



***Cornell University—Ithaca  
Building Energy Report  
Fiscal Year 2018***

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## Table of Contents

Executive Summary:.....	1
Building Metering: .....	3
Campus Space Snapshot: .....	4
Steam Consumption.....	5
Electric Consumption .....	6
Chilled Water Consumption.....	7
Building Energy Use Intensity .....	8



## Executive Summary:

Fiscal year 2018 building energy consumption for central energy plant provided commodities (i.e. electric, steam and chilled water) was <1% above budget. Total building energy consumption was 2,068,000 mmBTU versus the budgeted value of 2,056,000 mmBTU. Actuals are <1% below the weather corrected budget. Notable factors impacting energy consumption are the following:

### 1) Biotech Steam Consumption:

Biotech experienced issues with steam equipment resulting in usage well over budget for multiple months. Impact is approximately 10,000mmBtu. Fixes were made in FY18.

### 2) Actual weather aligning with Forecast:

Actual heating degree days or HDD (an engineering heating metric) were 4% above budget. Actuals were 6,916 heating degree days versus a budget of 6,636. A difference of 281; however, much of the delta is the result of a colder April and does not impact steam use as much as a very cold February.

Enthalpy (a metric that considers temperature and relative humidity) was 1% below forecast.

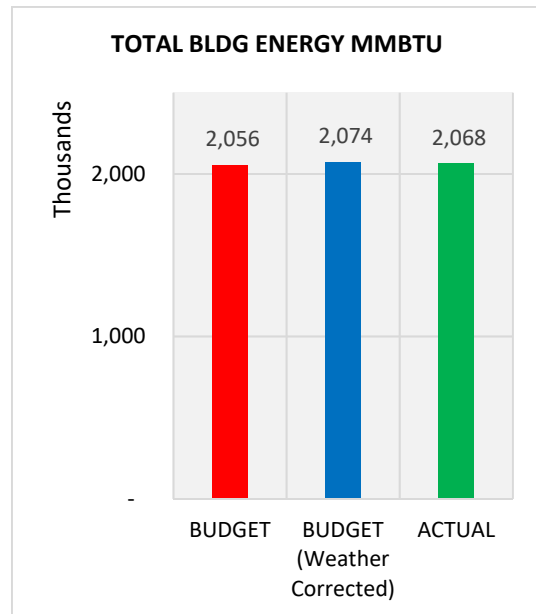
### 3) Keeping It Flat:

Campus wide efforts from Cornell's continuous commissioning team help to maintain good building energy performance.

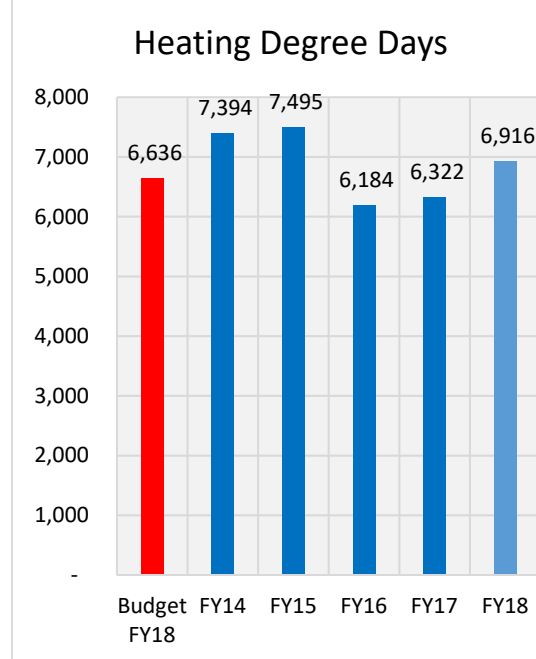
### 4) Wilson Lab:

Wilson Lab usage was 24.1 million kwh, 12% total campus usage. Budgeted usage was 25.9 million kwh. Decrease due to longer summer shutdown for facility maintenance.

