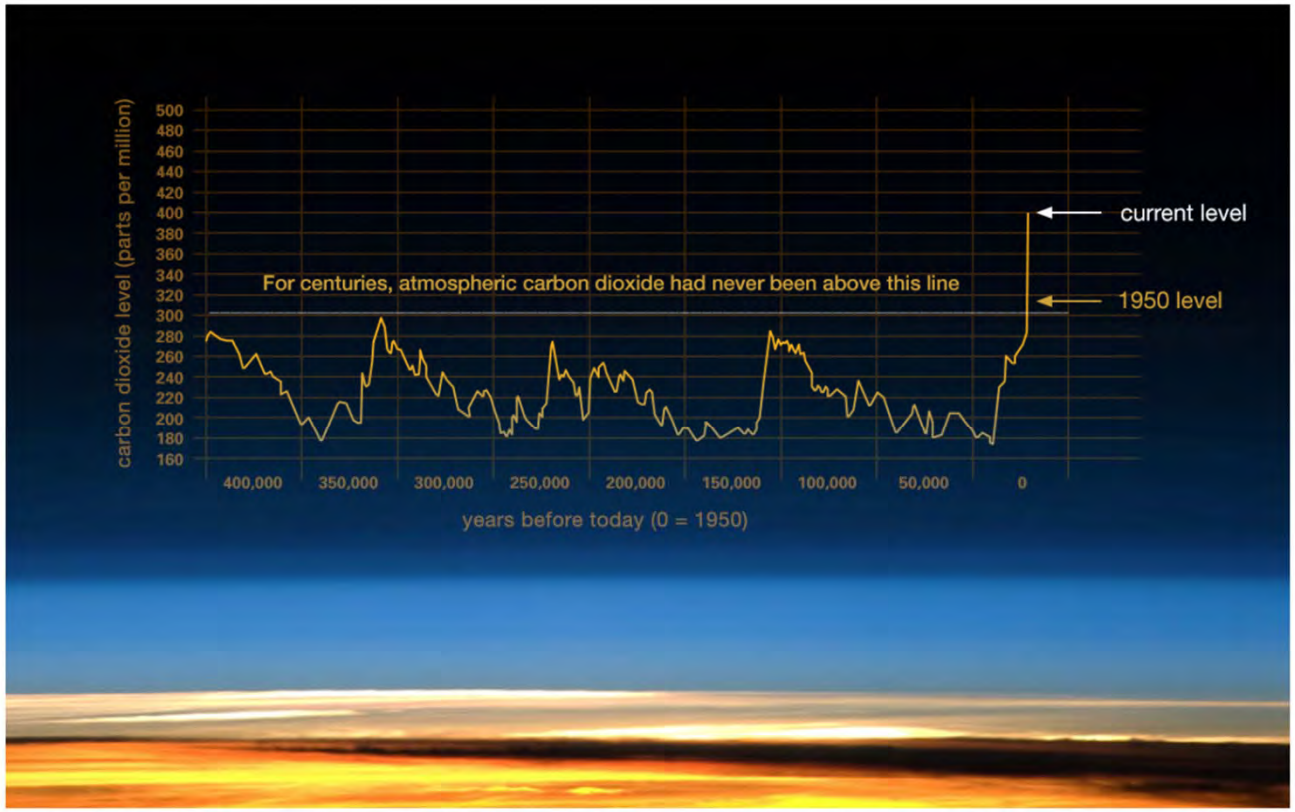
2017 – 42nd in US

2018 – 27th in US

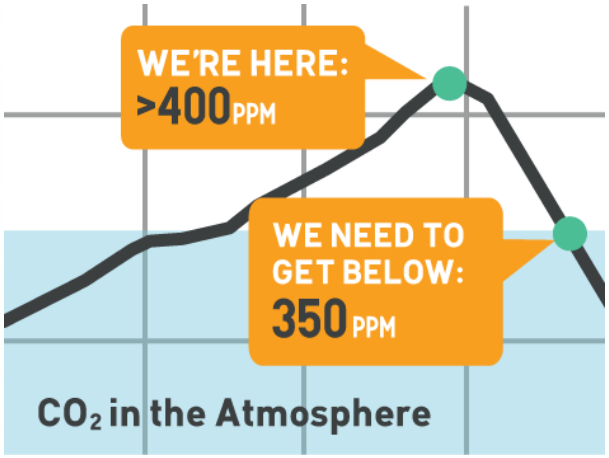

RECYCLE REX
©CA DEPT. OF CONSERVATION
Disney Educational Productions
1938
T. J. Hileman photo
Courtesy of GNP Archives
1981
Carl Key photo
USGS
1998
D. Fagre photo
USGS
2009
Lindsey Bengtson photo
USGS

The Hockey Stick/350

UMassAmherst



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Credit: Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO2 record.) Find out more about ice cores (external site).



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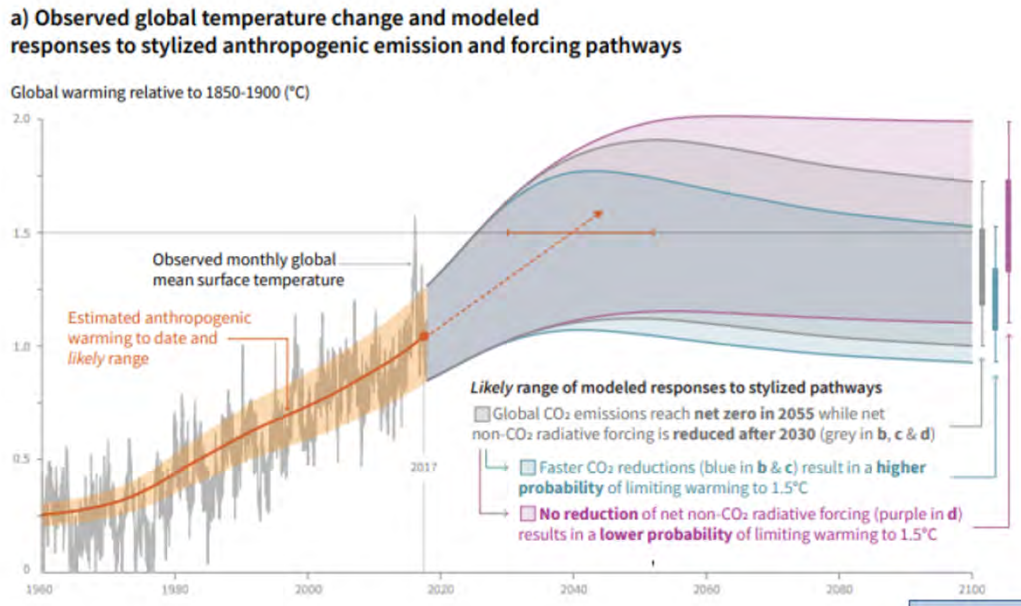
UN IPCC 2018 Report

UMassAmherst

- Human activities are estimated to have caused approximately 1.0°C (1.8° F) of global warming above pre-industrial levels
- **High confidence that global temperatures will increase to 1.5°C (2.7° F) above pre-industrial levels no matter what (between 2030 and 2052)**
- To avoid a 2°C increase, global net human-caused emissions of CO2 **would need to fall by about 45% from 2010 levels by 2030, reaching 'net zero' around 2050**



UN IPCC, 2018

UN IPCC 2018 Report

UMassAmherst

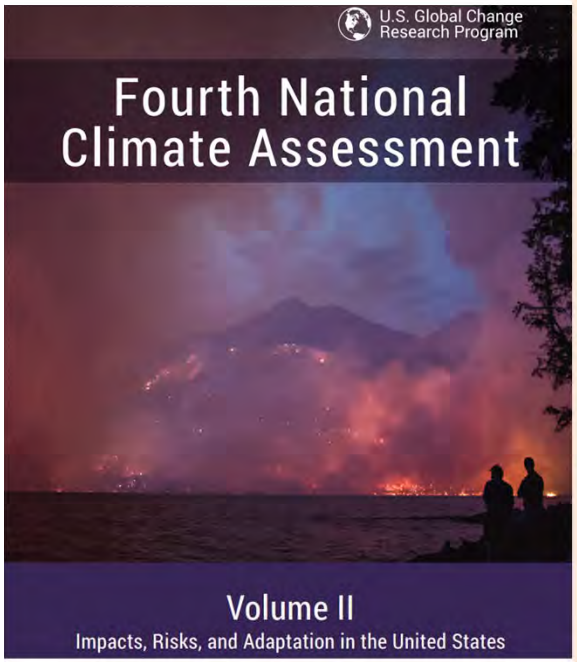
The Potential Impacts by 2100:

- Projections of global mean sea level rise (relative to 1985-2005):
  - If 1.5°C: 0.26-0.77 m (10.2 – 30.3 inches)
  - If 2.0° C: additional 0.04-0.16m (1.5 in – 6.2 in) **(or additional 14-20%)**
    - More warming also impacts rate of sea level rise (quicker rise = less time to adapt)
    - Likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5°C, compared with at least once per decade with 2°C
    - Marine ice sheet instability in Antarctica and/or irreversible loss of the Greenland ice sheet could result in multi-meter rise in sea level over hundreds to thousands of years – could be triggered around 1.5°C to 2°C of global warming
    - The risk of irreversible loss of many marine and coastal ecosystems increases with global warming, especially at 2°C or more
    - Coral reefs would decline by 70-90 % with global warming of 1.5°C, whereas virtually all (> 99 percent) would be lost with 2ºC

