The University of Massachusetts Amherst
Energy Master Plan

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DEA2015 – BOSTON
ummer 2015

Agenda

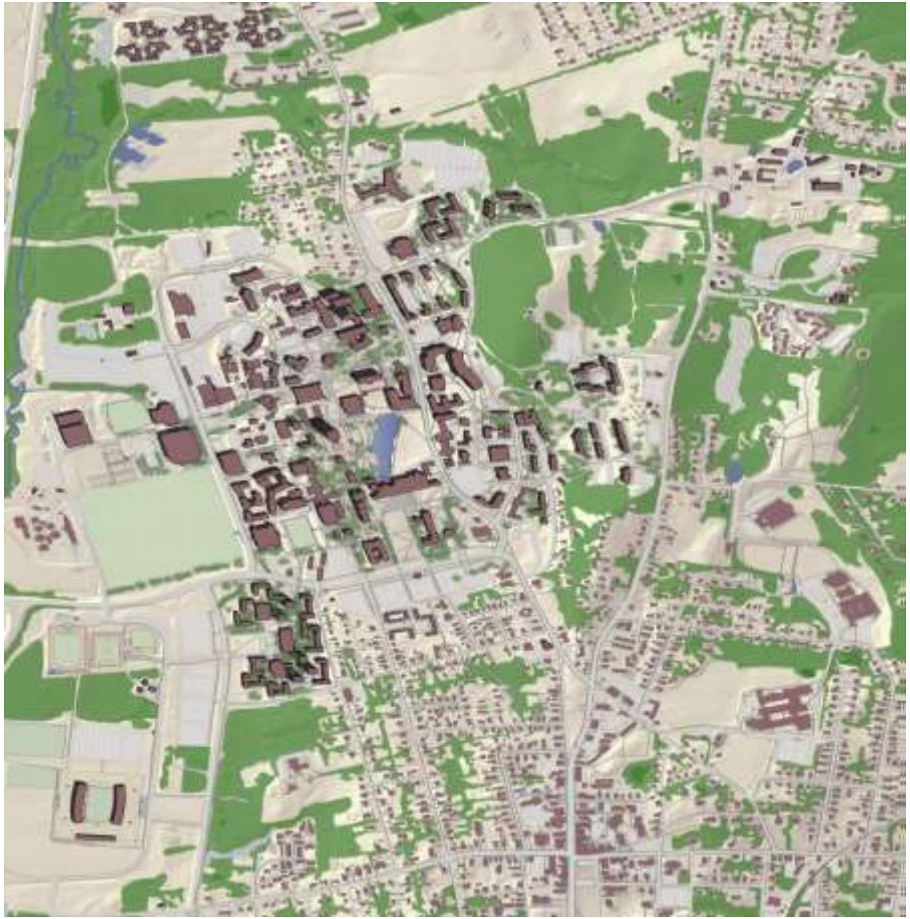
- Campus Master Plan and need for a Utility Master Plan
- Overview of the Energy Master Plan Process
- Findings from the Process
- Energy Master Plan Recommendations
- Meeting EO484 Goals

2006-2011 – 937,402 gsf added to Campus

2011-2014 – 1,070260 gsf added to Campus

Beginning to tax utility systems, both internally and regionally

Losing N+1 capacity for steam generation and electrical capacity

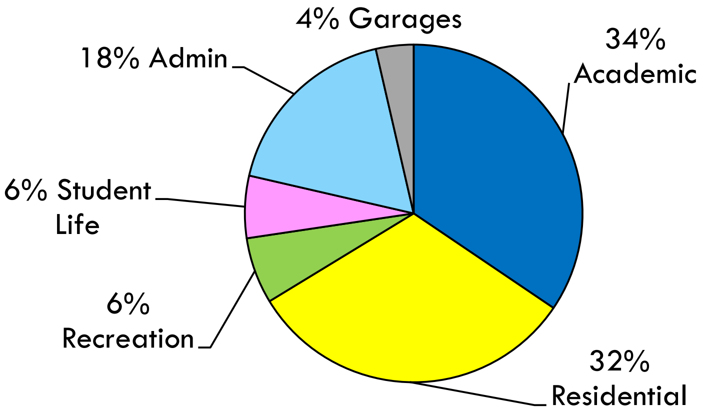


Existing program (2010)

Campus Total GSF 10.8M GSF

This space can accommodate approximately:

- 24,300 Students
- 8,000 Faculty/Staff
- 12,500 Beds

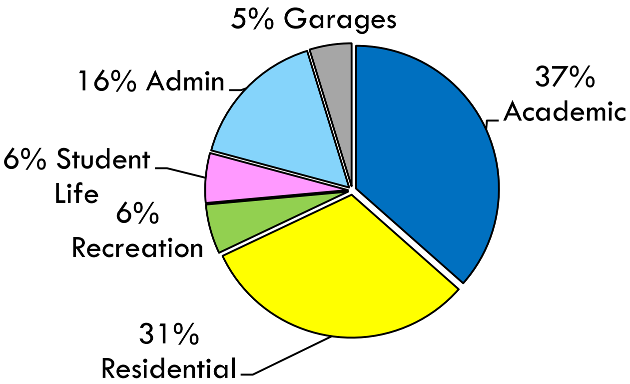


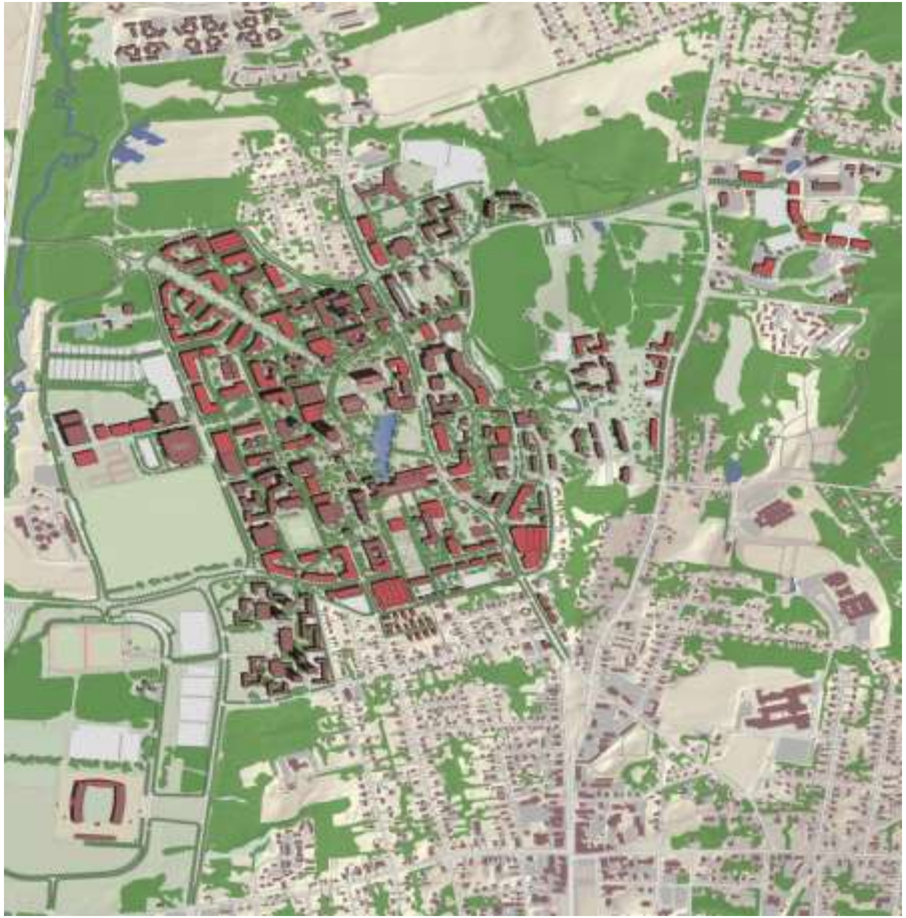
Near Term Plan Program

Campus Total GSF 12.5M GSF

This space can accommodate approximately:

- 27,700 Students
- 8,800 Faculty/Staff
- 14,000 Beds



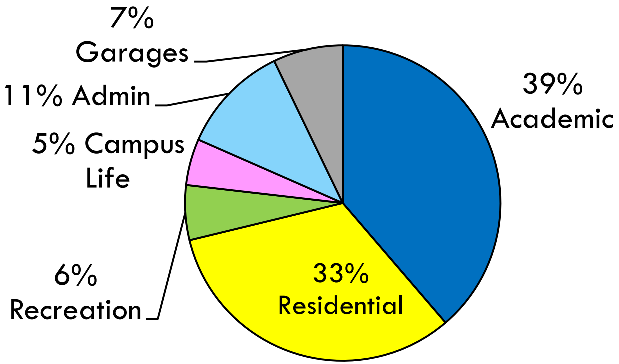


Long Term Accommodation (50 Years)

This space can accommodate approximately:

- 36,700 Students
- 11,700 Faculty/Staff
- 19,000 Beds

Campus Total 18.2M GSF



Campus Energy Master Plan: Request for Proposals

Goal of Energy Master Plan: "To develop a plan for the reliable delivery of energy at University of Massachusetts Amherst over the next 30 years and to define and prioritize categories of projects to achieve the most transformative effect on current and future energy consumption at the UMA Amherst campus at the minimum cost and with the highest measure of greenhouse gas emission reduction."

- Overview of Existing Campus Energy Systems
- Challenges/Opportunities Created by Physical Master Plan
- Commitment to Sustainability
- Inventory/Discovery
- Analysis/Assessment
- Alternatives/Implementation

Needed Information for the development of Capital Plan

Campus Energy Master Plan: Steering Committee & Stakeholder Group

Physical Plant

Ray Jackson, Director Physical Plant
Jeff Bryan, Assistant Director, Utilities
Steve Grden, Utility Electrical Engineer
Jason Burbank. Campus Energy Engineer
Sandy Beauregard, Controls Specialist

Design and Construction Management

John Matthews, Assistant Director, Campus Projects
Ted Mendoza, Capital Projects Manager
Jason Venditti, Capital Projects Manager

Campus Planning

Niels la Cour, Senior Physical Planner
Ludmilla Pavlova, Senior Facilities Planner

Administrative Services

Shane Conklin, Director

Competitive Energy Services

Andrew Price
Keith Sampson
Zac Bloom

Stakeholder Group

- Juanita Holler, Assoc. VC, Facilities & Campus Services
- Dennis Swinford, Director, Campus Planning
- Tom Shaw, Director, Design and Construction Management
- Ray Jackson, Director, Physical Plant
- Jeri Baker, Director, Transportation Services
- Shane Conklin, Director, Administrative Services
- Andy Mangels, VC Finance & Budget Director
- Eddie Hull, Exec. Director of Residential Life
- Ken Toong, Exec. Director, Auxiliary Enterprises
- Dan Markowski, Assoc. Athletic Director, Facilities/Operations
- Will Shea, Director, Finance & Cost Analysis
- Ezra Small, Sustainability Manager, Physical Plant
- Professor John Collura, Assoc. Dean of College of Engineering
- Craig Nicolson, Sustainable Science Program Director
- Ben Weil, Assistant Professor, Environmental Conservation

Campus Energy Master Plan Process

1. **Develop a thorough understanding of existing utility systems**
   - Reliability limitations
   - Efficiency
   - Capital renewal requirements

2. **Evaluation of replacement and expansion options**
   - Future campus growth
   - Life cycle cost analysis and comparison
   - Feasibility assessment (operational, sustainability, etc…)

3. **Implementation plan**
   - A utility project list synchronized with the 10-year campus plan
   - A schedule of funding requirements
   - A benchmark of current efficiencies with future milestones