## Actual Energy consumption close to budget



## Colder April than budget

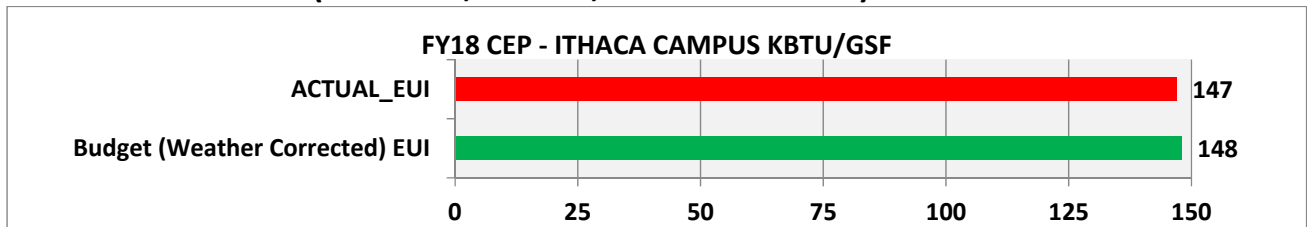




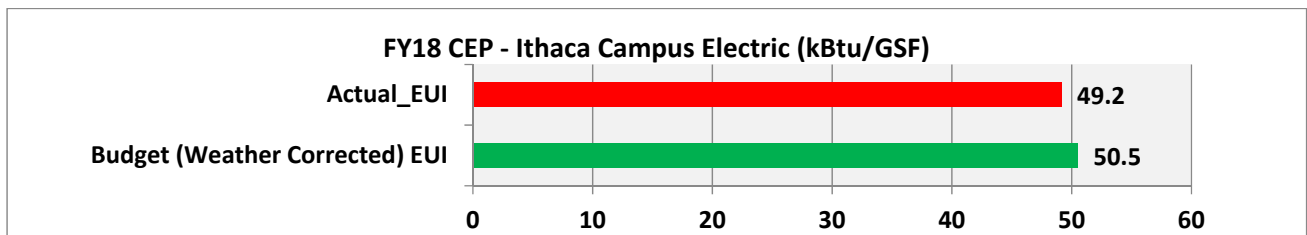
**Energy Use Intensity:**

Energy Use Intensity (kBtu per GSF) for each commodity is below the respective weather corrected projected values. The results demonstrates that efforts to reduce building energy consumption across campus through energy conservation and proper maintenance are effective. Please note (1) cooling energy is the actual energy of the cooling versus the electric energy input to produce the cooling and (2) GSF for each commodity is different.

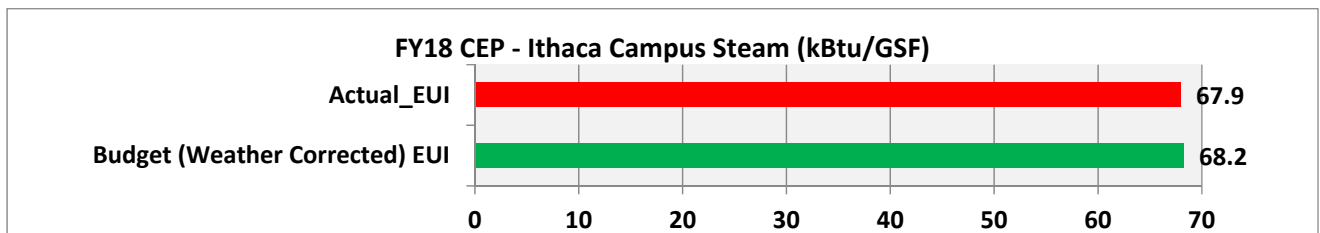
**ALL COMMODITIES (ELECTRIC, STEAM, CHILLED WATER) GSF: 14.1 million GSF**



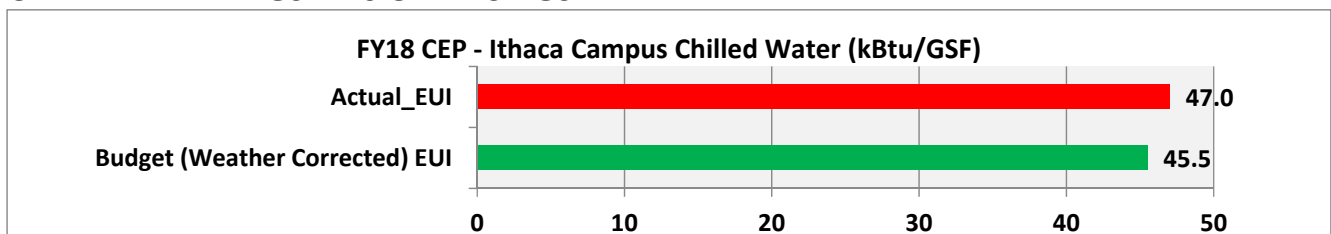
**ELECTRIC GSF: 14.1 million GSF**



**STEAM GSF: 12.8 million GSF**



**CHILLED WATER GSF: 10.8 million GSF**





## Building Metering:

The Cornell Central Energy Plant provides campus heating (steam), electric and cooling (chilled water) to Ithaca campus facilities. These facilities are metered to allow for the recovery of the costs of production, procurement, and maintenance from University departments and administrative units based on usage for each utility. The meters are “Revenue” grade versus “HVAC” grade. A brief introduction of the metering system for each commodity follows:

**Electric meters:** Over 200 facility codes are metered. In addition, there are numerous sub-meters, especially for newer buildings to allow for enhanced usage visibility (i.e. plug load versus lighting). The Electric metering system has a circuit report. Circuits are verified from the building level up through hierarchical circuits to the main production meters. Meters can be verified either from a parallel data logger installed on the service or a revenue grade replacement meter is installed in its place

**Steam meters:** Over 150 facilities are metered. The condensate is actually metered because of the difficulty in reliable steam metering. This Steam/Condensate Metering System is verified monthly by a sales to production report. Anomalies are flagged. Suspect units are checked vs their consumption history. Metering units are standardized to two manufacturers to facilitate competition, as well as, to keep simple enough for document record keeping.