UN IPCC, 2018

Fourth National Climate Assessment

NCA, 2018

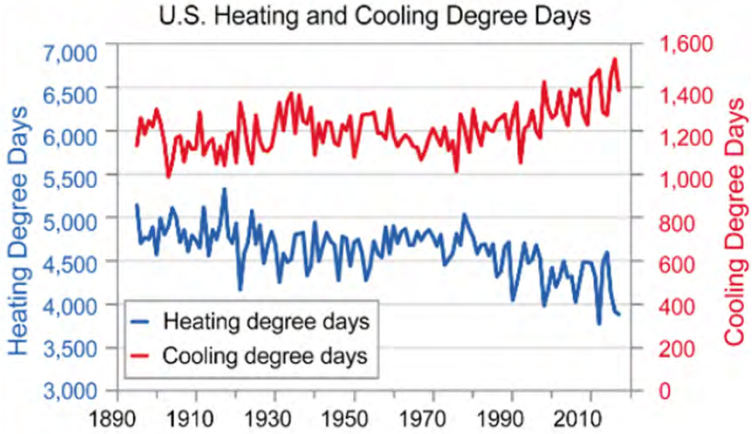


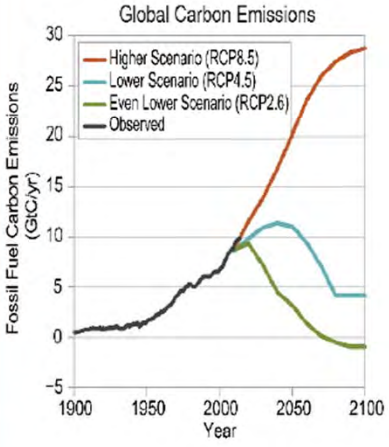
Report from 13 Federal Agencies

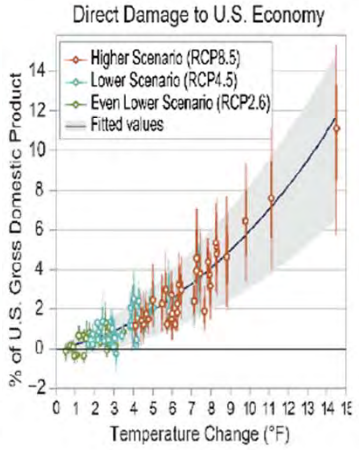
Actions to Reduce Risks:

- "While mitigation and adaptation efforts have expanded substantially in the last four years, **they do not yet approach the scale considered necessary to avoid substantial damages** to the economy, environment, and human health over the coming decades."

- "Because society is already committed to a certain amount of future climate change due to past and present emissions and because mitigation activities cannot avoid all climate-related risks, **mitigation and adaptation activities can be considered complementary strategies.**"







Climate Takeaways

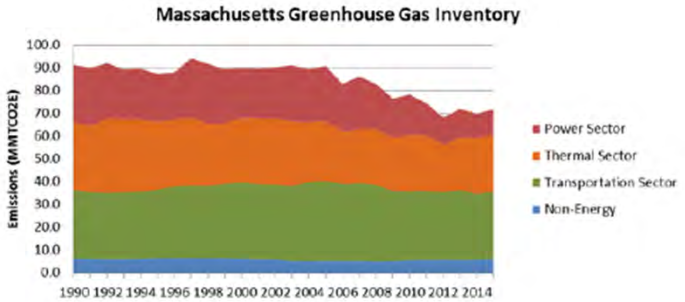
1. Climate Change is accelerating
2. Nothing can be done to completely stop future impacts
3. Adaptation strategies are and will be required
4. Mitigation is still critically important to avoid catastrophic environmental and economic damage

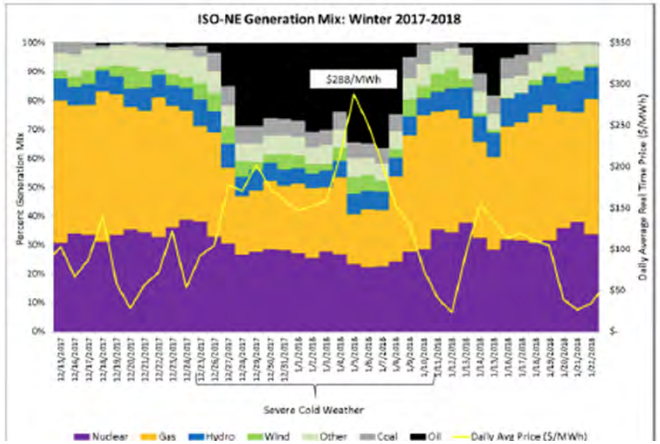
MA Comprehensive Energy Plan

Press Release, 2018

Some Key Findings:

- Electric generation contributes the fewest GHG emissions in MA and is also where we have made the greatest progress in reducing emissions
- NE states have some of the highest electric rates in the nation, however MA on path to become more competitive
- Region remains at risk for price spikes and emission increases during extended cold periods

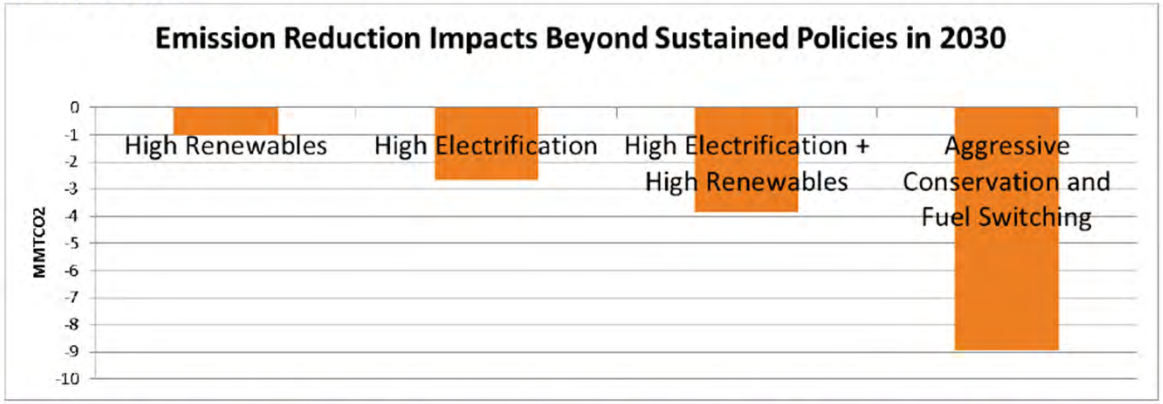




Findings: Impact on Emissions

UMassAmherst

- With sustained policies, Massachusetts estimated to achieve 35% emission reduction from 1990 levels by 2030 (~61 $MMTCO_2$); key findings for additional reductions:
  - Focusing policies primarily on the electric sector has diminishing returns, increasing rates with while realizing only modest decreases in GHG emissions
  - Electrifying the thermal and transportation sector leverages investments made in a cleaner electric grid
  - Conservation and peak demand reduction important as use of electricity for heating and transportation grows
  - Improving building efficiency is important to achieving reduced emissions in thermal sector
  - Alternative fuels, such as biofuels, can assist in transition to cleaner heating and transportation



Greatest amount of emissions reductions are achieved by combining increased use of clean energy in all sectors while simultaneously decreasing overall energy consumption


