A journey towards sustainability through demand side energy conservation efforts

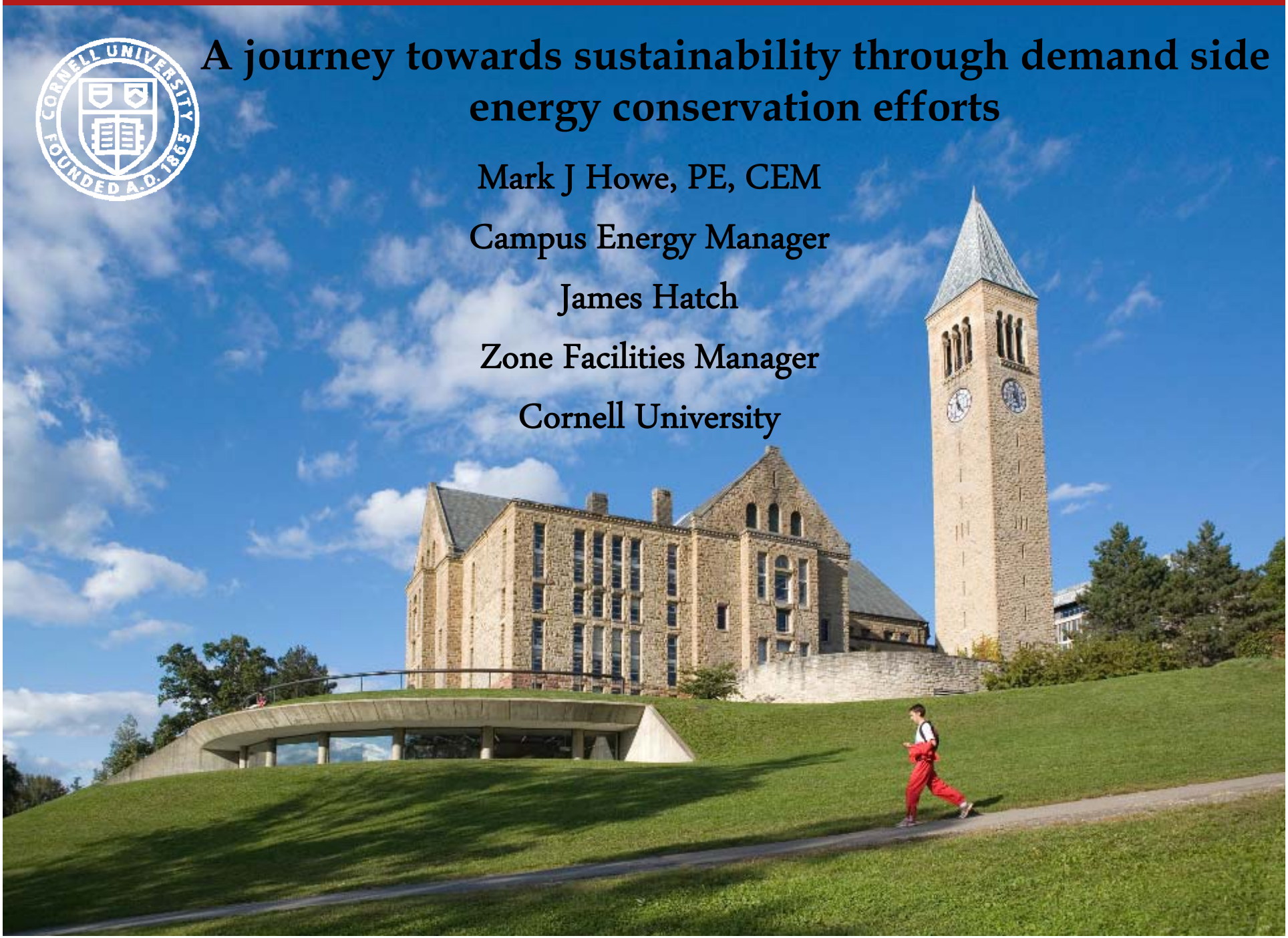
Mark J Howe, PE, CEM

Campus Energy Manager

James Hatch

Zone Facilities Manager

Cornell University



Agenda

- Cornell Climate Action Plan
- Overview of Cornell energy use
- Energy conservation program
- Retro Commissioning Program
- Sustainable Human Ecology Program
- Questions

Climate Action Plan

Making Climate Neutrality a Reality

- Actions to eliminate greenhouse gas emissions, broaden academic research, and enhance educational opportunities and outreach efforts by the year 2050.
- Cornell's Climate Action Plan (CAP) promotes the education and research needed to generate solutions for the challenges of global warming —and will demonstrate these solutions in campus operations.

Climate Neutrality by 2035

- Broad vision for the campus.
- Lab ventilation constitutes about 50% of the $60 million energy costs per year.
- Cornell's fume hood exhausts represent about 15% of Tompkins County's carbon footprint.
- Ventilation is the largest user of energy in labs.
  - One fume hood = 3 households annual energy usage.
  - Lowering your fume hood sash is both safer and conserves energy.
- Cold storage of samples is the second largest use of energy.