Summary of Energy Challenges

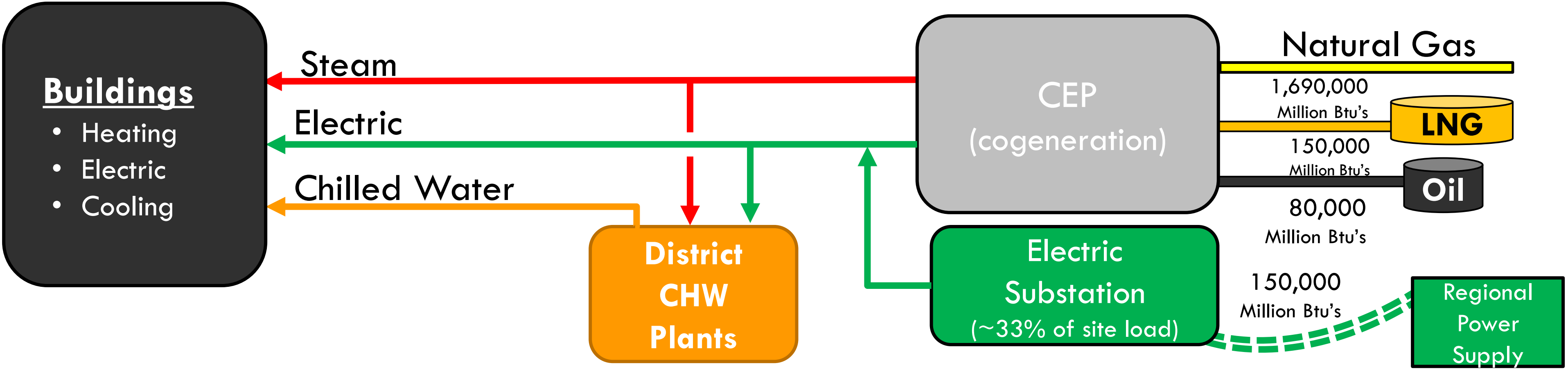
- Fiscal Year 2014

Natural gas*	1,700,000 Million Btu's	$16.4 M/yr
Liquid natural gas	194,000 Million Btu's	$4.6 M/yr
Oil	96,000 Million Btu's	$2.4 M/yr
Electric Purchased	150,000 Million Btu's	$6.0 M/yr
TOTAL	2,140,000 Million Btu's	$29.4 M/yr

* Includes fuel for on-site cogeneration

- Utility infrastructure is a significant asset (value ~$800 M)
- Campus operations rely upon uninterrupted utility services
- Goals to reduce energy use, fuel costs and carbon footprint
- Need to support future expansion

Review of Campus Energy System



Distribution

Capacity

Reliability

Efficiency

Generation Plants / Utility Supply

Capacity

Reliability

Efficiency

Balance energy

Regional Fuel

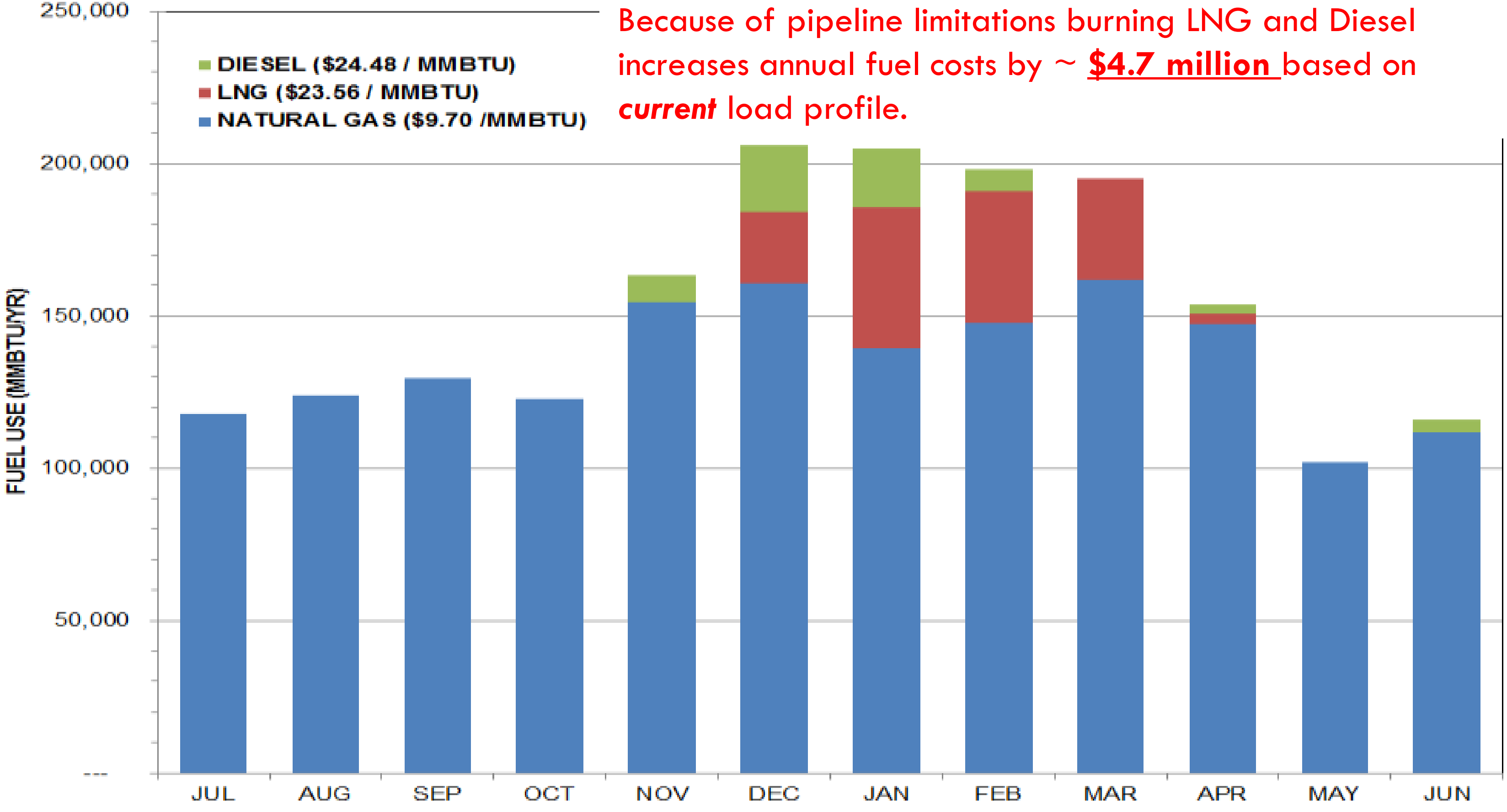
Supply Capacity

Cost

Carbon emissions

Existing steam fuel use profile

Because of pipeline limitations burning LNG and Diesel increases annual fuel costs by ~ **$4.7 million** based on ***current*** load profile.