LEARN
LIVE
LEAD
Sustainable
UMASS

UMass by the numbers…

1,450 acres

13,500+ residents

30,000+ students

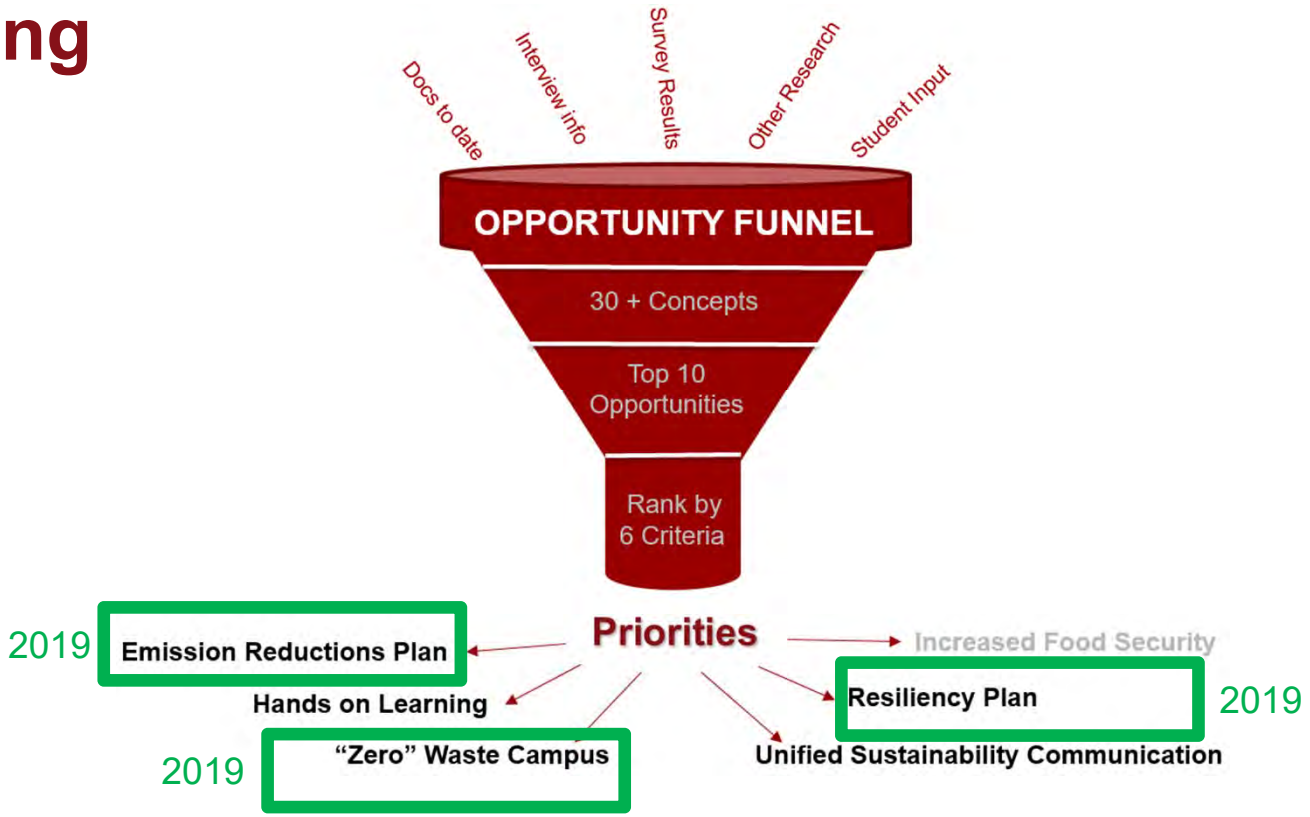
60,000 meals a day

13 million square feet of facilities

$214 million of research annually

University of Massachusetts Amherst

Planning


Docs to date
Interview info
Survey Results
Other Research
Student Input
OPPORTUNITY FUNNEL
30 + Concepts
Top 10 Opportunities
Rank by 6 Criteria
Priorities
2019
Emission Reductions Plan
Hands on Learning
2019
"Zero" Waste Campus
Increased Food Security
Resiliency Plan
2019
Unified Sustainability Communication


ACADEMICS

UMassAmherst

Sustainability Curriculum Fellowship


IT'S WRONG TO PROFIT FROM WRECKING THE CLIMATE
Whose Side?
INVEST in JUSTICE
WHOSE SIDE ARE YOU ON?
STUDENT POWER


IDEA FUNDING
SUSTAINABILITY
INNOVATION AND
ENGAGEMENT
FUND


FOOD SYSTEMS

Food

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UMASS DINING

UMassAmherst

UMassAmherst

Rated #1 Best Campus Food by the Princeton Review

- Sustainability
- Health & Wellness
- Customer Service
- Culture of Innovation

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By the Numbers

- Largest foodservice program in the country (by revenue)
- Independently operated and self-supporting
- Serves over 60,000 meals daily
- The most awarded campus dining program in the nation

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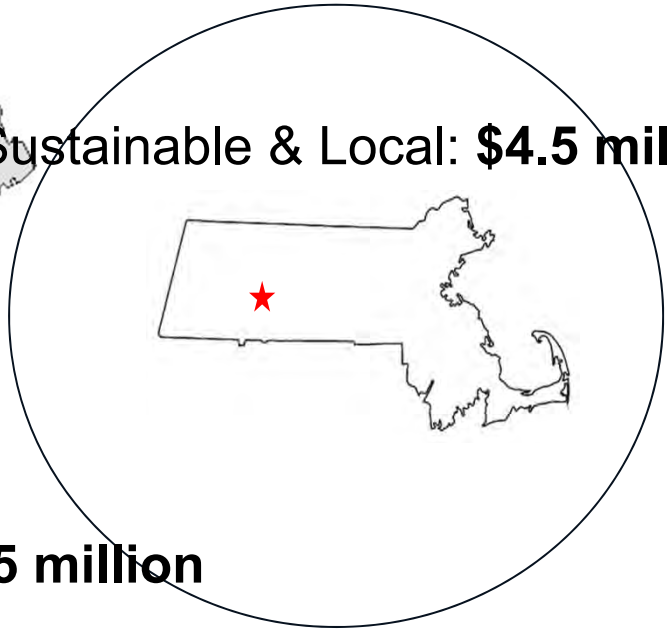
Sustainable & Local Purchasing in FY16

Massachusetts: **$2 million**

Sustainable & Local: **$4.5 million**



ALL New England: **$3.5 million**

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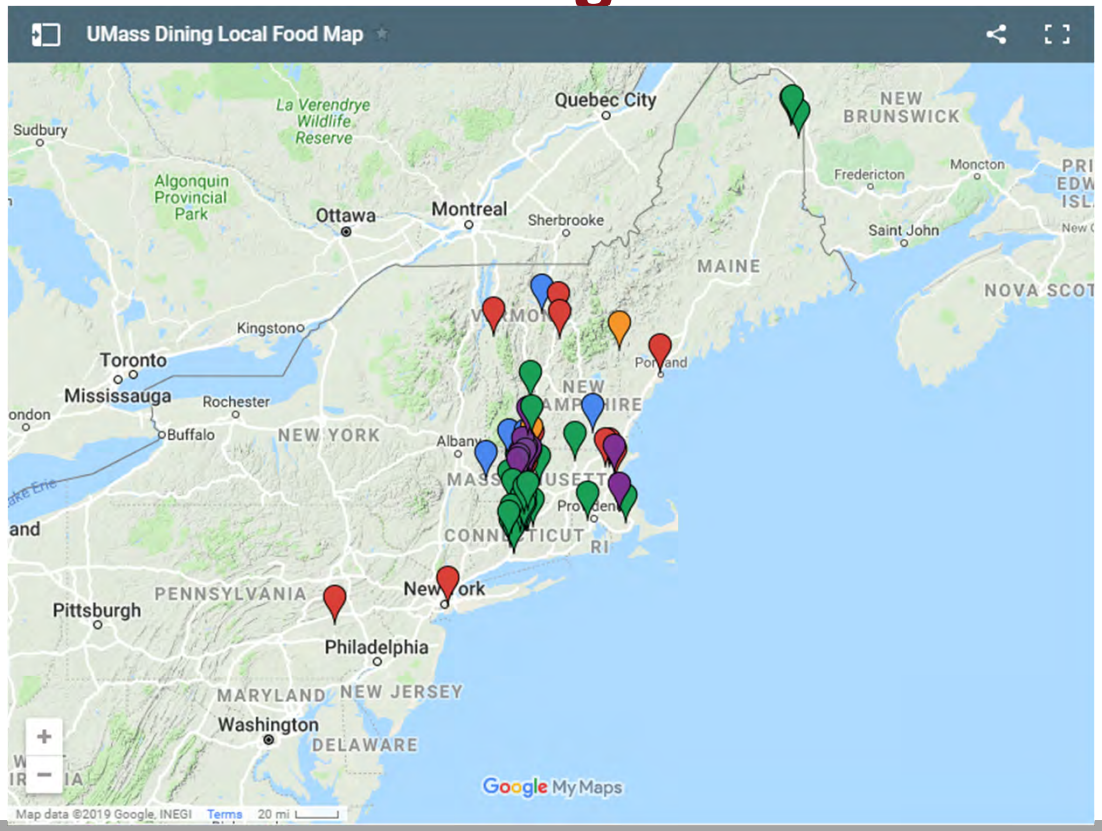
100 + Local & Regional Vendors



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UMass Permaculture

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Kendall Foundation Grant

Lean, Local, Low Carbon Proteins

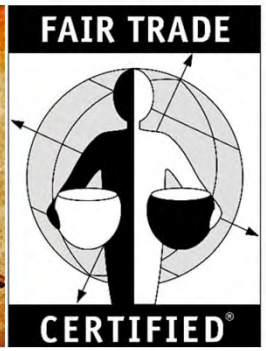
- Increased plant based menu items by 30%
- Decrease pork and beef
  - 50/50 mushroom & beef blended burgers
- Doubled our purchasing of local poultry
- Increase sustainable/underutilized seafood

What is Real Food?