Climate Action Plan

Four Tiered Strategy

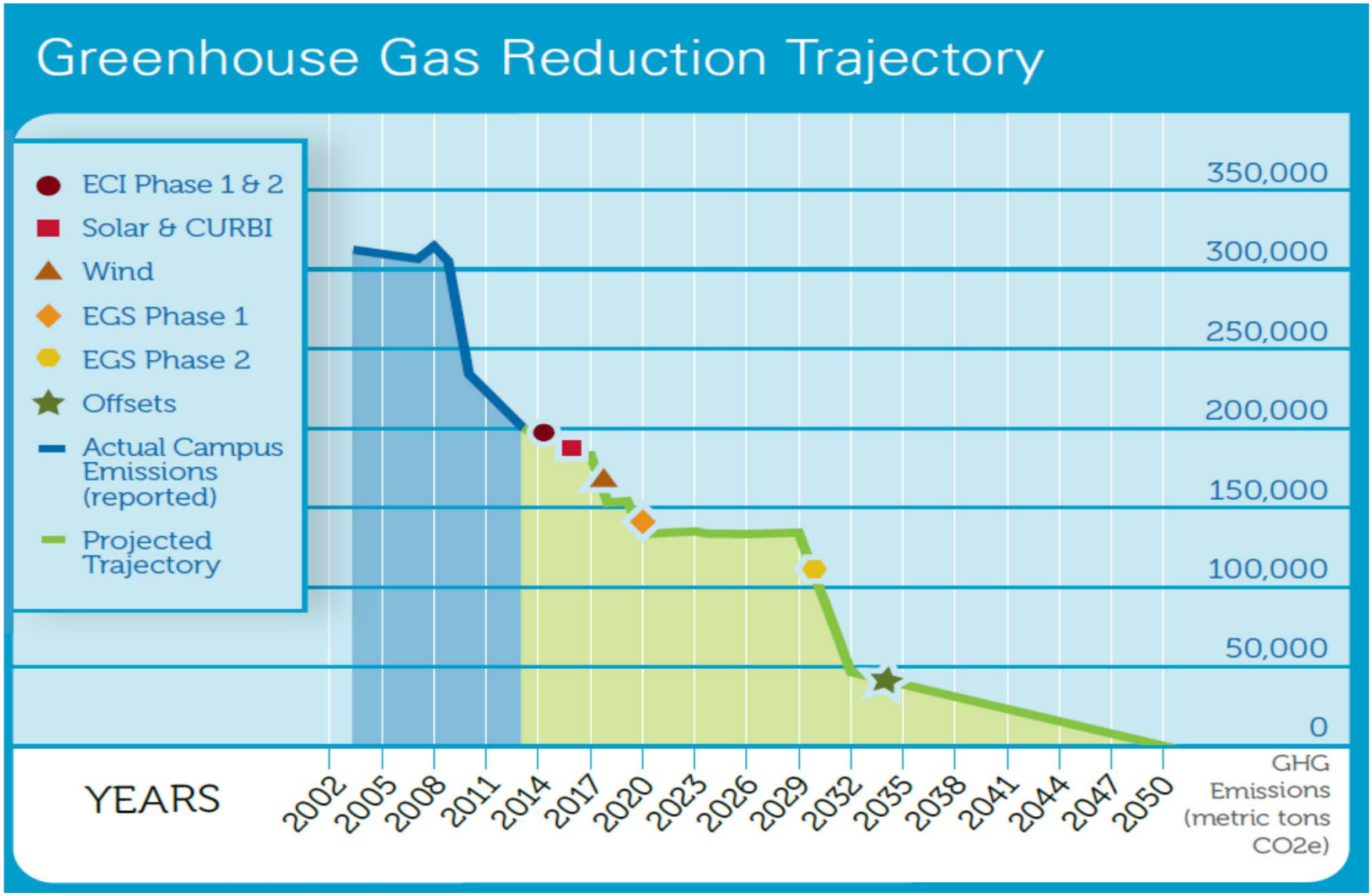
1. Plan space to avoid new buildings

2. Reduce energy demand

3. Use renewable electricity and renewable heat

4. Offset business travel and commuting

Path to Carbon Neutrality



Campus Energy Use

Central Energy Plant provides:

Electric for about 14,000,000 GSF
214 million kwh
(24,500 homes)

Steam for 12,800,000 GSF
970,000 klb
(9,500 homes)

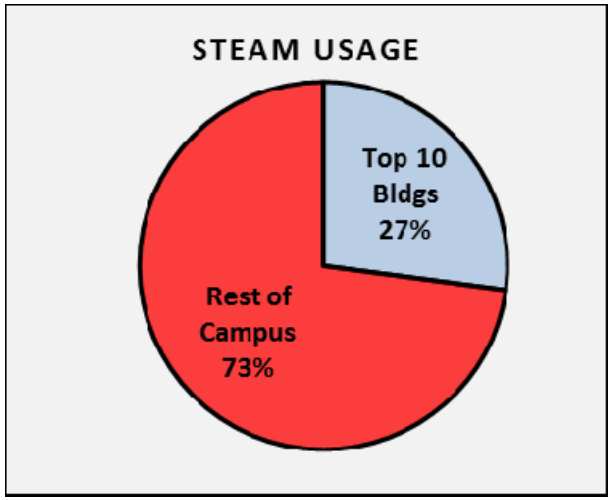
Cooling for 8,700,000 GSF
45 million ton-hrs
(11,500 homes)

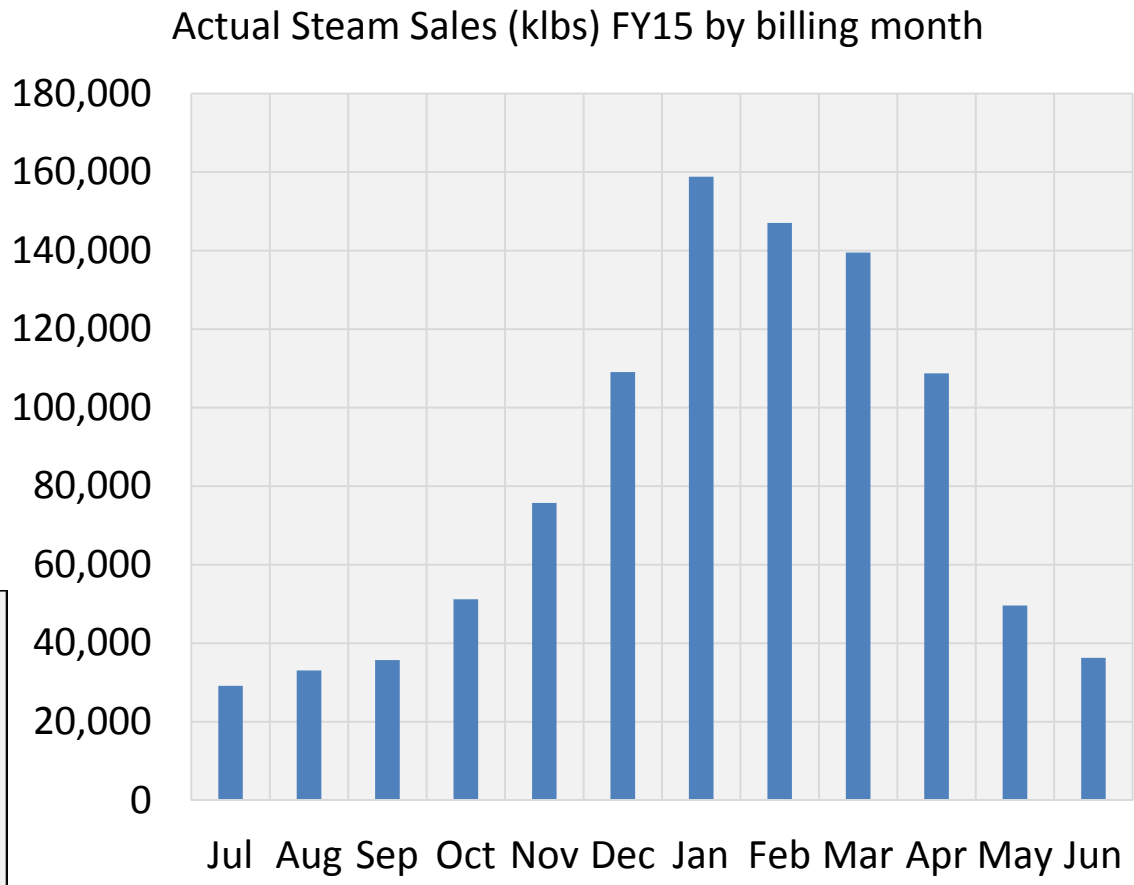
Steam Energy Use

Metered Building sales:
970,000 klbs

Steam use in summer:
Reheat; dehumidification and process loads

Peak Hourly Steam Load:
380,000 lbs. per hour
(every minute we boil 760 gallons of water)