**Chilled Water meters:** Over 100 facilities are metered for chilled water. Chilled Water Metering is verified based by use of a sales to production report. Anomalies are flagged. Suspect units are checked versus their consumption history. Meters are also checked by a download of meter information to an excel spreadsheet for an initial check for suspect data.

Meter data is available online at <https://buildingdashboard.com/clients/cornell/>

To meet financial reporting deadlines the billing month for consumption data is not the same as the calendar month

The number of billing days in the billing month does vary from FY to FY and needs to be considered when comparing monthly values



## Campus Space Snapshot:

The amount of space associated with each commodity differs significantly. This is important when performing energy use intensity (EUI) analysis which focuses on energy (kBtu) per gross square foot (GSF). The space hierarchy is Electric GSF > Steam GSF > District Cooling GSF. For FY 2018 the GSF associated with each commodity is as follows:

Commodity	GSF connected (approx.)
Electric	14,100,000
Steam	12,800,000
District Cooling (i.e. Lake Source Cooling)	10,800,000

We categorize the campus space with each facility assigned a College/Unit. Campus Life (i.e. dorms/campus housing) is the largest category with 19% of the total GSF. The College of Information Science (i.e. Gates Hall) is the smallest at < 1%. The only major building addition for FY18 is the Cornell Health facility.

College/Unit	GSF (1,000s)	% of Total
CAMPUS LIFE	2,700	19%
CALS	2,270	16%
ARTS SCIENCES	1,990	14%
ADMIN SUPPORT	1,300	9%
ENGINEERING	1,190	8%
VET SCHOOL	950	7%
ATHLETICS PHYSED	680	5%
PROVOST SPECIAL	540	4%
LIBRARIES	530	4%
HUMAN ECOLOGY	440	3%
HOTEL ADMIN	350	2%
ILR	280	2%
ARCH ART PLAN	230	2%
LAW SCHOOL	230	2%
JOHNSON MBA	150	1%
BTI	120	1%
INFORMATION SCIENCE	110	1%
TOTAL GSF	14,060	100%

Since 2008, Cornell has added over 1 million GSF of new conditioned space, most lab & research type buildings





## Steam Consumption:

FY 2018 steam consumption was approximately 846,000klbs (871,000 mmBTU). Actuals were 10% below the budgeted value of 840,000 klbs, and below the weather adjusted budget value of 849,000 klbs. The steam budget was based on 6,636 HDD; however, the actual HDD were 6,916 (4% more heating degree days).

Steam usage has decreased over the last 20-years despite significant campus growth and renovation. Without conservation, steam usage would be 25% - 30% higher.

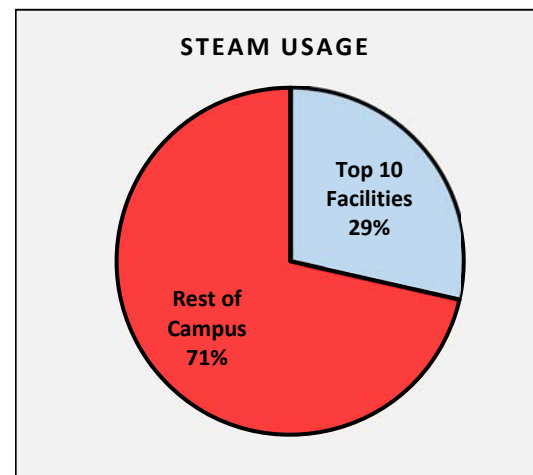
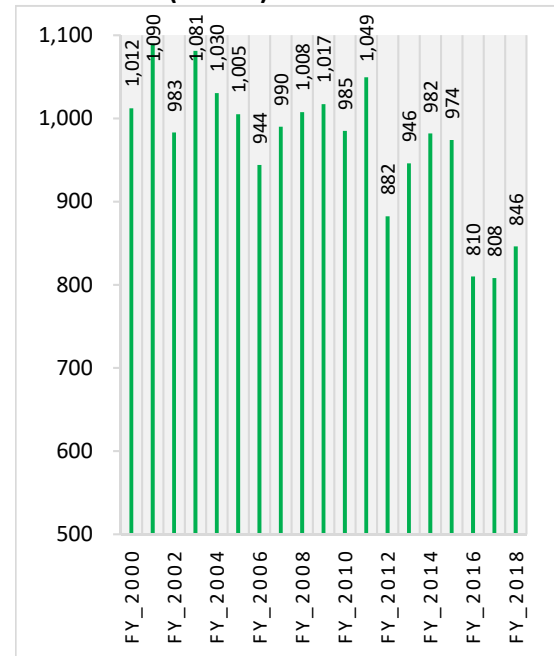
Ten facilities/complex consume 29% of campus steam. These facilities are primarily large research/lab buildings that have significant outdoor air requirements or special heating requirements (i.e. greenhouses).