UMassAmherst

Community-based

real food challenge



Fair Trade

Humanely-raised

Ecologically-Sound

Student Farm

UMassAmherst


WASTE SYSTEMS
MARTIN'S FARM

Amherst

ANNUAL COMPARISONS				
	12 Months Ending 6/30/18	12 Months Ending 6/30/18	12 Months Ending 6/30/17	12 Months Ending 6/30/17
	Tons	*Percent Share*	*Tons*	*Percent Share*
Animal Bedding	940.5	11.6%	904.8	11.1%
Ballasts, PCB	1.3	0.0%	2.5	0.0%
Batteries	5.6	0.1%	7.75	0.1%
Books	13.1	0.2%	8.8	0.1%
Cardboard	526.4	6.5%	550.8	6.8%
Clothing & Reused Furniture	10.0	0.1%	15.0	0.2%
Concrete	253.1	3.1%	343.8	4.2%
Electronic Scrap	71.5	0.9%	76.9	0.9%
Fluorescent Tubes	6.4	0.1%	4.5	0.1%
Food Waste	1,616.6	20.0%	1,535.9	18.9%
Mattresses	4.8	0.1%	12.6	0.2%
Greenhouse Waste	33.2	0.4%	45.3	0.6%
High Grade Paper	39.6	0.5%	44.1	0.5%
Leaves/Yardwaste	322.3	4.0%	322.0	4.0%
Plastic, Bulky	4.3	0.1%	6.4	0.1%
Single Stream Recyclables	543.2	6.7%	503.4	6.2%
Paint	4.4	0.1%	4.0	0.0%
Scrap Metal	489.2	6.0%	452.8	5.6%
Toner Cartridges	4.0	0.0%	4.1	0.1%
RECYCLABLES TOTALS	4,889	60.3%	4,845	59.6%
REFUSE TOTALS	3,213	39.7%	3,278	40.4%
GRAND TOTALS	8,103	100.0%	8,124	100.0%

Food Waste / Composting

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Single Stream Recycling

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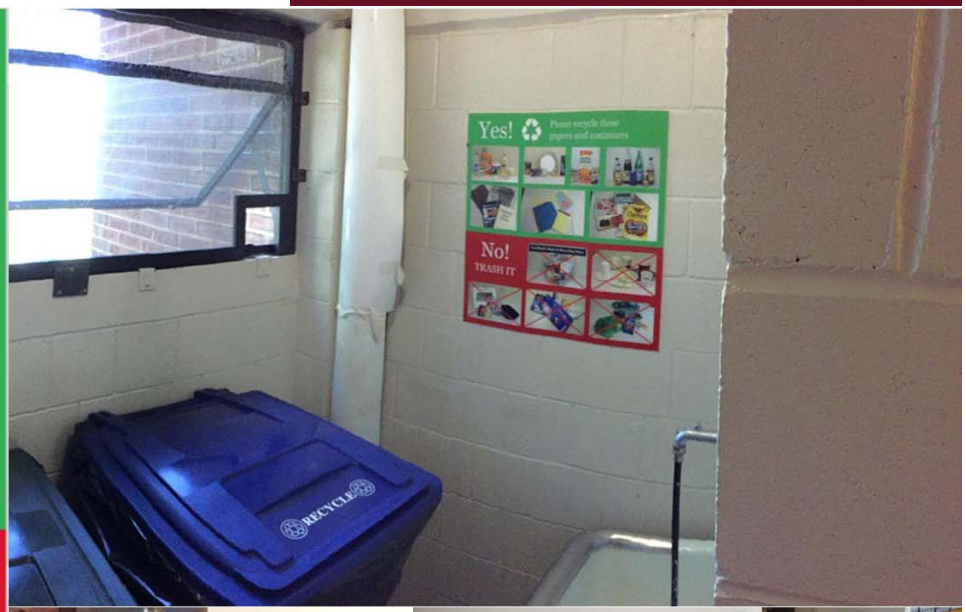
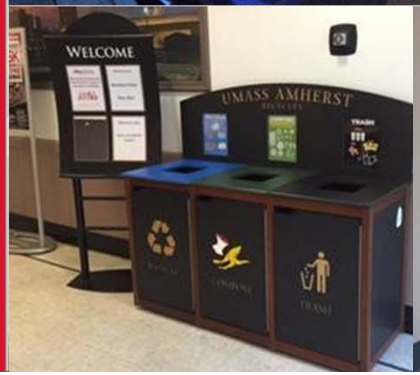




Waste Reduction Events

UMassAmherst

CNS College Day Barbecue

New2U – Move In / Out

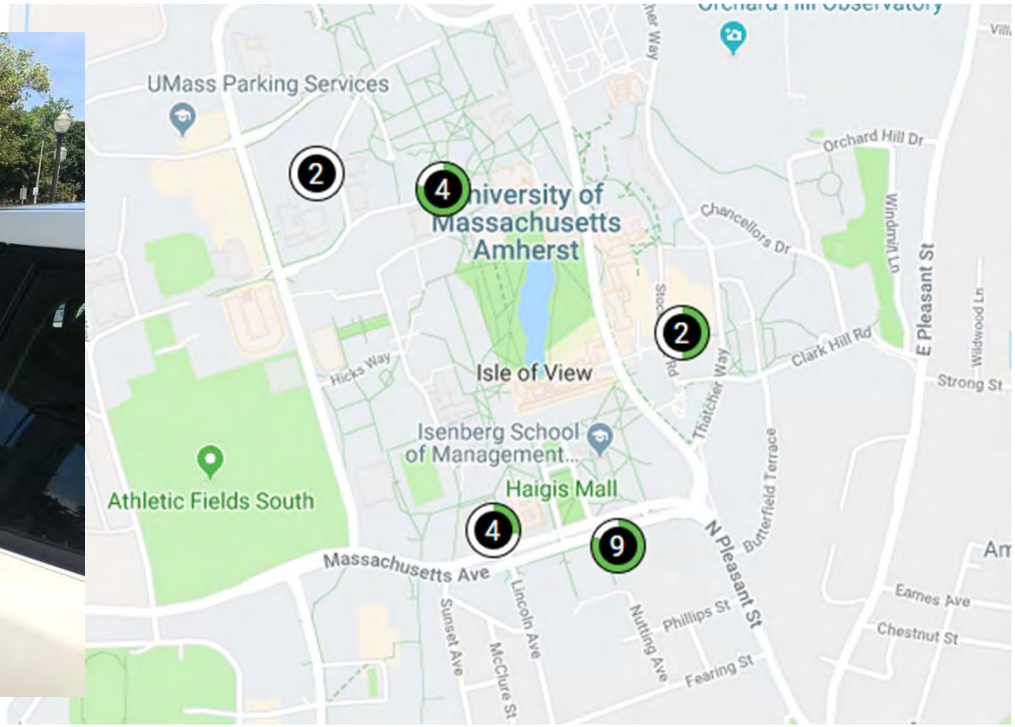
TRANSPORTATION SYSTEMS

PIONEER VALLEY BIKE SHARE

UMassAmherst

pvpc City of Northampton Massachusetts · UMassAmherst · Massachusetts Amherst The place to visit, live and work. · Town of South Hadley Massachusetts · HOLYOKE

EV Infrastructure



Commuting and Carsharing…

UMassAmherst

zipcar®

nuride

Commuter Options

About

The UMass Commuter Options Program will help you get to campus. Mixing up your trips by using public transit, bicycling, walking, carpooling or... more

Carpool and Rideshare

Carpool permits are available to UMass employees and students who regularly share rides to the University. If you are looking for a carpool... more

Clean Vehicle Permits

Discounted parking permits are available for select hybrid, electric, compressed natural gas (cng), liquefied petroleum gas (lpg), and bi-fuel... more

Emergency Ride Home

No one wants to be stuck at work in an emergency. Staff and faculty who commute via walking, bicycling, carpooling, or public transportation at... more

NuRide

Get Rewards for Greener Trips

Join NuRide and get rewards when you walk... more

Van Pools

The UMASS Commuter Options Program (COP) has partnered with MassRides in facilitating the... more

Bicycle Commute Program

UMass works to promote bicycling as a healthy, environmentally friendly way of getting around campus and the surrounding towns. These efforts are... more


GREEN BUILDING

LEED Buildings

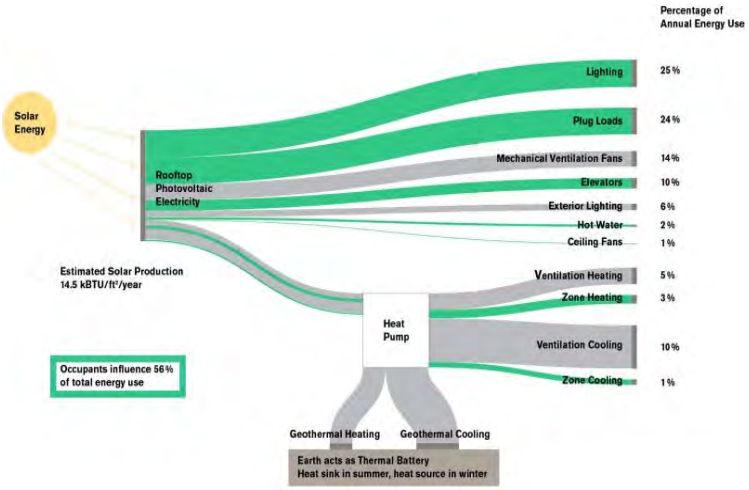
UMassAmherst

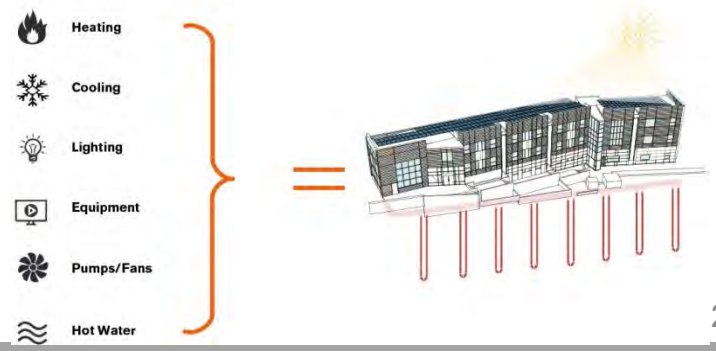
LEED Certified Projects

Building Name	Certification Date	LEED Certification	LEED GSF
George N. Parks Minuteman Marching Band Building	4/1/2012	V2.2 LEED Gold	21,424
UMass Police Station	5/1/2012	LEED V2.2 Gold	27,250
CNS Greenhouses	1/28/2013	LEED v2009 Gold	15,555
Hampshire Dining Commons	7/1/2014	LEED v2009 Gold	46,001
McGuirk Stadium & Football Champions Center	10/1/2014	LEED v2009 Gold	52,960
Life Sciences Laboratories	7/1/2015	LEED Gold	231,006
Commonwealth Honors College Residential Complex	10/23/2015	LEED v2009 Silver	512,485
Lincoln Campus Center Dining Renovations	9/13/2016	LEED Retail CI 2009 Gold	35,095
Integrative Learning Center	12/9/2016	LEED v2009 Gold	172,970
Paige Laboratory Renovations	2/17/2017	LEED v2009 Silver	26,500
Chapel Renovation	5/8/2017	LEED v2009 Gold	13,296
Total LEED Certified GSF			**1,154,542**
Percentage of total campus GSF			8.9%