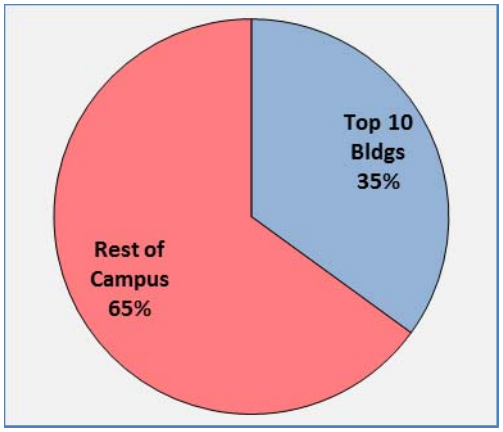


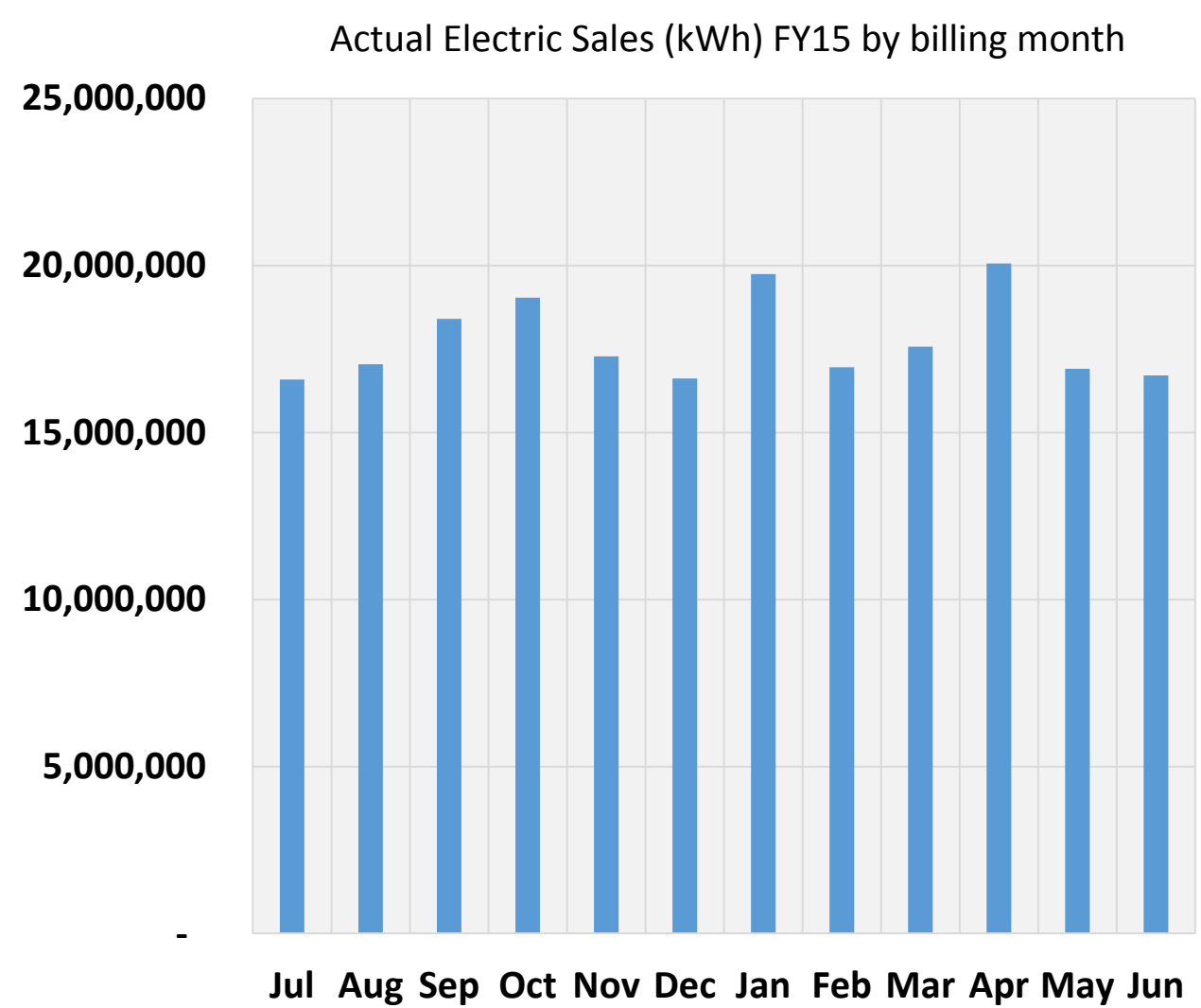
Electric Energy Use

Metered Building sales:
213 million kwh

Usage is quite flat thru out the year, average about 18 million kwh/month

Peak load is 35MW, which is about 1/1000 of the New York State peak





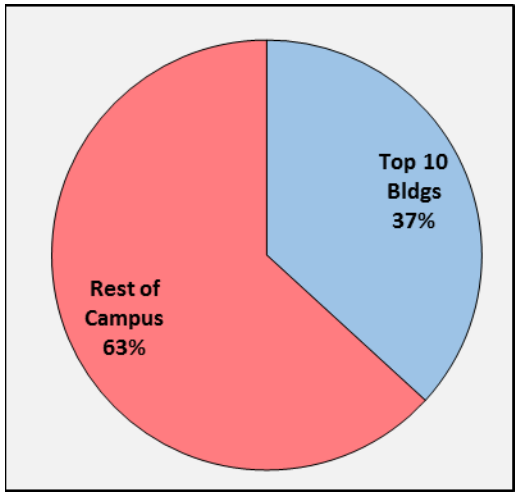
Chilled Water Use

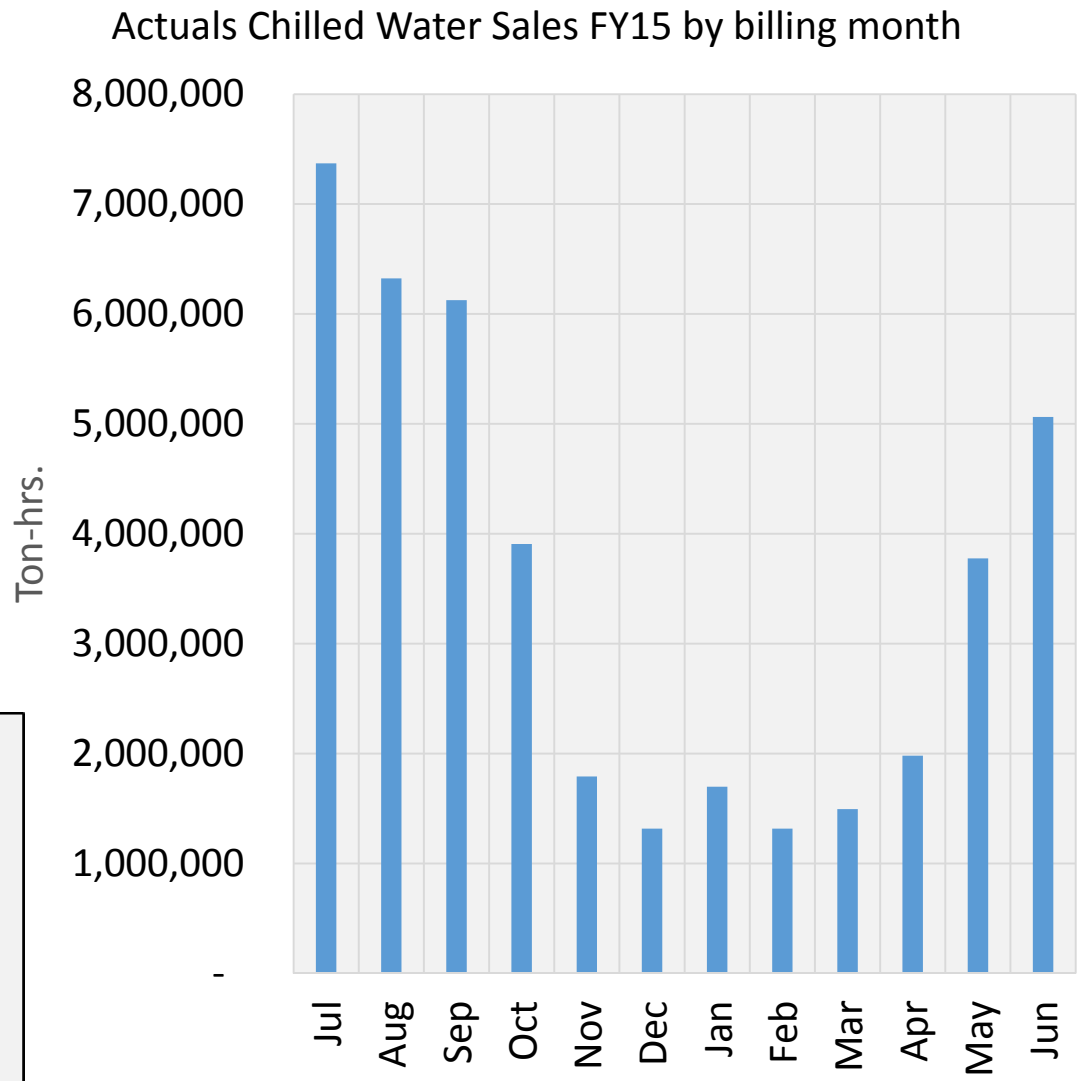
Metered Building sales:
42 million ton-hrs.

About 47% of usage occurs in July/Aug/Sept

Winter usage for process cooling and some space cooling

Peak load is 25,000 tons
(1 ton is the heat rate required to melt one ton of ice in a day)