Facility	Actual klbs	% of Total	Cumulative %
1164 Vet Medical Center	45,716	5.4%	5.4%
1018 Biotechnology	33,005	3.9%	9.3%
2000 Duffield Hall	31,664	3.7%	13.1%
1014 Weill Hall	23,078	2.7%	15.8%
1028B Bradfield Hall	22,880	2.7%	18.5%
2087 Uris Hall	19,805	2.3%	20.8%
2019 Baker Laboratory	17,087	2.0%	22.8%
1068B Guterman Bioclimatic Lab	16,424	1.9%	24.8%
2083 Olin Chemistry Research Wing	15,938	1.9%	26.7%
1150C Schurman Hall	15,849	1.9%	28.5%
<b>Top 10 Totals</b>	<b>241,445</b>		
<b>Campus Totals</b>	<b>845,760</b>		

**FY 2018 steam sales align with weather adjusted budget.**

**Building steam usage is trending downward despite campus growth**

Steam Sales (mmlbs)





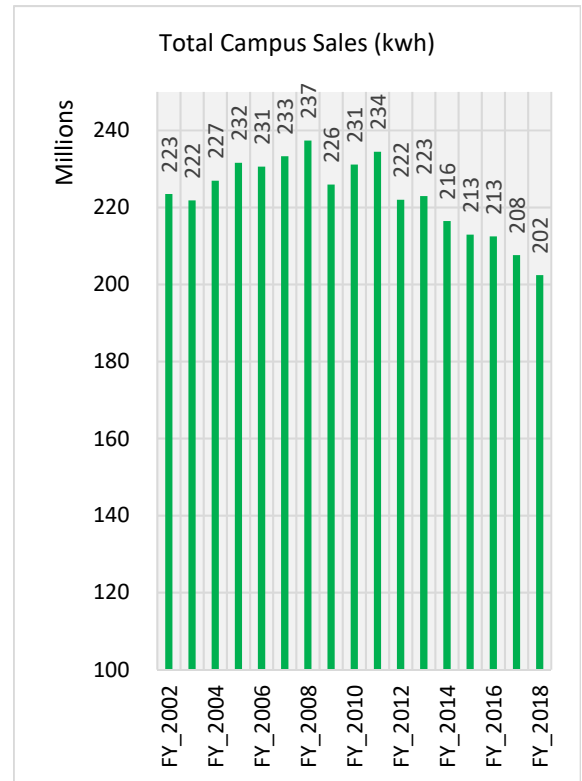
### Electric Consumption:

Electric consumption for FY 2018 was 202.4 million kwh; approximately 0.3 million kwh higher than the budgeted value of 202.1 million kwh.

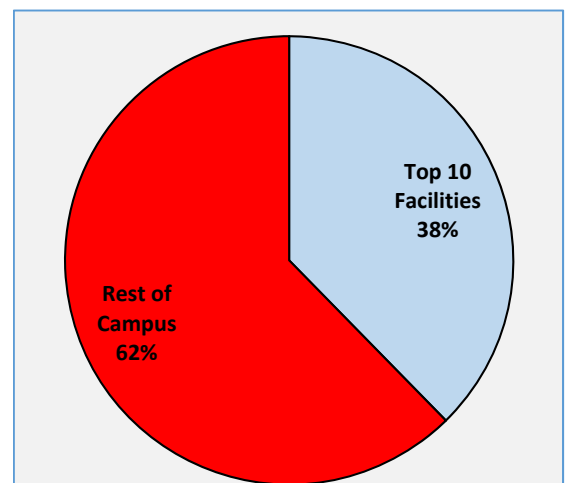
Ten facilities (see table below) are responsible for 36% of the campus electric sales despite being just 16% of the space. These ten facilities have a large research/lab focus.

Facility	Actual kwh	% of total	Cumulative %
2085 Wilson Synch	24,132,165	12%	12%
1164 Vet Medical Center	8,610,400	4%	16%
2000 Duffield Hall	7,512,800	4%	20%
2051 Frank H T Rhodes Hall	6,505,600	3%	23%
1014 Weill Hall	6,317,200	3%	26%
1018 Biotechnology	4,772,640	2%	29%
2082 Clark Hall	4,095,500	2%	31%
1076 Boyce Thompson Institute	3,997,500	2%	33%
2076 Physical Sciences Building	3,985,800	2%	35%
1041 Stocking Hall	3,942,400	2%	36%
<b>Top Ten Totals</b>	<b>73,872,005</b>		
<b>Campus Totals</b>	<b>202,448,450</b>		

**FY18 Electric Sales are the lowest in the last 20 years; despite campus growth of over 2 million GSF**



**Ten facilities use 36% of electricity**







## Chilled Water Consumption:

Chilled Water consumption for FY 2018 was 42.2 million ton-hrs; 1.4 million ton-hrs higher than the weather adjusted budgeted value of 40.8 million ton-hrs. Much of the increase is associated with higher than anticipated usage by the Central Energy Plant.