Option Consideration

- Install natural gas boiler
- Install 8 MW combustion turbine
  - W/ absorption chiller
  - W/ additional HP steam turbine
- Install 10 MW combustion turbine (new plant)
  - W/ absorption chiller
  - W/ additional HP steam turbine
- Install 12 MW combustion turbine (new plant)
  - W/ absorption chiller
  - W/ add. HP steam turbine
- Install biomass (new plant)
  - Just to replace secondary fuel usage
  - Base loaded boiler

Steam Distribution System

Distribution:

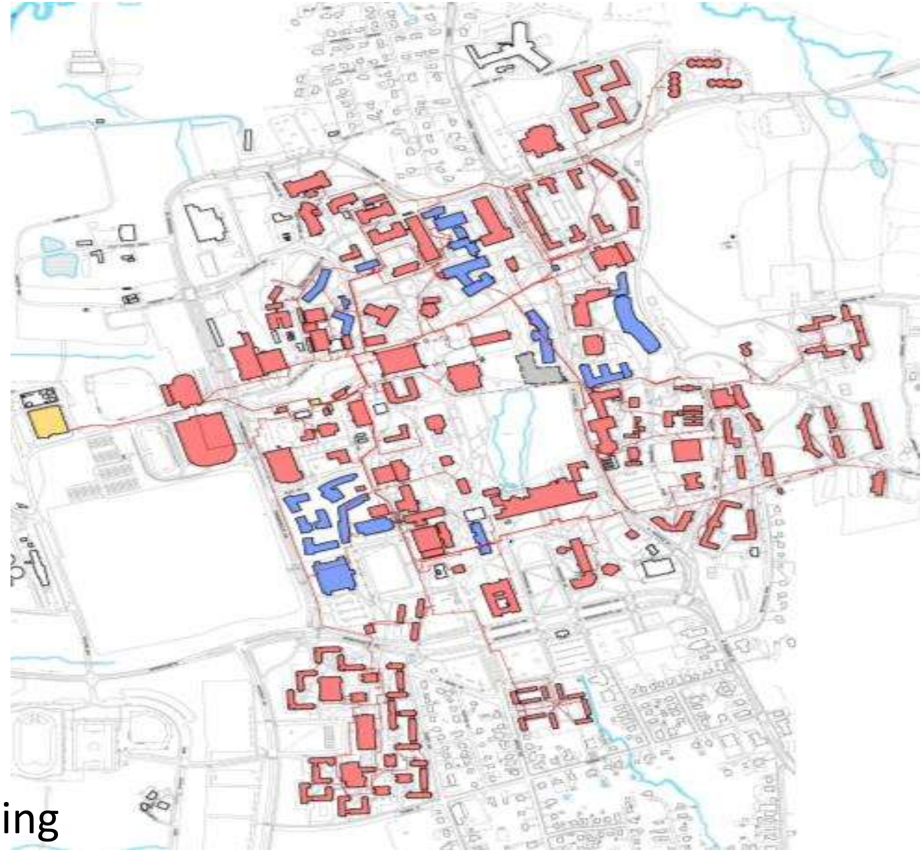
- 8,700 LF Walkable tunnel
- 7,000 LF Trench
- 35,000 LF Direct buried piping

Piping condition

- 65% Good condition (46,700 LF)
- 20% Fair condition (14,800 LF)
- 15% Poor condition (9,300 LF)

Steam efficiency

- Estimated distribution loss 15% (Representative of piping condition)
- 70% of steam generated is utilized by building



Chilled Water System

Existing system summary

- 7 District chiller plants
- 12 Individual cooling systems

Chiller summary

- 13,280 tons of W/C
- 5,730 tons of absorption
- 930 tons of A/C
- 19,940 tons Total

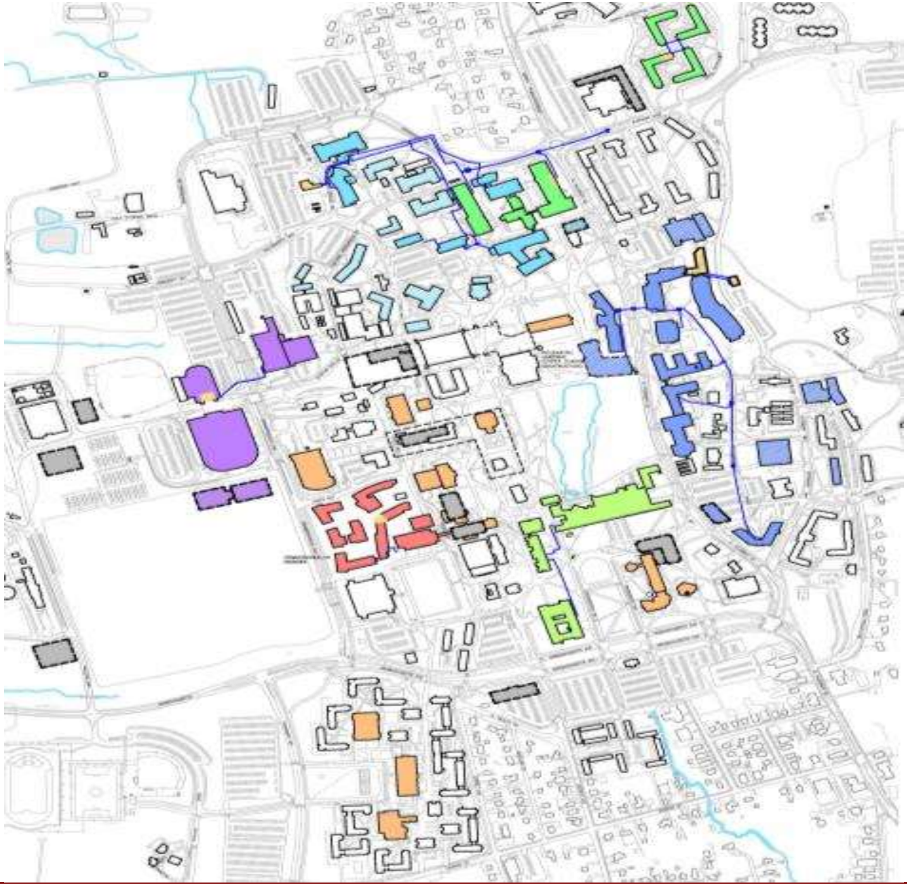
Chiller age

- 11,810 tons of 0-10 years
- 2,550 tons 11-20 years
- 5,580 tons > 20years
- 600 Ton utilize CFC or HCFC

Energy for chilled water generation represents ~10% of the total building energy use