Forecasting

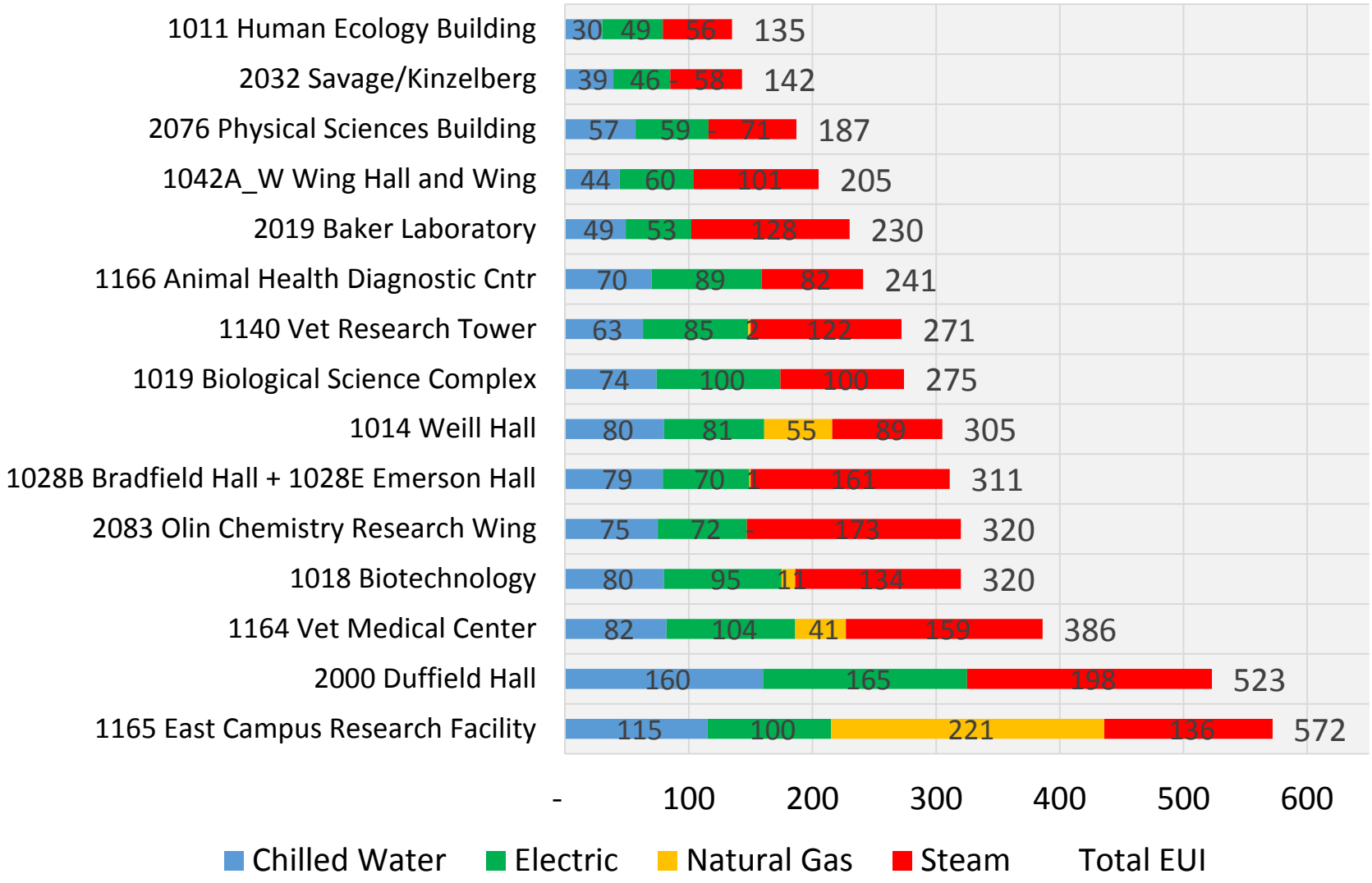
- Provides the basis for setting budgets
- Weather based for heating and cooling
- Take into account:
  - ECI projects and ECCT recommissioning
  - Major building renovations/new construction
  - Building maturation (important for newer buildings)

Forecasting

- Forecast is developed for each meter
  - 100 chilled water, 150 steam, 300 electric
  - Steam and chilled water require weather regression
- Reviewed / Updated each budget year based on performance.
- Track performance quarterly
- Building and Campus EUI is tracked and managed
- EUI reporting is part of online IPP metrics