Zero Net Energy Buildings

UMassAmherst






ENERGY & EMISSIONS

UMassAmherst

UMass Energy System by the Numbers

150M – the number of kWh that UMass generated or purchased in FY18

$0.07 – the blended cost per kWh of that electricity above

1.2B – pounds of steam generated annually at the CHP

14 – MW of electricity that the two generators at the CHP can produce

26 – miles of campus steam distribution pipelines under the campus

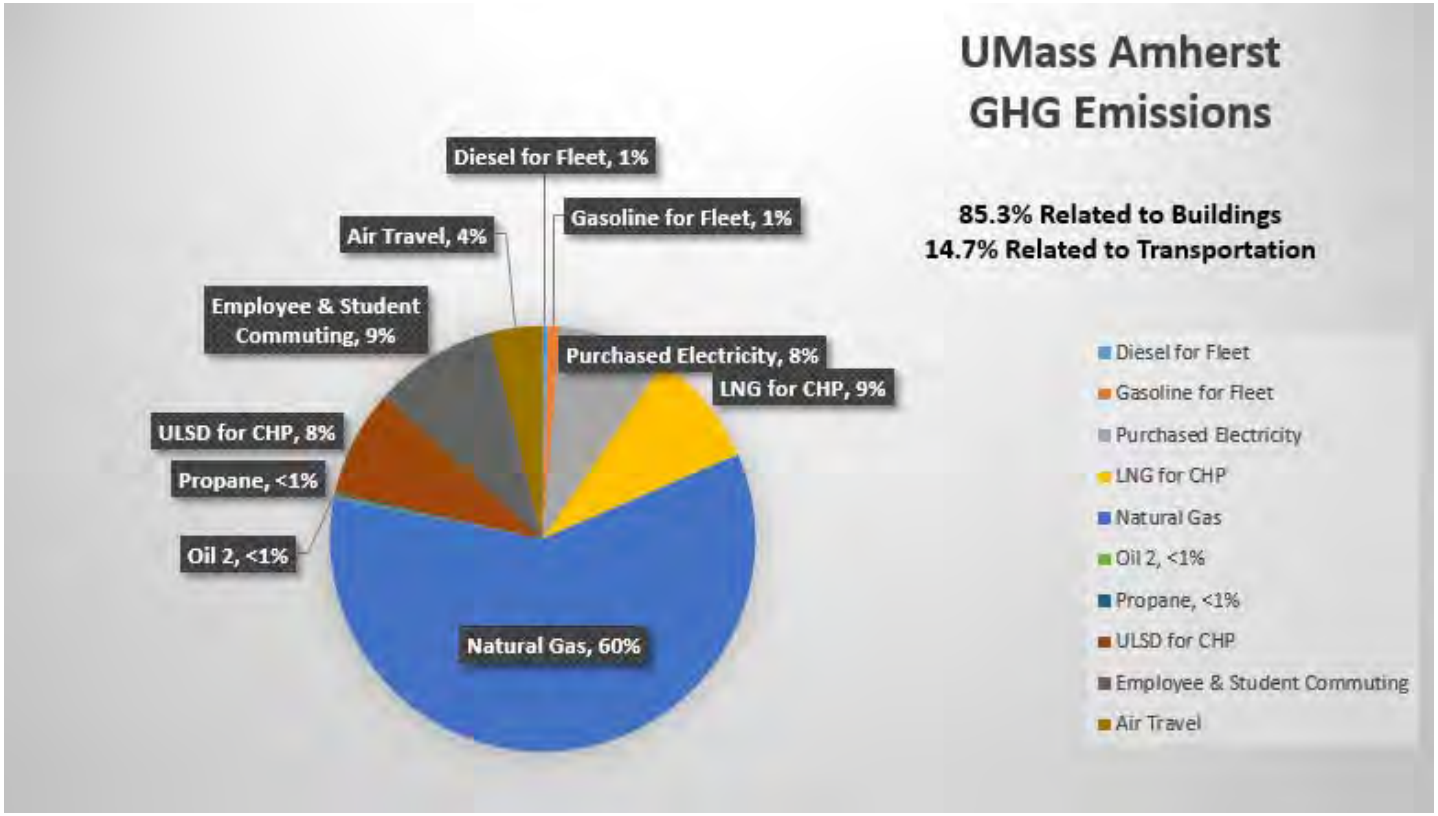
5.5 – MW of solar electricity capacity installed on the campus by 2018

~13M – Total square footage of building space on campus

17M – Therms of natural gas that UMass consumed in FY18 (1 therm = 1.055×10^8 joules)

UMassAmherst

Emissions Inventory



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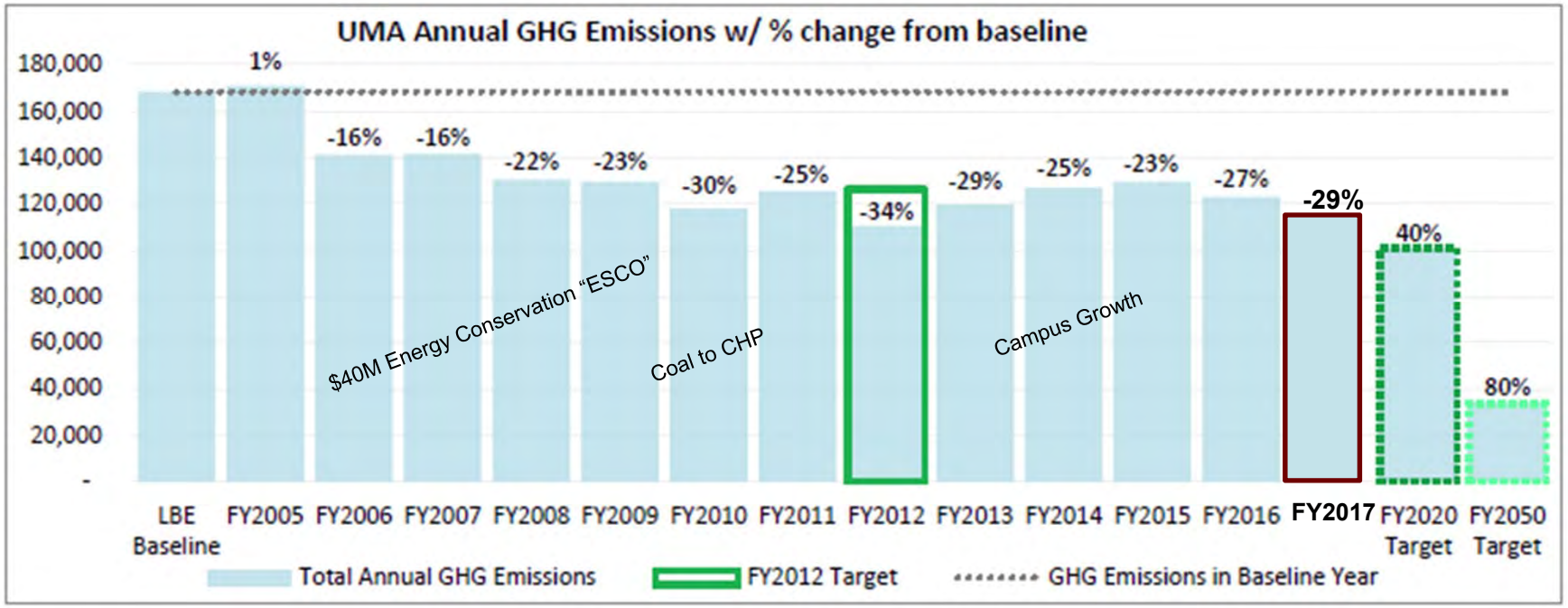
Emissions, a short history…



Energy Conservation

UMassAmherst

Energy solutions – customer example
University of Massachusetts Amherst

The challenge: Make campus-wide improvements to reduce energy costs and meet sustainability goals.

The solution: Comprehensive energy and water conservation improvements with $40 million worth of retrofits and upgrades.

Benefits to customers:

- **$55.5 million of savings over the 10-year contract term**
- **Received the Massachusetts Environmental Purchasing and Sustainability Award**

38
Number of energy conservation measures implemented at UMass Amherst to reduce deferred maintenance and improve the learning environment.

21,000 metric tons
Reduction in carbon dioxide emissions in fiscal year 2009.