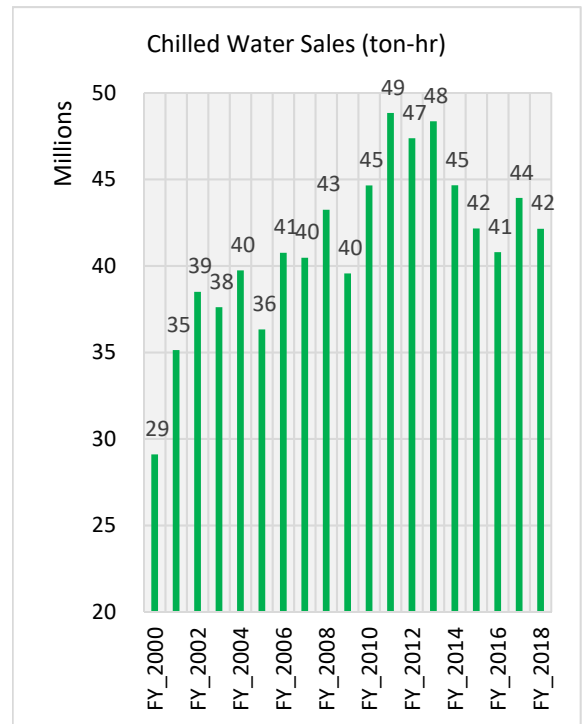
Ten academic facilities use 38% of the campus chilled water. The facilities are major lab/research facilities with significant airflow requirements.

The Central Energy Plant uses the most cooling, 4.1 million ton-hrs. The CEP uses chilled water for air inlet cooling and equipment cooling.

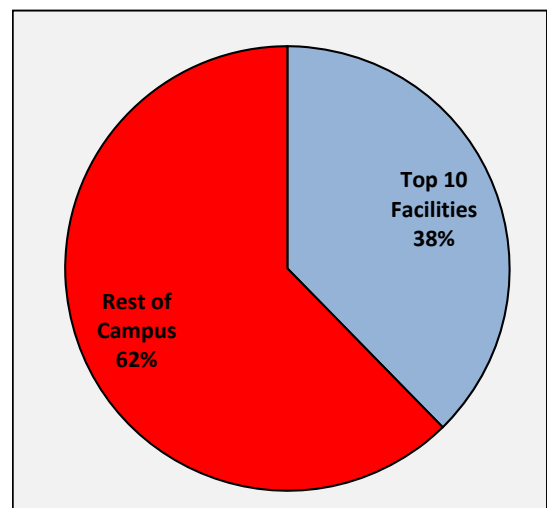
Facility	Actuals	% of total	Cumulative %
2000 Duffield Hall	2,209,290	5%	5%
2085 Wilson Synch	2,151,099	5%	10%
1164 Vet Medical Center	2,078,802	5%	15%
2051 Frank H T Rhodes Hall	1,827,845	4%	20%
1014 Weill Hall	1,813,769	4%	24%
1018 Biotechnology	1,353,287	3%	27%
2082 Clark Hall	1,327,574	3%	30%
2076 Physical Sciences Building	1,121,745	3%	33%
2087 Uris Hall	1,074,420	3%	35%
1041A Stocking Hall Addition	922,657	2%	38%
<b>Top Ten Totals</b>	<b>15,880,488</b>		
<b>Campus Totals</b>	<b>42,149,572</b>		

The 15+ year trend in chilled water sales reflects the growth of “conditioned” buildings. The GSF of “conditioned” space has increased over 35% due to new growth and renovations. Usage by the Central Energy Plant increased dramatically with the start-up of combined heat & power in FY2010. Growth in summer programs/camps have increased building summer occupancy.

Since 2000, GSF associated with chilled water has grown 37%, over 2.3 million GSF of new/renovated conditioned space.



Ten facilities use 38% of the chilled water for FY16





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## Building Energy Use Intensity

Building Energy Use Intensity (EUI) is provided for each commodity (chilled water, electric and steam) along with natural gas usage at the building (if data readily available from ebs). The EUI is based on the largest connected GSF. The highest EUIs are associated with intensive lab/research spaces.