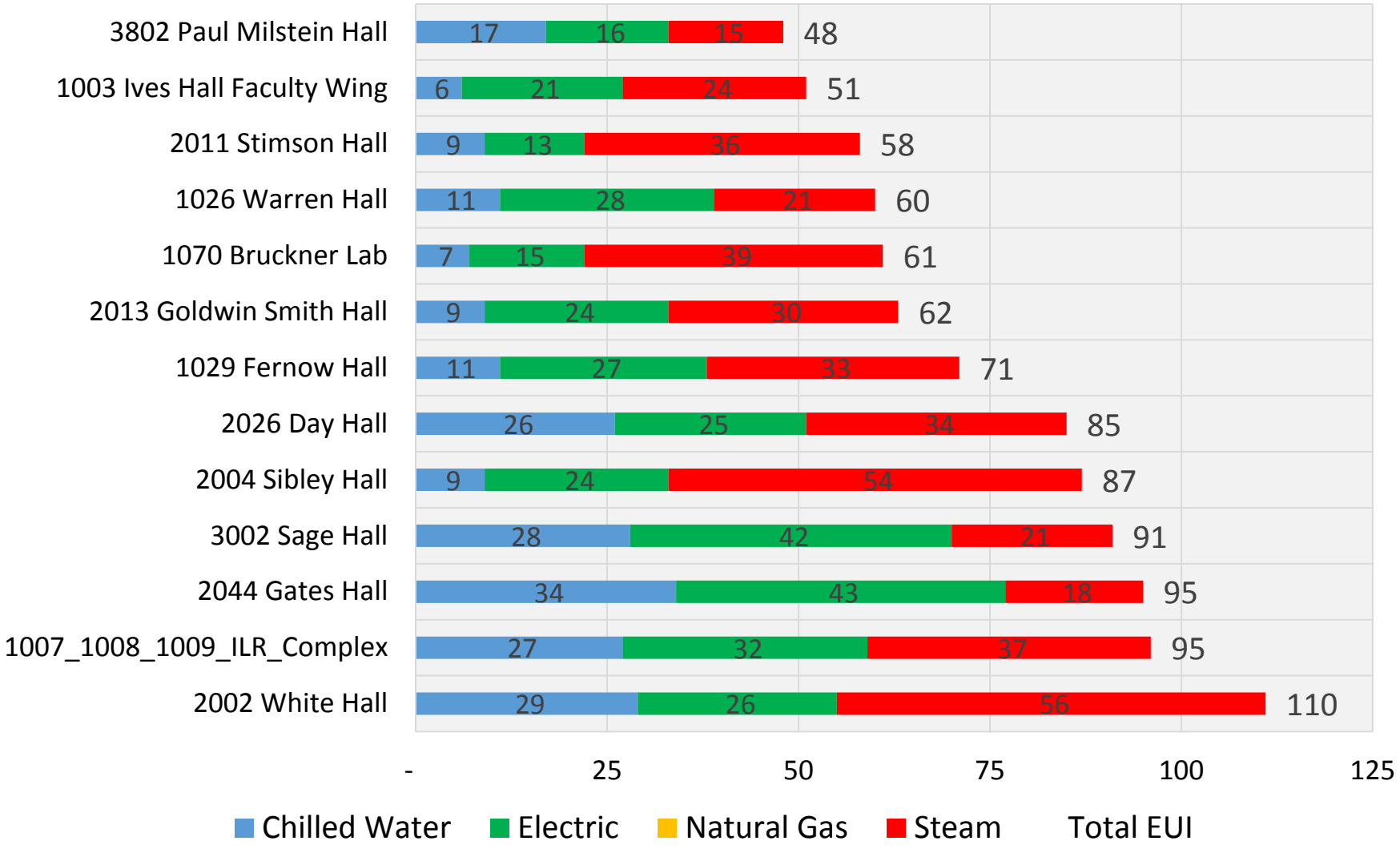
Building EUI (kBTU/GSF)

Lab/Research Facilities

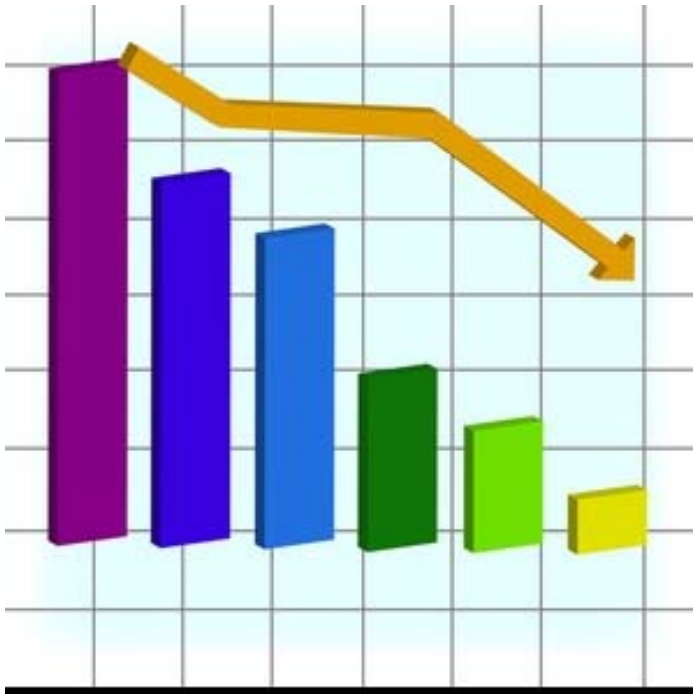


Building EUI (kBtu/GSF)