Johnson Controls' comprehensive energy solutions enabled the University to implement improvements to create learning environments that foster academic excellence.

http://www.makeyourbuildingswork.com/

13 Johnson Controls

Johnson Controls

Fuel Switching

UMassAmherst

Solar Energy

UMassAmherst

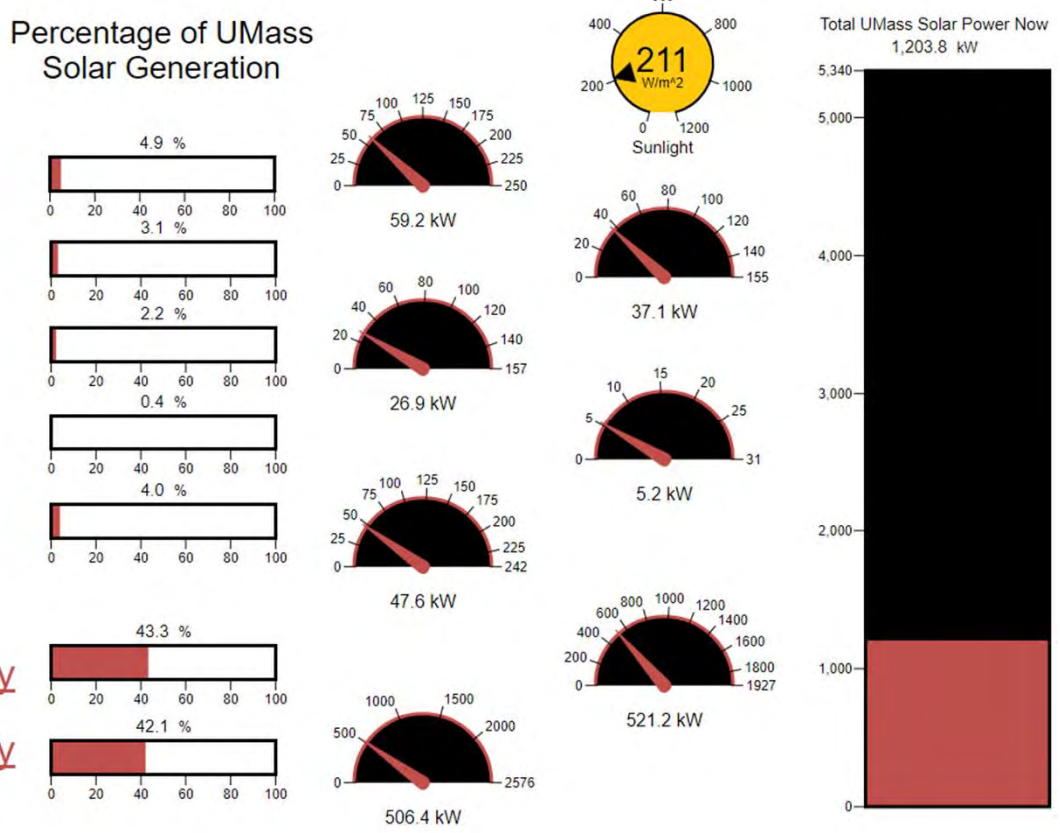
Sustainable UMASS

Roof-Mounted Solar Systems:

- UMass Amherst Champions Center
- UMass Amherst Computer Sciences
- UMass Amherst Fine Arts Center
- UMass Amherst Police Station
- UMass Amherst Recreation Center

Parking Canopy Solar Systems:

- UMass Amherst Lot 25 Parking Canopy
- UMass Amherst Lot 44 Parking Canopy



Battery Storage Coming Soon…

UMassAmherst

News & Media Relations

News Archive | Inside UMass | Experts and Media Resources | Video Services | Contact U

UMass Amherst Receives $1.1 Million Grant for Large Battery Project to be Built with Tesla

December 7, 2017


UMass Amherst Central Heating Plant

AMHERST, Mass. – The University of Massachusetts Amherst has been awarded a $1.1 million state grant from the Advancing Commonwealth Energy Storage (ACES) project to work with Tesla Energy to construct a large battery at the Central Heating Plant on the west side of campus. The award was announced today by Gov. Charlie Baker.

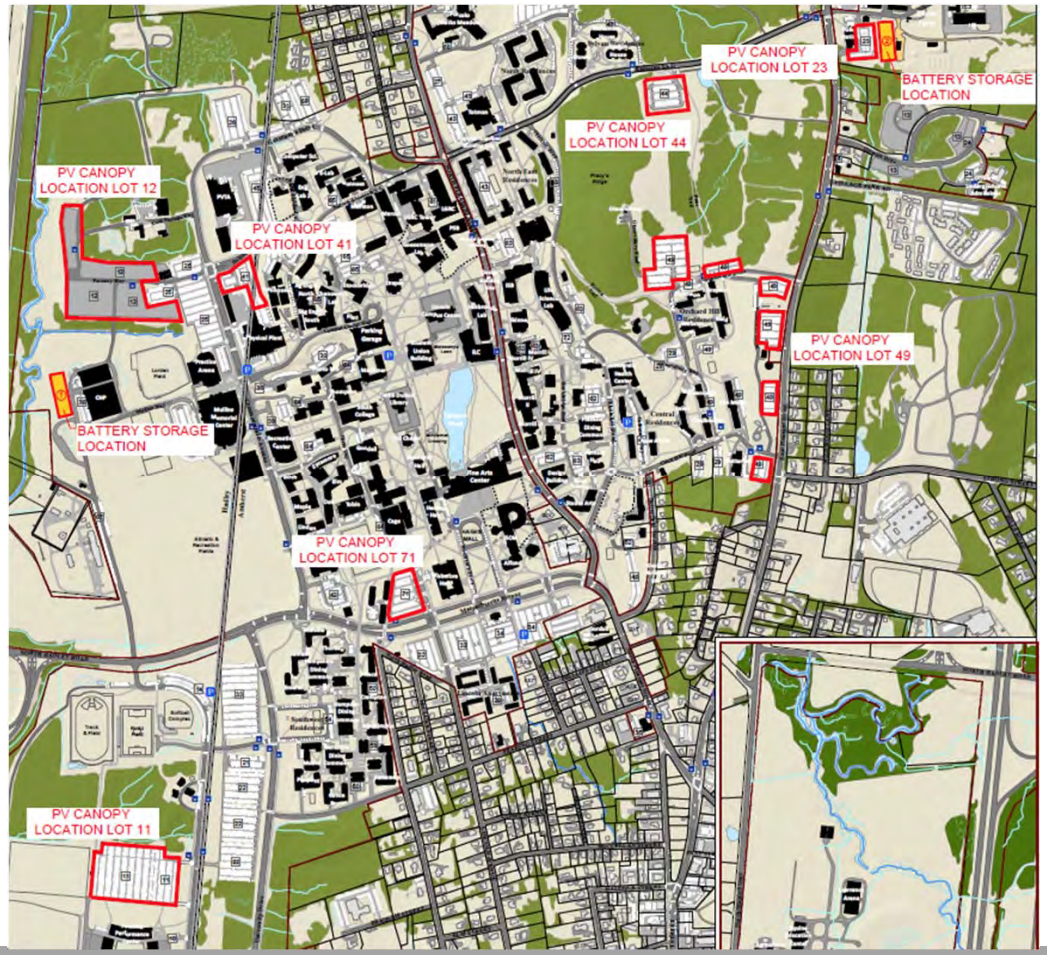
The project involves a 1 megawatt/4 megawatt-hour lithium ion battery storage system that will be designed and constructed by Tesla Energy adjacent to the campus power plant. Working with Tesla and the UMass Clean Energy Extension (CEE), the goal is to reduce peak energy demand on the Amherst campus and related costs. The battery storage system will provide power that would otherwise be purchased from the power grid at premium rates, will help optimize how the campus integrates its current mix of power generation and will provide a research site for clean energy experts, researchers and students.

Baker announced the award of 26 grants totaling $20 million at an event in Marlborough. "The development and deployment of energy storage projects will be vital to the Commonwealth's ability to continue leading the nation in energy efficiency," Baker said. "Funding these storage projects is an investment in our energy portfolio that will reduce costs for ratepayers and help create a clean and resilient energy future."

Shane R. Conklin, associate vice chancellor for facilities and campus services, said, "This project is an excellent example of how collaboration between academic research and facilities operations increases benefits to the campus and our students. Not only will we see utility budget savings, our project will provide on-campus data to support research, and Tesla will provide $80,000 of educational initiatives for our students."

More Canopies and Storage…

UMassAmherst



Solar Massachusetts Renewable Target (SMART)

MA's New Solar Incentive

More Energy Efficiency

UMassAmherst

UMass Amherst, Eversource Sign Second Agreement for Energy Efficiency Partnership

July 28, 2017
Contact: Larry Rivais 413/545-0444

AMHERST, Mass. – The University of Massachusetts Amherst and Eversource have signed a three-year memorandum of understanding continuing their energy-efficiency partnership with the goal of saving the university $1.8 million in energy costs annually.

The non-binding agreement runs through the first half of 2020 and includes a tentative list of campus projects in which Eversource will participate as an energy advisor. This is the second such agreement setting actions and commitments for the two parties. The first was signed in 2014.

"We are pleased to renew this important part of our working relationship with Eversource," said Andrew Mangels, vice chancellor for administration and finance. "The partnership has already contributed significantly to reducing electrical consumption on campus, and it has supported the UMass Amherst commitment to sustainability, reduced carbon emissions and responsible use of energy."

Under the second agreement, as the first, UMass Amherst will collaborate with Eversource early in the design of new construction and major renovations to achieve significant energy savings. In addition, Eversource will help the university secure incentives to offset the cost of new projects.