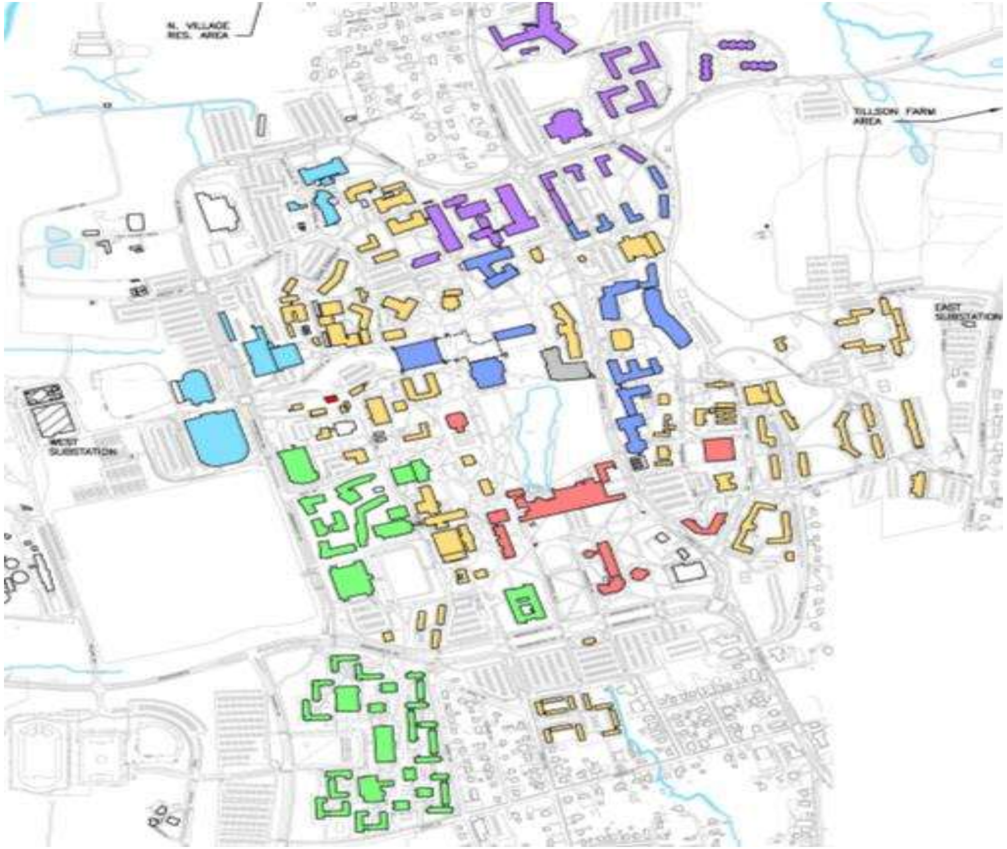
Future Chilled Water Options

- Potential future options
  - District CHW system (status quo)
  - Central chilled water plant
  - Indiv. system for future only
- Chiller generation options
  - Electric centrifugal
  - Steam driven chiller
    - Absorption
    - Steam turbine
  - Thermal Energy Storage
    - Chilled water storage
    - Ice storage



Existing Electrical Main Substation

- **26.1 MW peak load in September 2013**
  - **Maximum power generation 16 MW**
  - **Utility feeder firm capacity is 27 MW**
- **37.0 MW campus peak, near term growth**
  - **Lab space**
  - **Data center**
  - **Cooling for building not currently air conditioned**
  - **Tillson Farm Substation**