Office/Teaching Facilities



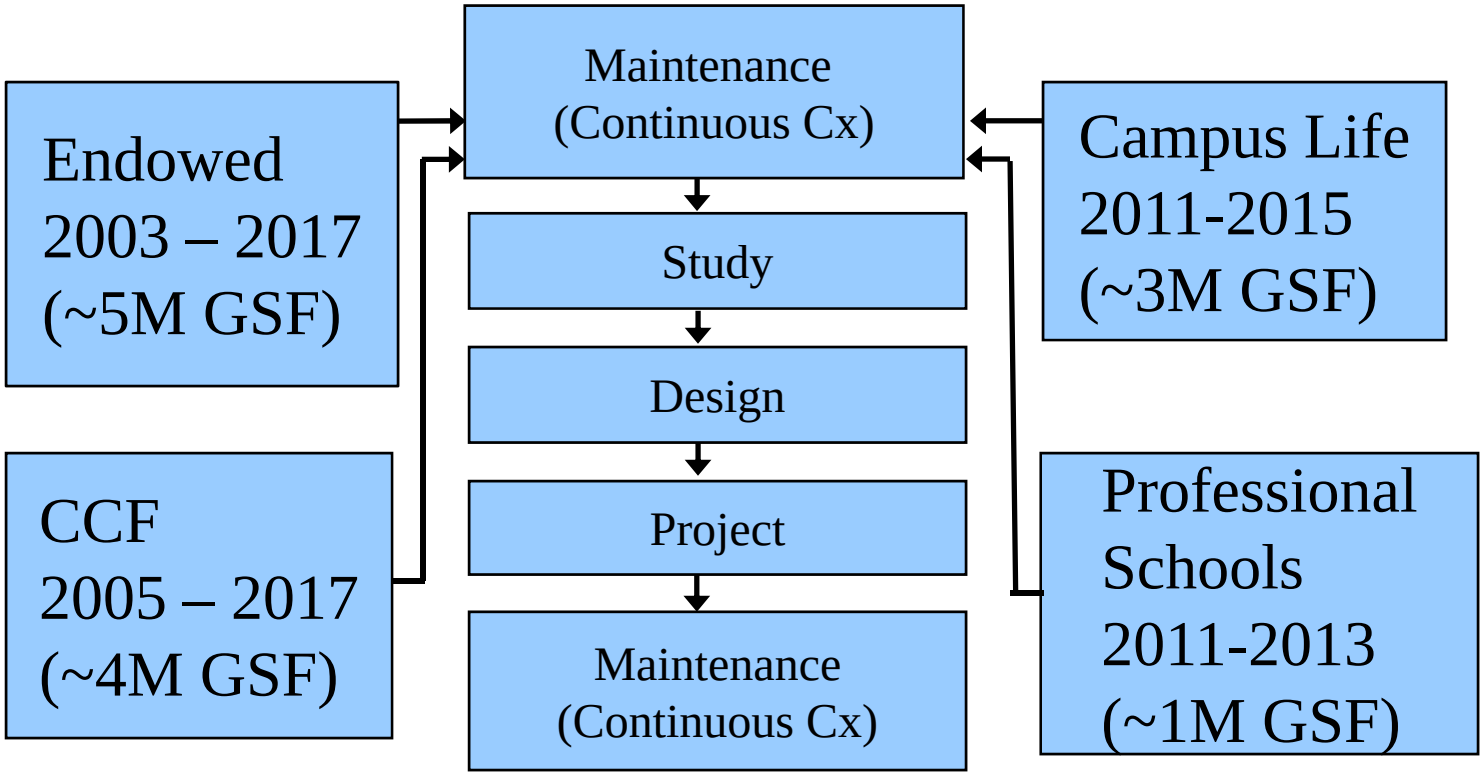
Energy Conservation Program



Energy Conservation Initiative (ECI) Phase I and II

- Phase I
  - 2000-2008 $10 Million project cost
    - Energy savings target of $1M annually
- Phase II
  - 2010-2015 $33 Million project cost
    - Energy savings target of $4M-$5M annually

Steps of ECI


Maintenance
(Continuous Cx)
Endowed
2003 – 2017
(~5M GSF)
Campus Life
2011-2015
(~3M GSF)
Study
Design
CCF
2005 – 2017
(~4M GSF)
Project
Professional
Schools
2011-2013
(~1M GSF)
Maintenance
(Continuous Cx)

Conservation Project Elements

- Lighting – fixtures and occupancy control
- Updating of controls and control logic
- Complete Cx and Re-Cx of systems
- Humidification systems

Energy conservation in laboratories

Laboratory ventilation is responsible for approximately half of all energy use on campus ~ $30 million per year at billed rates

- Focus on controls to reduce outside air use
- Occupancy sensors to index room occupancy air flows, and lighting
- Relax temperatures to reduce reheat

Energy conservation in laboratories

- Work with EH&S to determine spaces that can have their airflow reduced from 8/4 air exchanges per hour (ACH) to 6/3 ACH occupied/unoccupied
  - CFD analysis
  - Pilot testing
- 25% Airflow reduction in laboratory spaces represents a very large potential savings - $ millions/year

LED Lamp Replacement Project

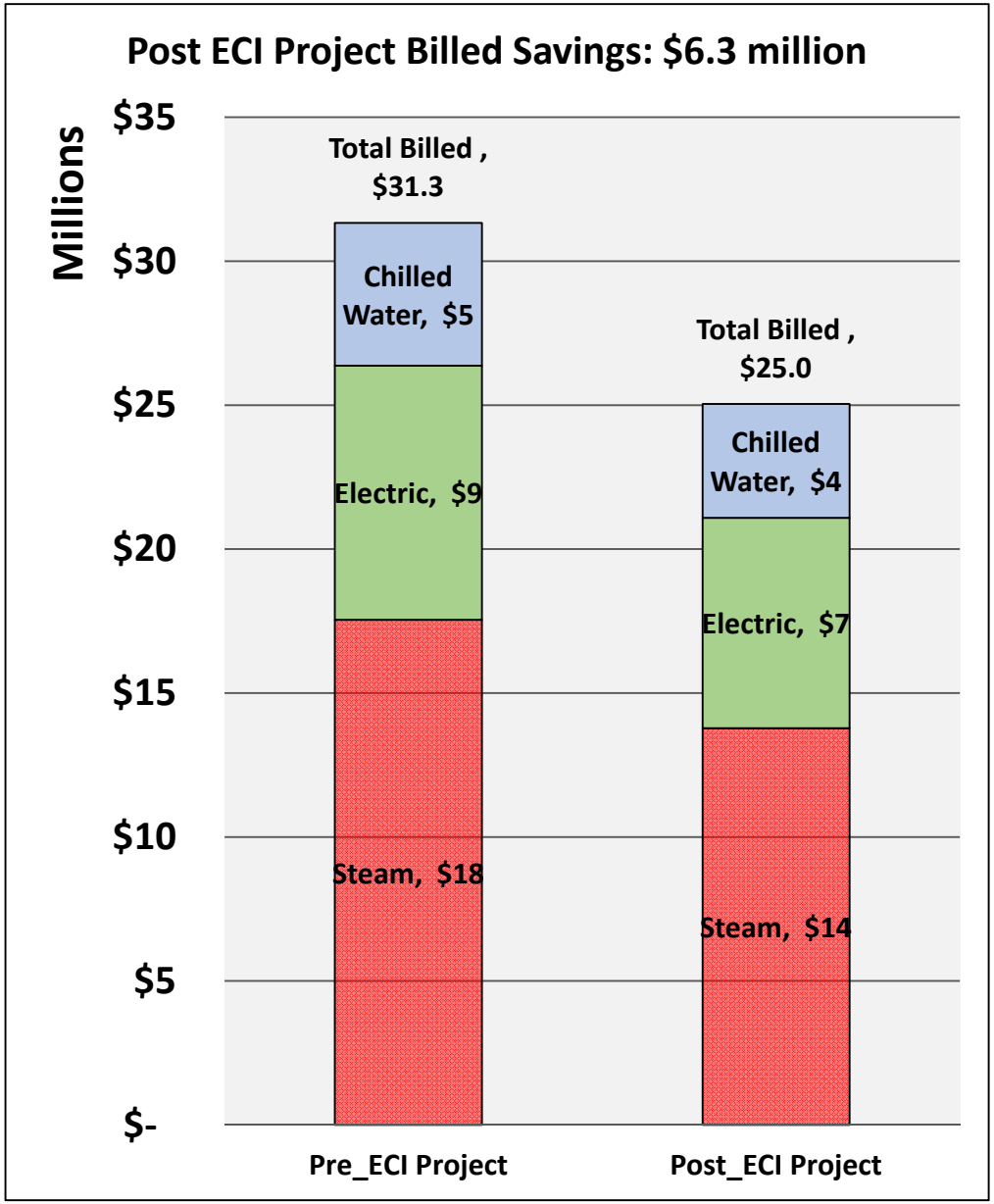
- Electrical savings to date
  - Over 50 buildings retrofitted
  - ~1400 kW reduction (peak)
  - 5,000,000 kWh/ year
  - 4.2 year simple ROI (2.1 year after incentive)