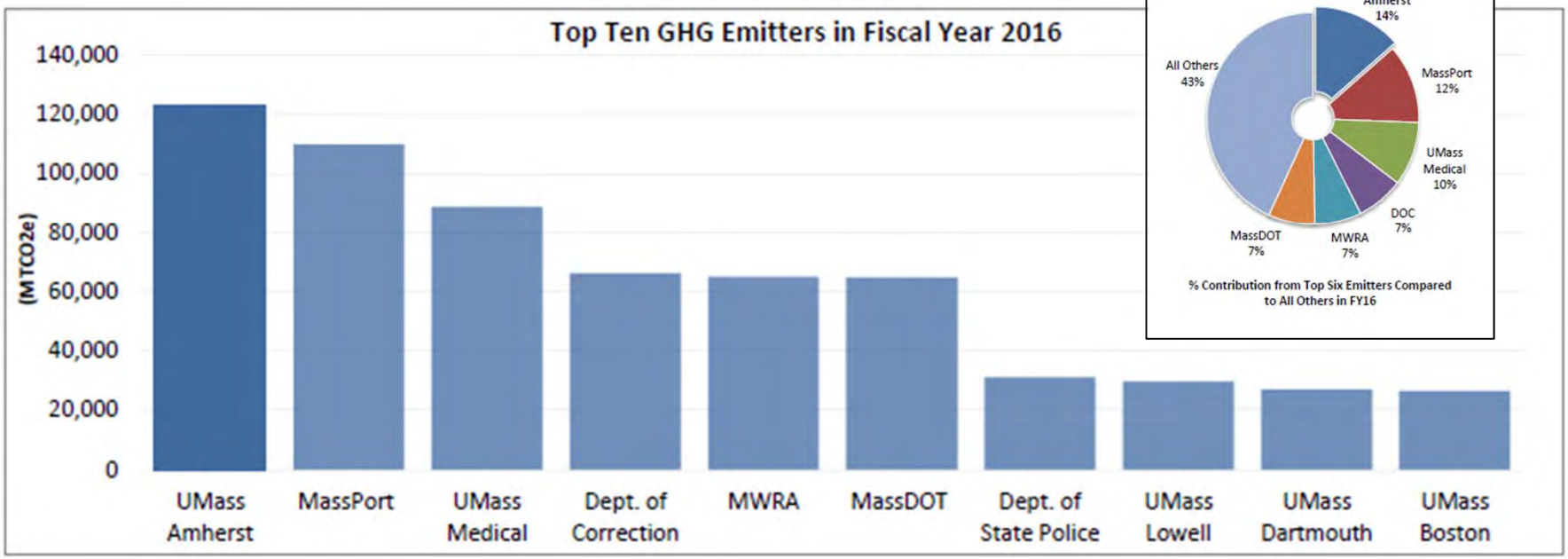
"UMass Amherst has been a shining example of efficient and sustainable growth," said Eversource Vice President of Energy Efficiency Tilak Subrahmanian. "We are excited to announce our ongoing collaboration, which will help the university continue to cut energy costs, grow efficiently and contribute to a cleaner and healthier state environment."

UMass Amherst and Eversource are currently working together on a series of improvements across campus including additional campus-wide LED upgrades, enhancements to HVAC systems, and the continuation of its Green Labs initiative, which targets research labs on campus to reduce ventilation airflow and energy usage while improving lab safety.

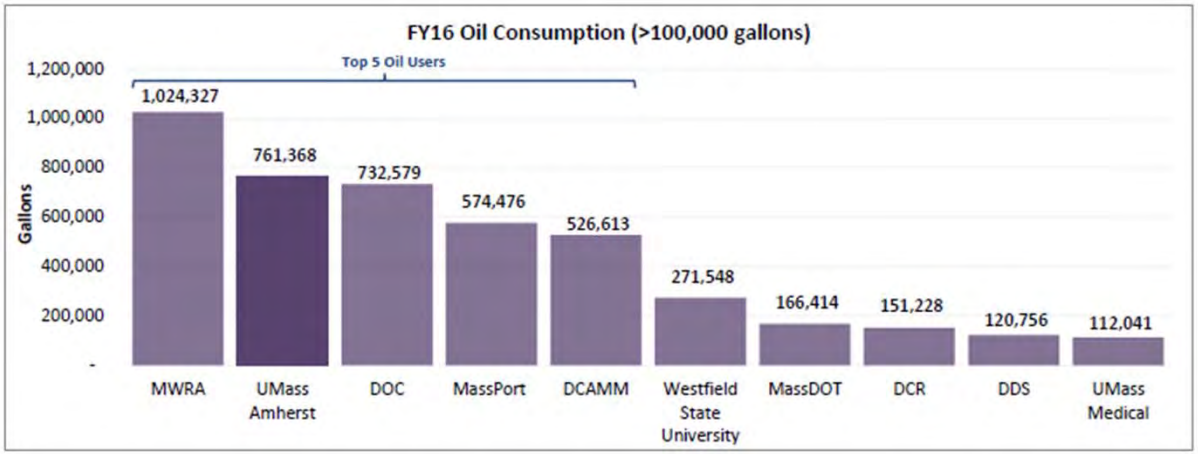
Through first year:

- 50+ projects
- Total Annual Savings: $2M+
- 5M+ kWh saved
- Over 2,000 tons of emissions reduced

Challenges - Scale

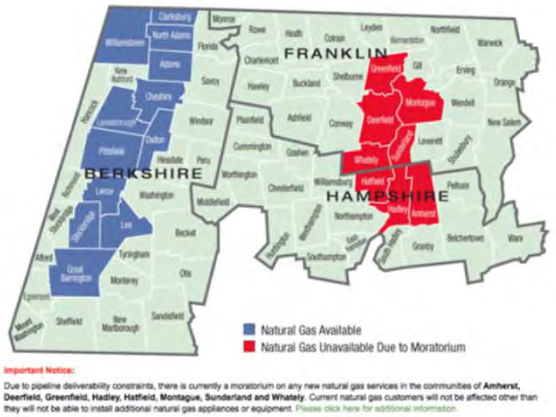


Challenges – Regional context



Massachusetts regulators approve Berkshire Gas 5-year plan, while insisting company must work to lift moratorium

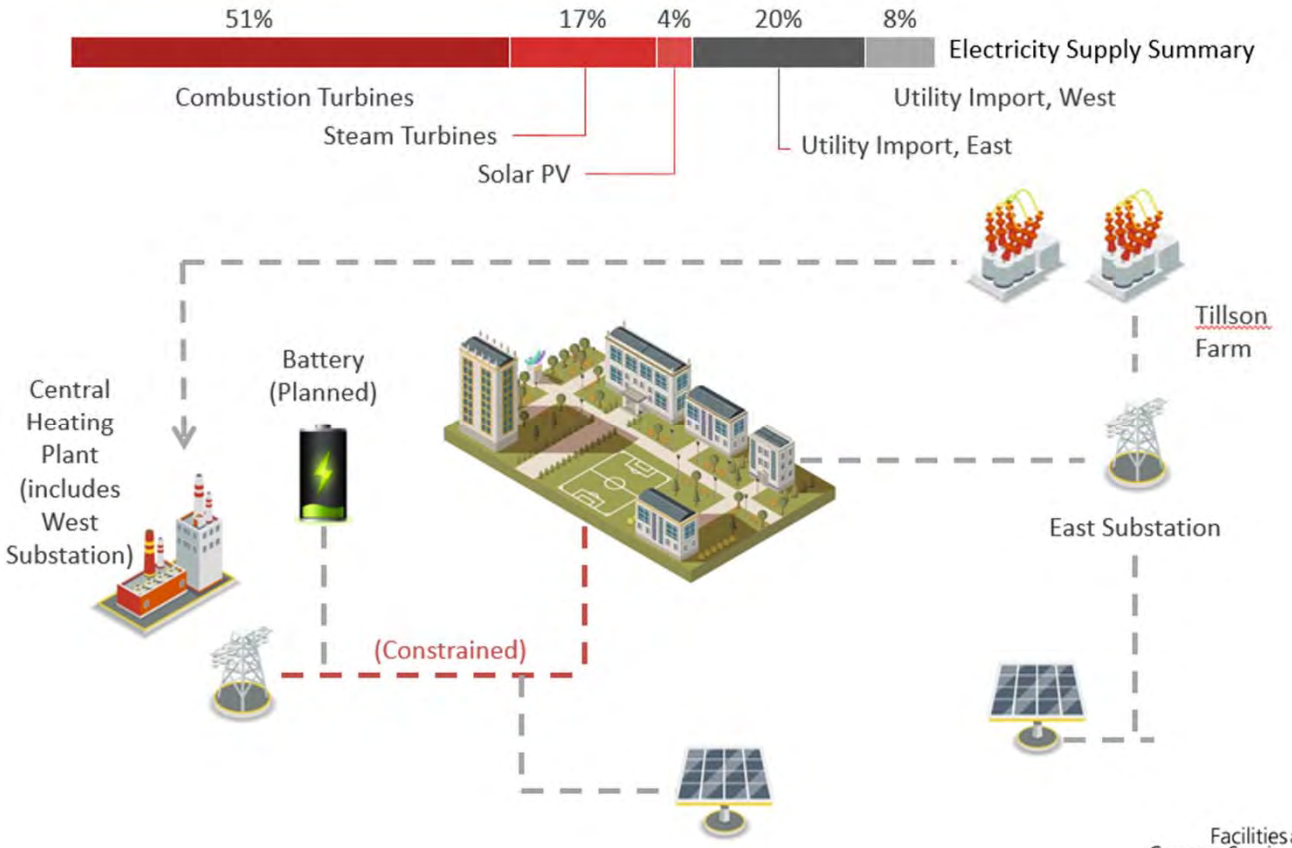
Updated Jul 11, 2017; Posted Jul 11, 2017



Berkshire Gas has issued a moratorium on new or expanded service in eight towns, citing pipeline constraints. (Berkshire Gas)

Current Campus Micro-Grid

UMassAmherst



Facilities & Campus Services

Steam Load Growth Challenge

UMassAmherst

Central Heating Plant

The Central Heating Plant is the sole source of heating steam to the campus.