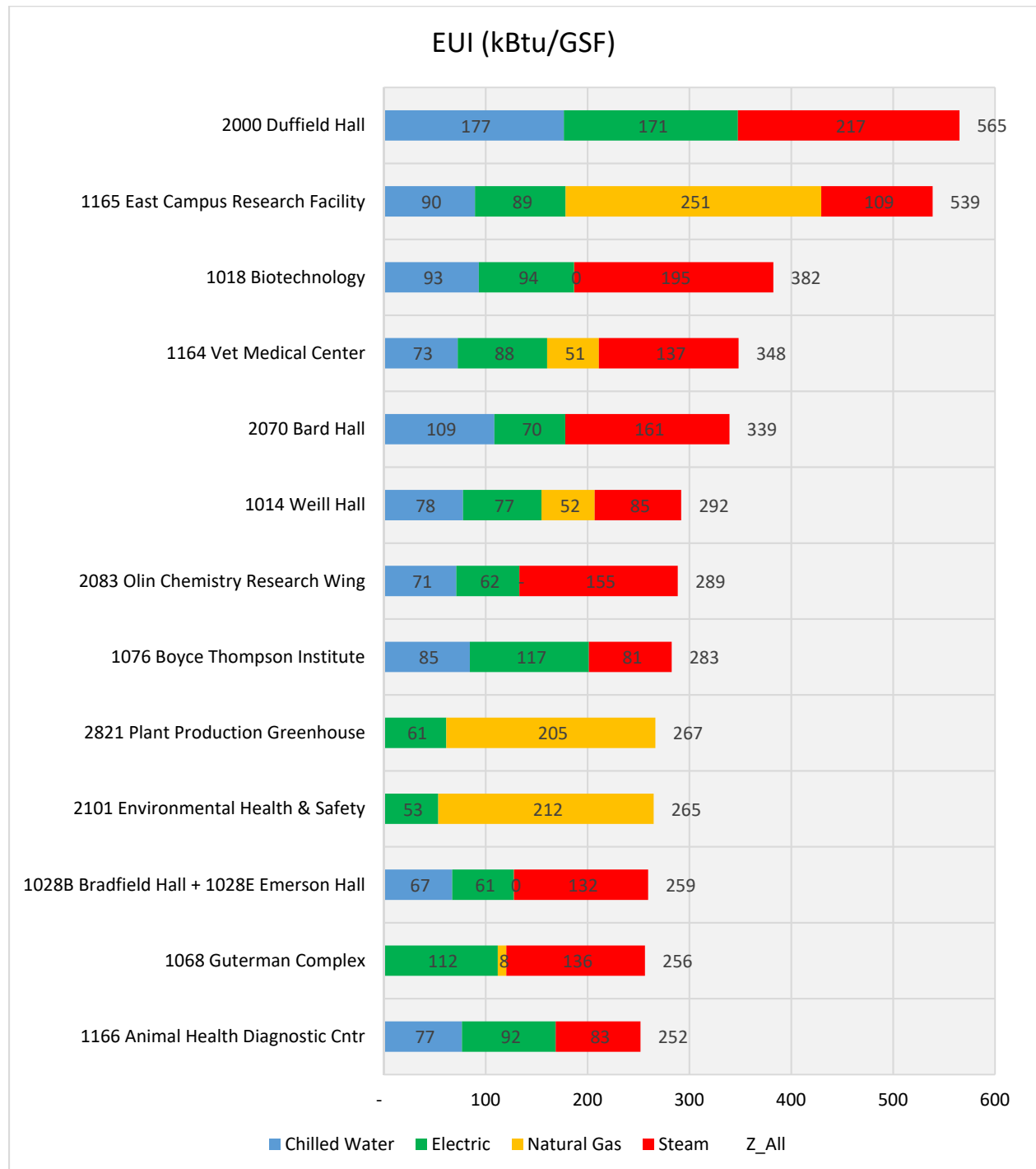
The list below only include facilities with at least two commodities provided by the central energy plant. This typically includes electric and steam.

The campus average EUI is 155 kBtu/GSF, 35 for chilled water, 49 for electric, 62 for steam and 9 for natural gas used at the buildings based on 14.1 million GSF.