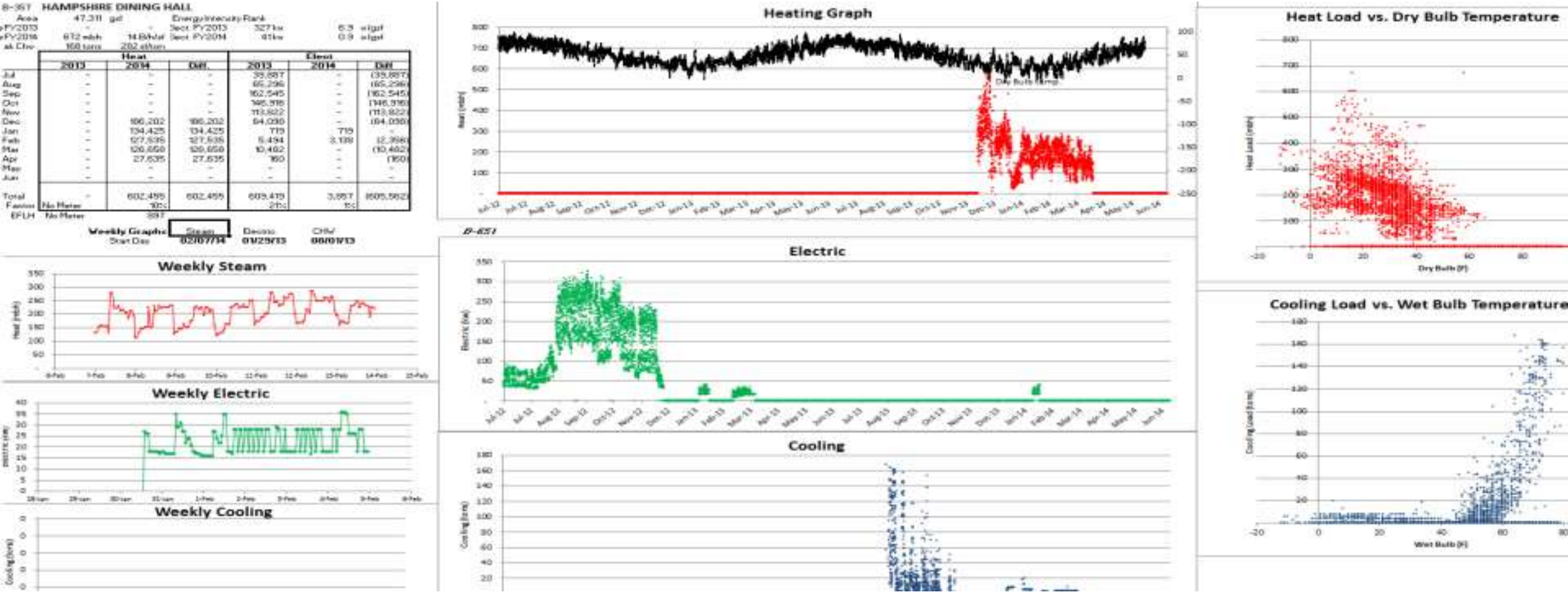
Tillson Farm Substation

New High Voltage Substation

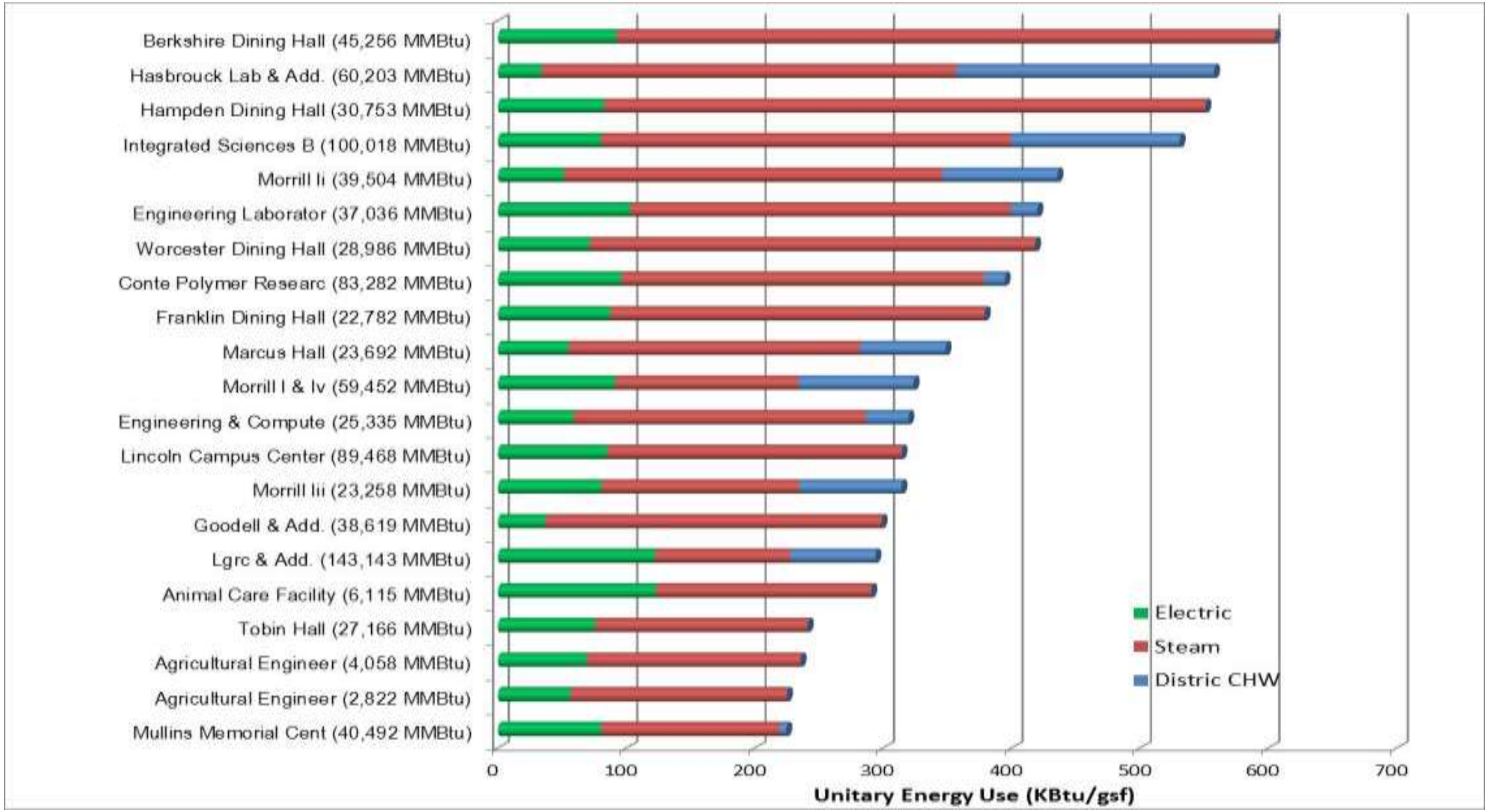
New Feeders to existing switch stations

- (2) 14.3 MW Feeders to each Switch Station
- Firm capacity 42.9 MW

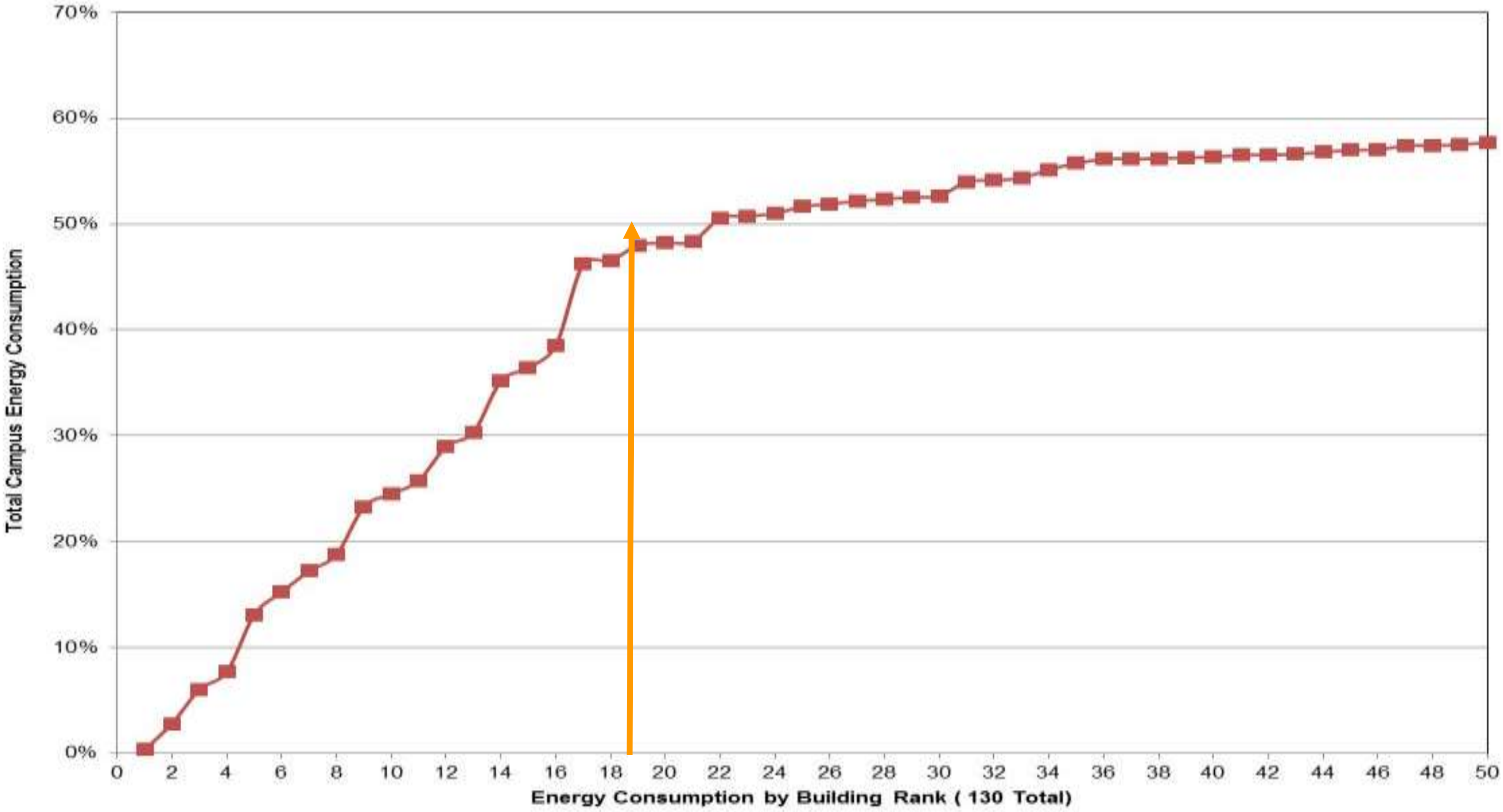
Building Energy Data



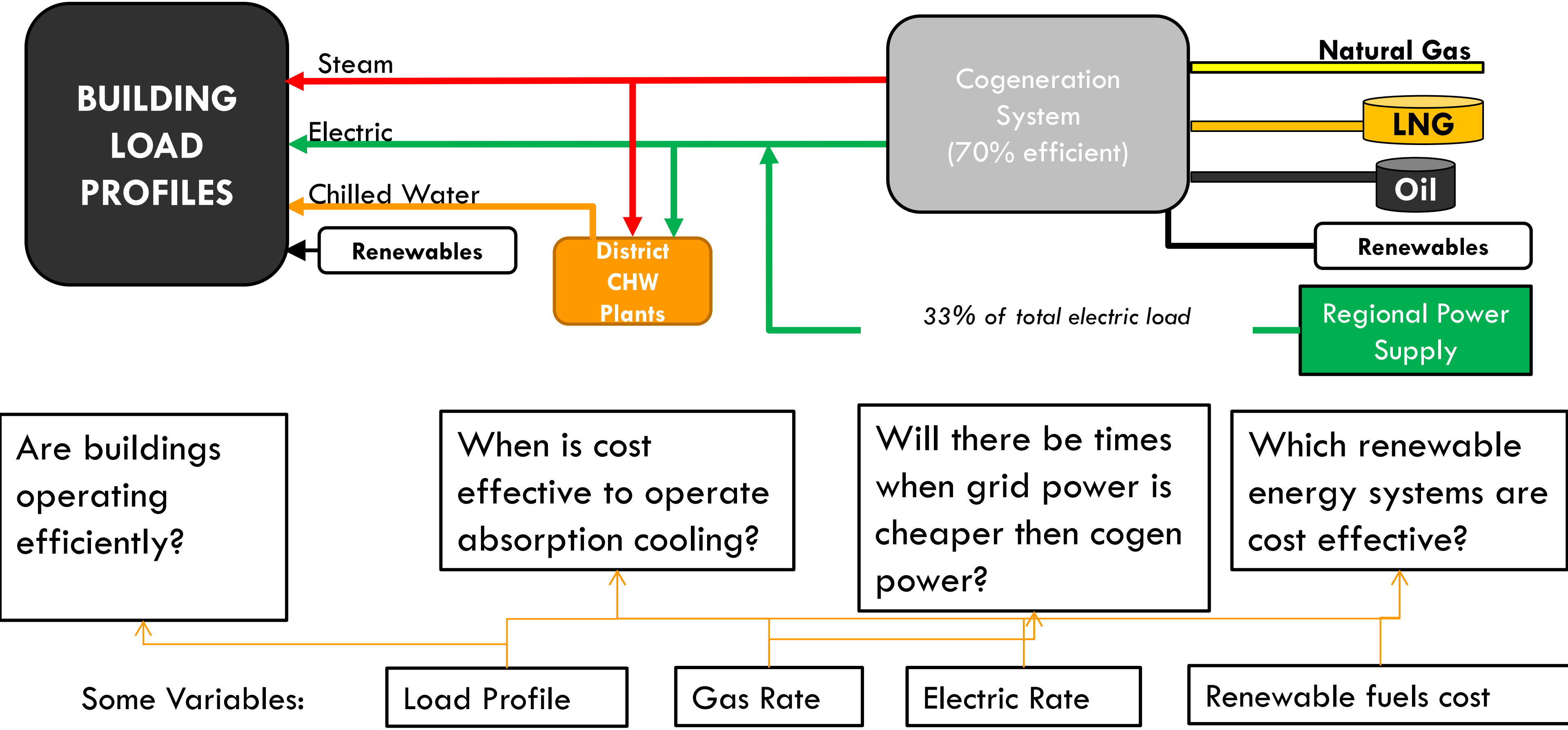
Top 20 Building Unitary Energy Use



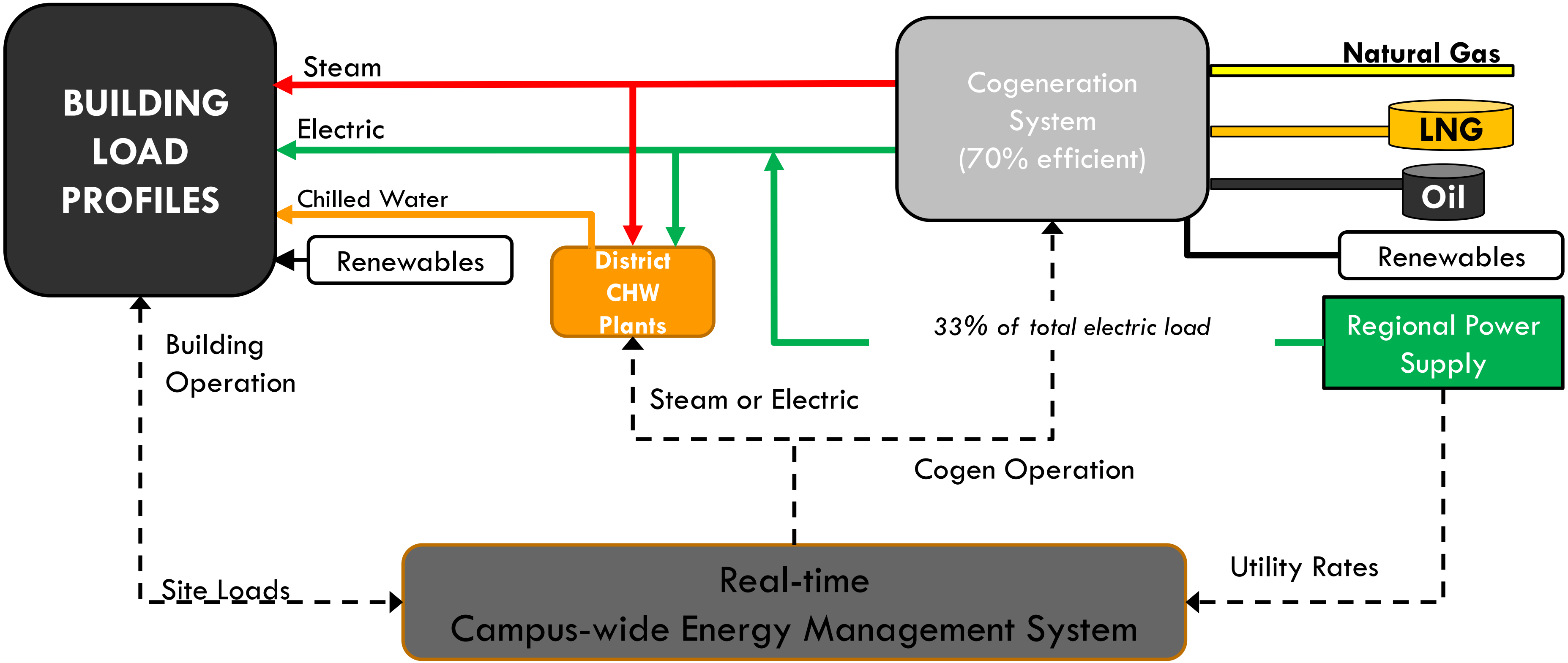
Total Energy Consumed By Top 50 Buildings



Dynamic System Operation



Management and Flexibility



Load Management Summary

Reduce Existing Building Energy Use 177 Kbtu/gsf

- At least 5% to 10% energy reduction possible

A 10% site energy reduction is an average of 20% reduction for top 25 buildings (~$25 Million in capital)

Capital renewal projects could reduce energy use another 5%