ECI Project Facts:

- Over 60 Facilities
- Over 90 projects
- Project Cost $33 million
- Project Savings: $6.3 million at billed rates with 5.3 year payback

ECI project savings	% energy savings from ECI project
Steam: 126,000 klbs	21%
Chilled Water: 5,000,000 ton-hrs	25%
Electric: 19,000,000 kwh	17%



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EMS1 Is this ECI Phase 2?

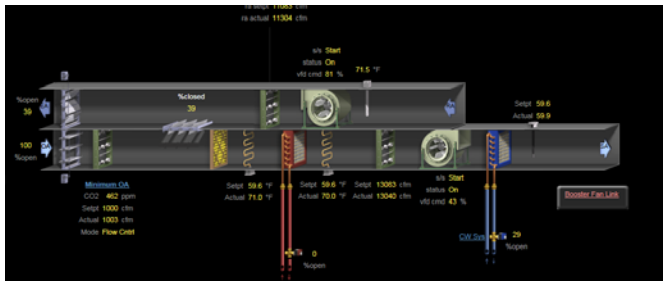
Ellen M. Sweet, 3/5/2016

Conservation focused preventive maintenance Energy Conservation Controls Team (ECCT)

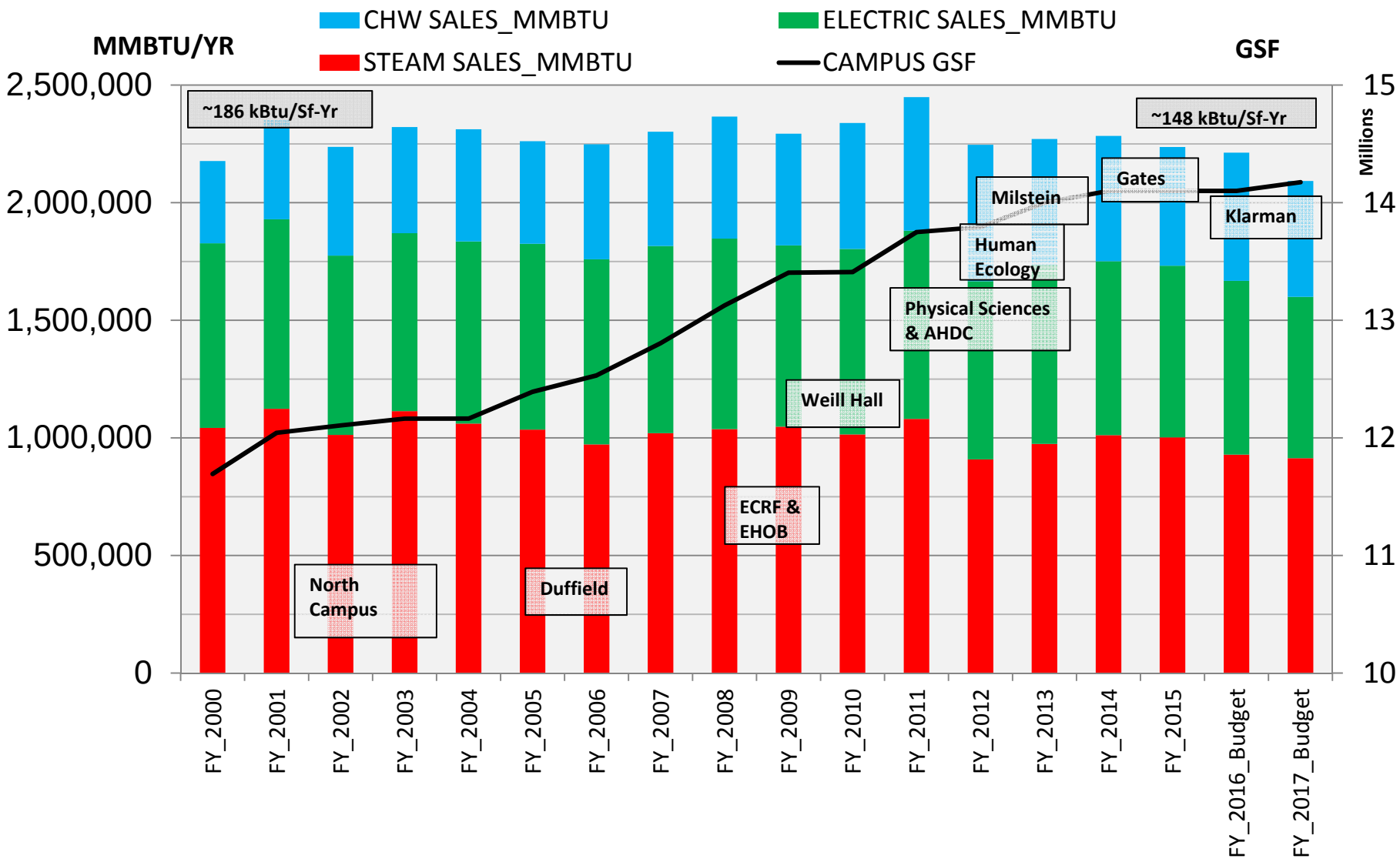
- Retro commissioning
  - 24 month typical cycle goal central mechanical Cx
  - 36 month cycle space Cx
- Empower staff with savings metrics
- Fully involve building managers/directors
- Feedback after the work is complete
- Coordination with routine maintenance crew
- All repairs paid for by maintenance budget

ECCT Staffing and Cost

- 10 million sq ft, 100 buildings
- 9 technicians, 1 working supervisor, .5 engineer oversight
- Highly skilled controls techs
- $1.5 million annual shop expense
- 2-8 % savings, budgeted at 5 %
- Billed cost annual savings is ~ twice cost



Energy Use vs Building Space



How can I afford to do these programs with my budget?

It's how we live and work at HUMAN ECOLOGY

College Level Collaboration

Everyone shares the vision and gives effort!