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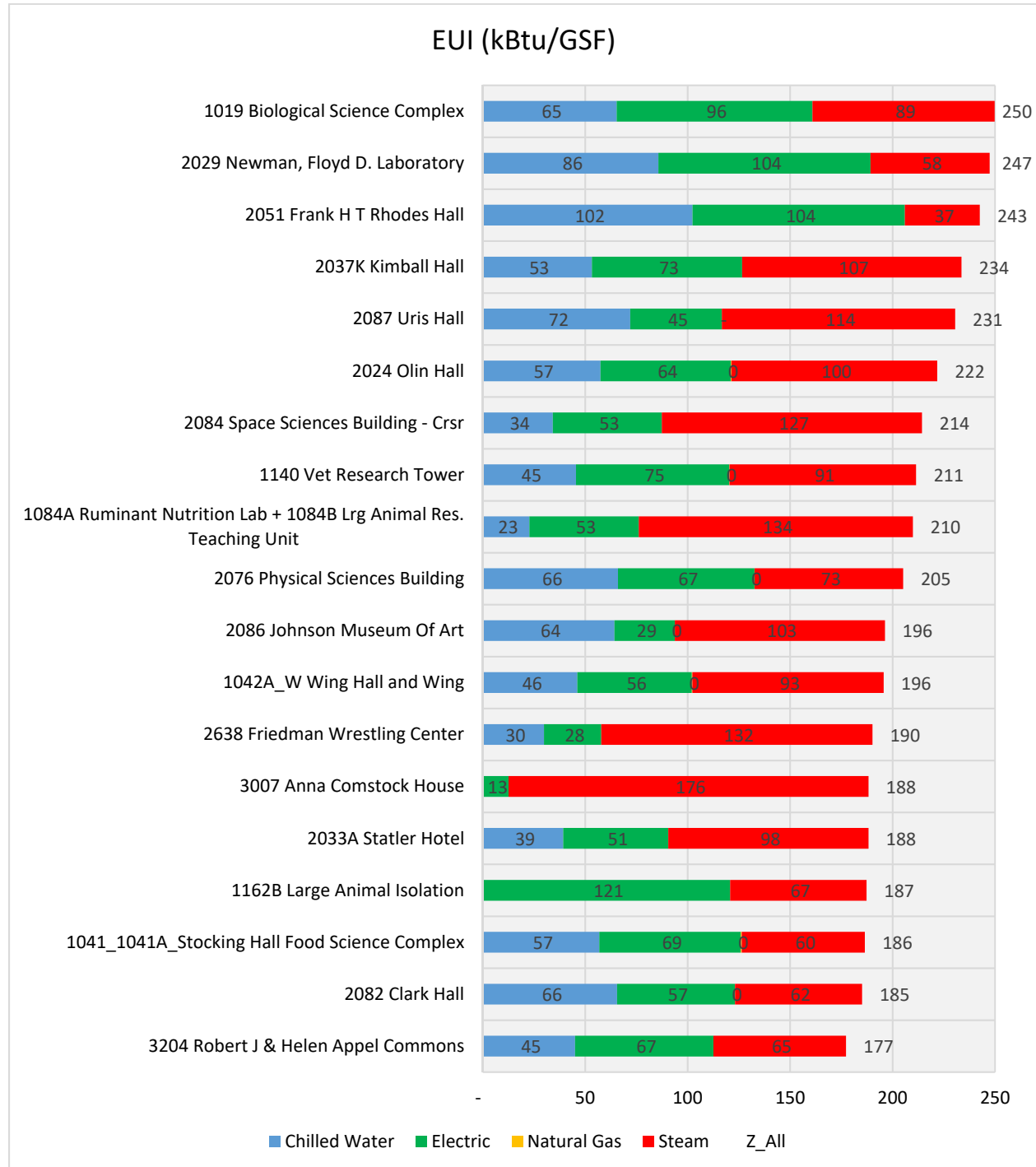
EUI > 250 kBtu/GSF: These facilities are lab/research and greenhouses. Duffield Hall is the highest at 565, followed by East Campus Research Facility. ECRF uses a large quantity of natural gas for hot water cage washing. Note: for this analysis we have excluded two unique facilities, (1) Wilson Lab and (2) Vet Waste Management Facility.