Coordination of the existing energy rates with ongoing DCAMM study is crucial

Load management projects would include…

- **Steam Distribution Improvements**
- **Chilled Water Capital Renewal**
- **Chilled Water System Optimization**
- **Load shifting (thermal storage)**
- **Building Design Enhancements**
- **Building Energy Conservation Measures**
- **Renewable Energy Systems**
- **Alternative Technologies**

Sustainable UMass & Executive Order 484

Energy Related Targets

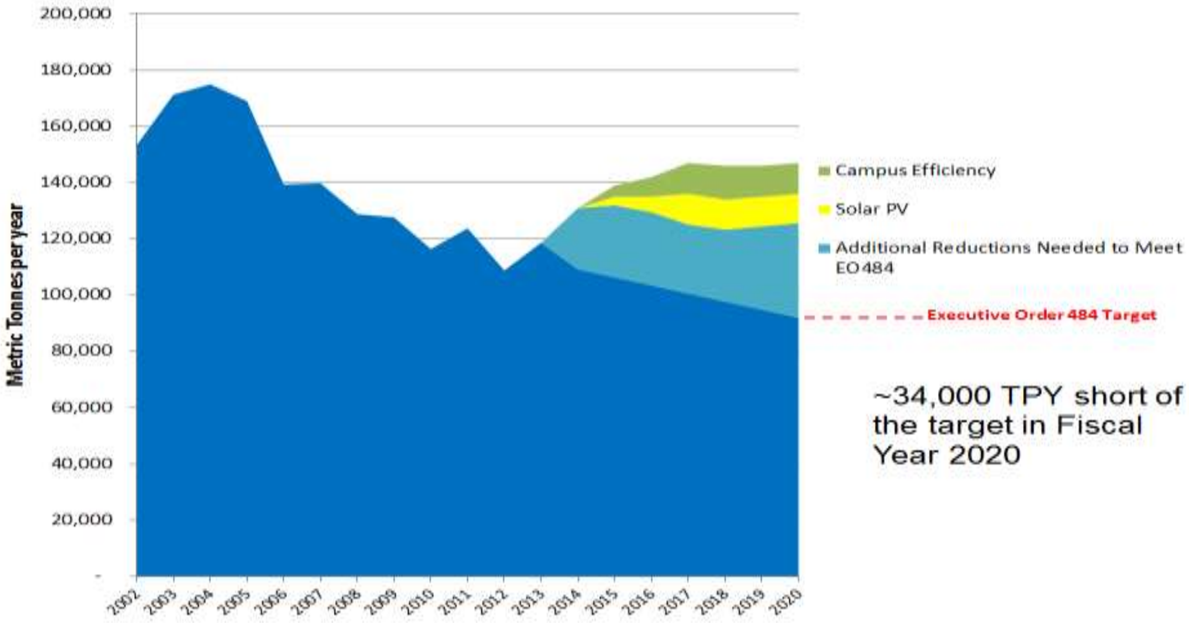
Category	Units	Base Year	2012	2020	2050
EUI	(Kbtu/sf)	2004	20%	35%	
GHG	(metric tons)	2002	25%	40%	80%
Renewables	(% of consumption)		15%	30%	

EUI Goal (kbtu/sf)

Category	Units	Base Year	2012	2013	2020
EUI	(Kbtu/sf)	2004	20%	5%	35%

GHG Goal

Category	Units	Base Year	2012	2013	2020
GHG	(metric tons)	2002	25%	27%	40%



Renewables Goal

Category	Units		2012	2013	2020
Renewables& Alternatives	(% of consumption)		15%	65%	30%

- Solar Power RFP
  - Bids Received
  - Up to 6-10 MW (DC) Parking Canopy & Rooftop Under Evaluation

Current Efforts

- Solar RFP
  - Underway
- Phased Design for Permanent LNG Facility
  - Reduced ULSD usage

- Expand CHP
  - Up to 8 MWs of new cogen
- Development of Energy Conservation Measures
  - 10% at existing top users

Executive Order 484 Challenges

- Future Campus Development (through 2022)
  - 12% increase in area results in a 26% increase in load
  - 29% increase in lab area
  - 12% increase in air conditioning for <u>*existing*</u> buildings
- Cost effective conservation measures have been performed
- Targets are difficult to achieve with <u>cost effective</u> projects and current technology

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