- **N+1 Reliability**
  - The steam generation capacity assuming the loss of the largest single asset.
  - Currently a UMA Resiliency Criterion
  - Risk increases as the N+1 operating value is approached.

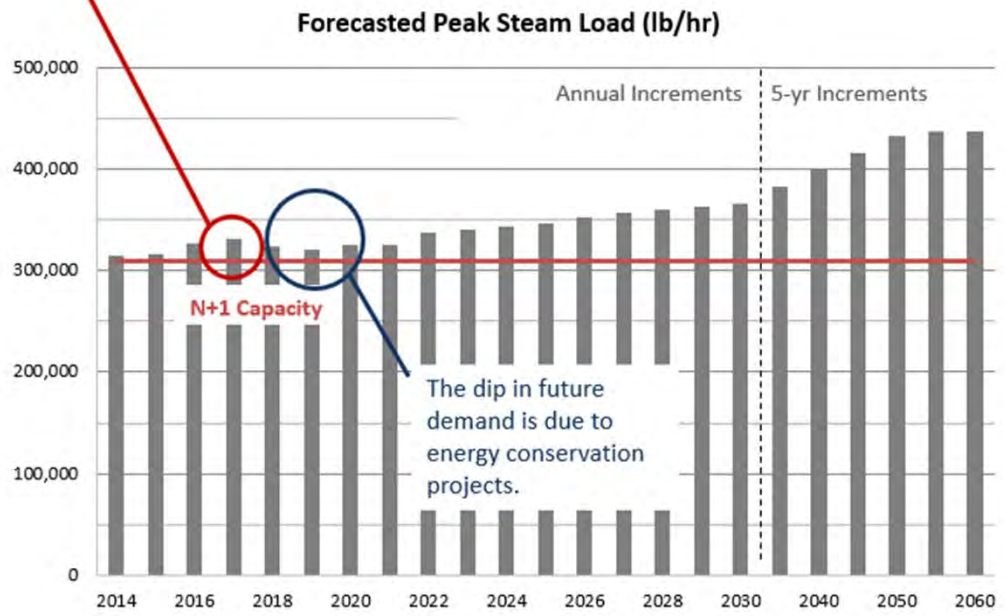
- **Impacts of Steam Shortage**
  - Research Losses
  - Damaged HVAC Coils
  - System Restoration Not Swift
  - Partial or Complete Building Shutdowns

Steam Load Growth Challenge

UMassAmherst

- The peak campus steam load in January, 2018—without students on campus—was 300 kpph. The estimated peak had students been on campus is 330 – 340 kpph.

- The current Steam Production Capacity on N+1 Basis is 310 kpph.



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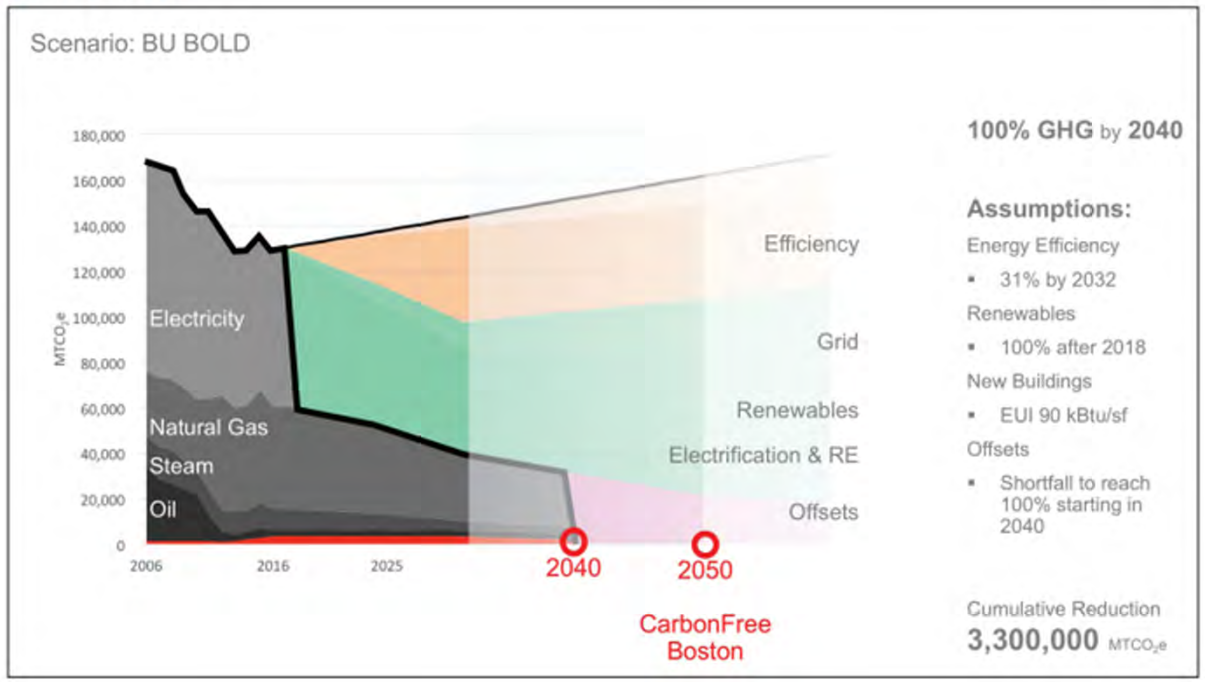
UMass Carbon Mitigation TF

- Develop RFP and hire consultant to provide technical advice
- Develop detailed and innovative plan that meets or exceeds state legislation.
  - Analyze energy and emissions impacts of current/planned sustainability efforts and capital development/regional energy policies/physical restraints now and into near-future 2018-2025.
  - Explore long term mitigation strategies, procurement initiatives, development and budgetary policies, and emerging technologies for campus to pursue 2025-2050.
  - Set ambitious and achievable scope I & II emission reduction goals
  - Examine what needs to be done to fully understand and mitigate scope III
- Identity how actions can integrate with academic mission
- Complete plan within 18 months

Carbon Mitigation Planning…

e.g. BU

FIGURE 9: BU BOLD



Boston University Wind PPA

UMassAmherst

- BU entering into 15-year power purchase agreement (starts 2020)
- 205,000 MWh wind power PPA helps providing financing to build South Dakota wind farm
  - Contract provides guaranteed price to wind developer while BU can see financial benefit in wholesale market when prices rise
  - BU will earn RECs to be used against BU's GHG emissions
  - BU: "Buying power outside of its New England backyard gives BU added punch against climate change because the power grid in the upper Midwest is far more reliant on environmentally harmful fossil fuels than New England's."

Statement from the Amherst College Board of Trustees, January 29, 2019

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Dear Members of the Amherst College Community,

Amherst College today announces the adoption of a Climate Action Plan that sets a goal for the College to achieve carbon neutrality by 2030. At its January 25-26, 2019, meeting, the Board of Trustees unanimously approved the College's plan, which is consistent with Amherst's strategic plan and the Board's 2015 Statement on Sustainability and Investment Policy and follows President Biddy Martin's recommendation to the Board.

Over the past few years, a College task force of students, faculty and staff has developed this roadmap, with the support of leading outside experts and engagement with other major colleges and universities with demonstrated success in climate action. The task force concluded that an energy system transformation would be necessary to achieve reductions that are desirable, necessary and real. This transformation will involve changing the campus energy infrastructure from a traditional fossil-fuel powered steam system to renewable electrical-powered heat pumps that use geothermal energy sources. The plan does not rely on the purchase of carbon offsets.

Amherst's commitment to responsible environmental stewardship is not new. We have already taken significant measures in support of climate action, resulting in a 30 percent reduction of the College's carbon footprint over the past 10 years. The College adhered to industry-leading, high-efficiency energy standards in the design and construction of our new state-of-the-art science center and residence halls. Those designs also anticipated a major transformation of our current energy system and included infrastructure for the energy conversion option we will now pursue. Amherst's recent establishment of and investment in a renewable energy solar project to replace all of our current grid-sourced electricity with solar power by 2020 will reduce our carbon output by a further 17 percent.

An essential element of the Climate Action Plan engages our students. Amherst recognizes the urgent need to educate graduates who will lead change on a much larger scale. The College's Department of Environmental Studies continues to expand and, working with the Office of Environmental Sustainability, provides co-curricular experiences, summer research projects and internships to develop informed and innovative leaders. President Martin intends to establish an advisory committee of faculty, staff and students to consider key issues in implementing the Climate Action Plan, and

WWW.UMASS.EDU/SUSTAINABILITY