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Toward a Sustainable Organization

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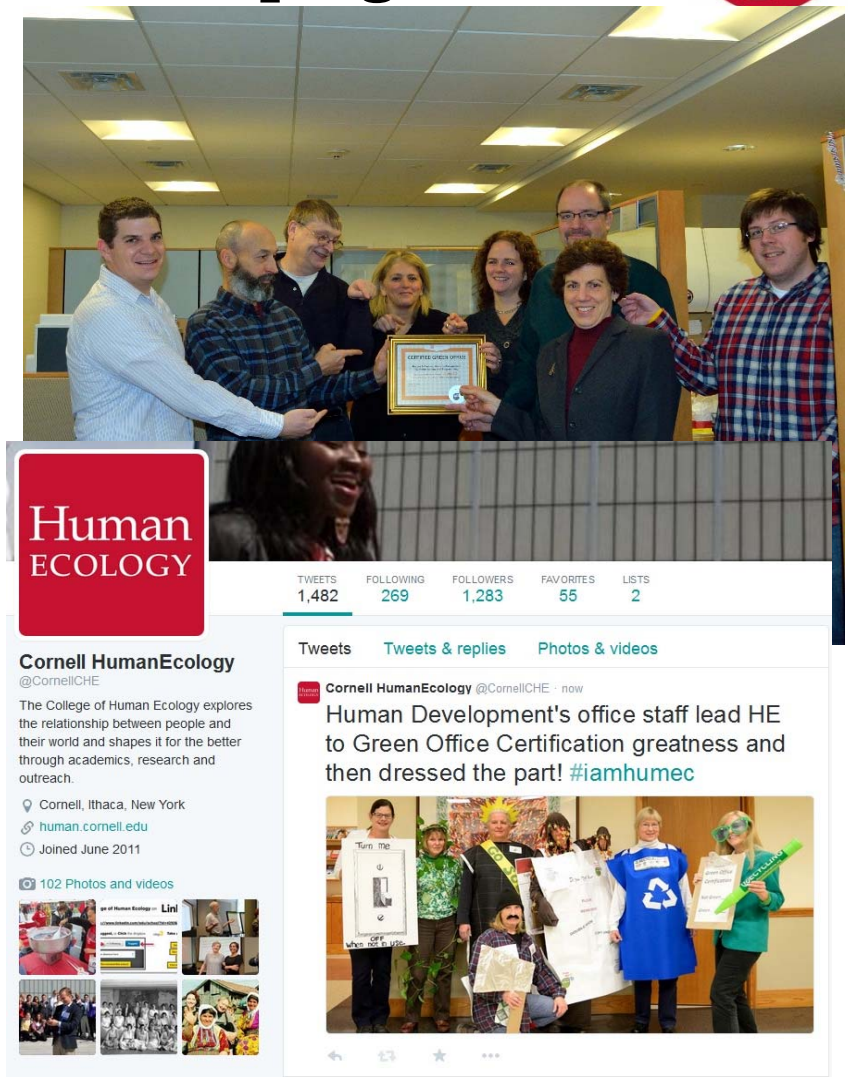
College Engagement Campaign

- Creation of College Level Green Team
- Bi-monthly campaign themes
- Peer to peer educational focus
- Role models for sustainable practices selected as green ambassadors
- Individual and team recognition for campaign successes
- Training identified and supported by the larger campus mission



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College Engagement Program Themes

Campaign Kickoff

Energy and Sustainability and CHE (August)

Green Recruitment

Recruiting of CHE Green Ambassadors (September)

GREEN Your Workplace

Green Labs and Offices certification program (October)

The Energy Smackdown: Building vs Building

1st energy competition of the program (November – December)

Recyclemania

Nationwide waste and reduction competition (February- March)

Community Well Being

Healthy Choices Campaign (April)

Green Ambassador celebration

Educational trip and awards May

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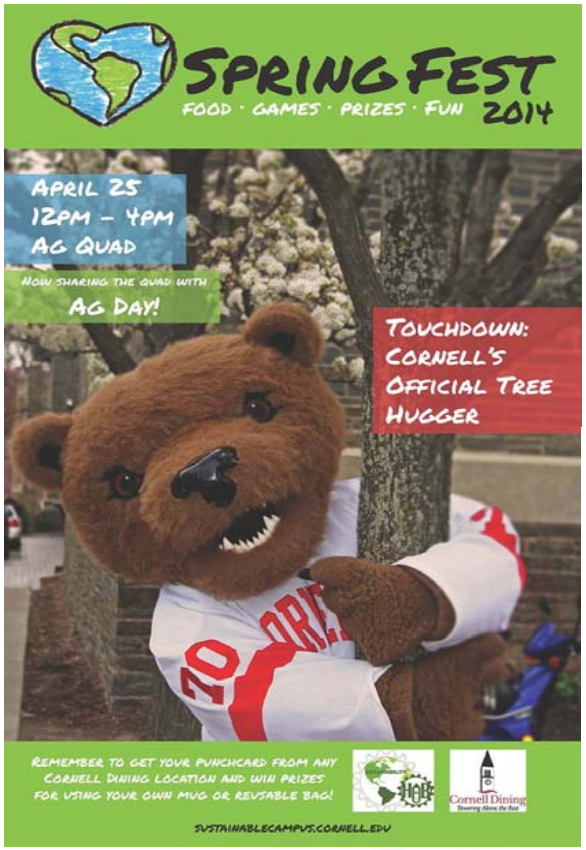
Campaign Kickoff and Green Recruitment

- Higher level green team collaborative sessions
- Soft launch entertainment event (earth day)
- Open recruitment for anyone interested
- Green team kickoff collaboration planning event
- Quick win event like a “lights out” or “turn back the stat” to engage the entire population.
- Selectively recruit those most active to lead departments and units as Green Ambassadors.



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Green Office and Lab certification program

Public recognition for staff and faculty engagement:

Personal lab and office assessments 180 people participated

Human Ecology has more office and labs green certified than the rest of campus combined

Awards were given for all certified labs and offices based on level of certification.

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Building Energy Dashboard Smackdown

Real time energy conservation competition using the building dashboards to track savings percentage under last years usage.

Building	%Reduction	2014	2015	LEED
Beebe Hall		24%	37%	None
MVR West		33%	34%	None
MVR Main		29%	30%	Gold
HEB		5%	21%	Platinum
S/K Hall		9%	14%	None

Total Saved 301,000 kwh in six weeks

These changes currently remain in place so the savings has continued

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Common Collaborative Opportunities

Lighting and technology-

- Use custodial support to re-lamp with LED lights
- Use students to lead a “Lights out” campaign
- Use BMS for building occupancy schedules

Building scheduling and common/ shared spaces

- Encourage the use of shared teaching labs
- Work with registrars to consolidate schedules
- Encourage the use of commons areas as the hub

Understand the Programs needs for use of spaces

- Not all labs are heavy chemical labs
- Space programing for HVAC comfort
- Consolidate and share specialty equipment

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Use Fun Facts to stay on target

These efforts have saved a combine 301,693 KWH over a six week period of time within 650,000 sq ft of building spaces.

Multiplying those savings out for the year is equivalent to :

Driving 176 trips around the world

83-garbage trucks of waste recycled instead of landfilled

271-family homes fully powered for a year

Or 1838- 30’ tall balloons filled with CO2e

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Questions?
Contact info: Mark Howe mjh69@cornell.edu
Jim Hatch jfh89@cornell.edu