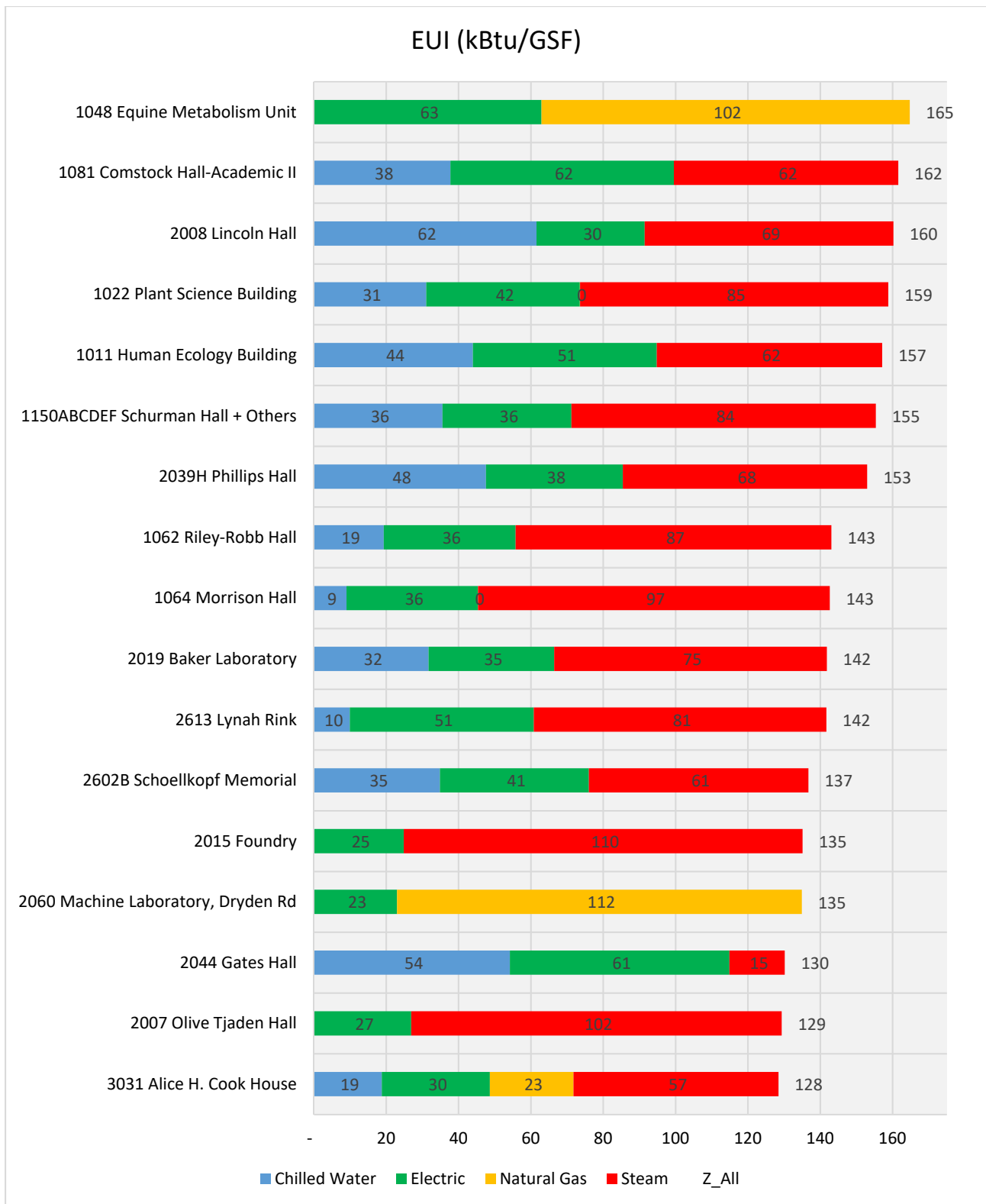
EUI: 175 to 250 kBtu/GSF

The majority of these facilities have a significant lab/research component, or other unique high energy component (such as laundry for Statler Hotel).



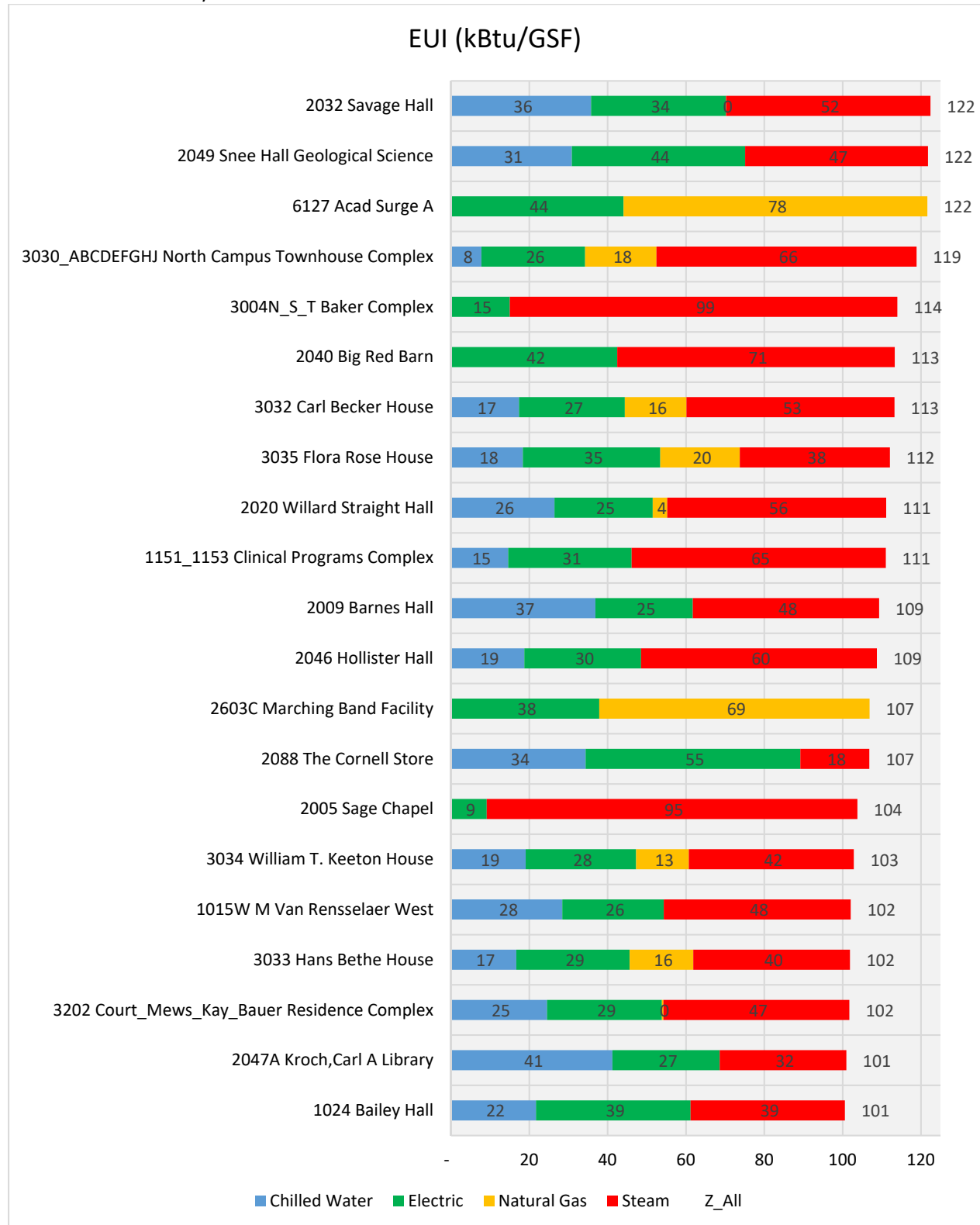


EUI: 125 to 175 kBtu/GSF



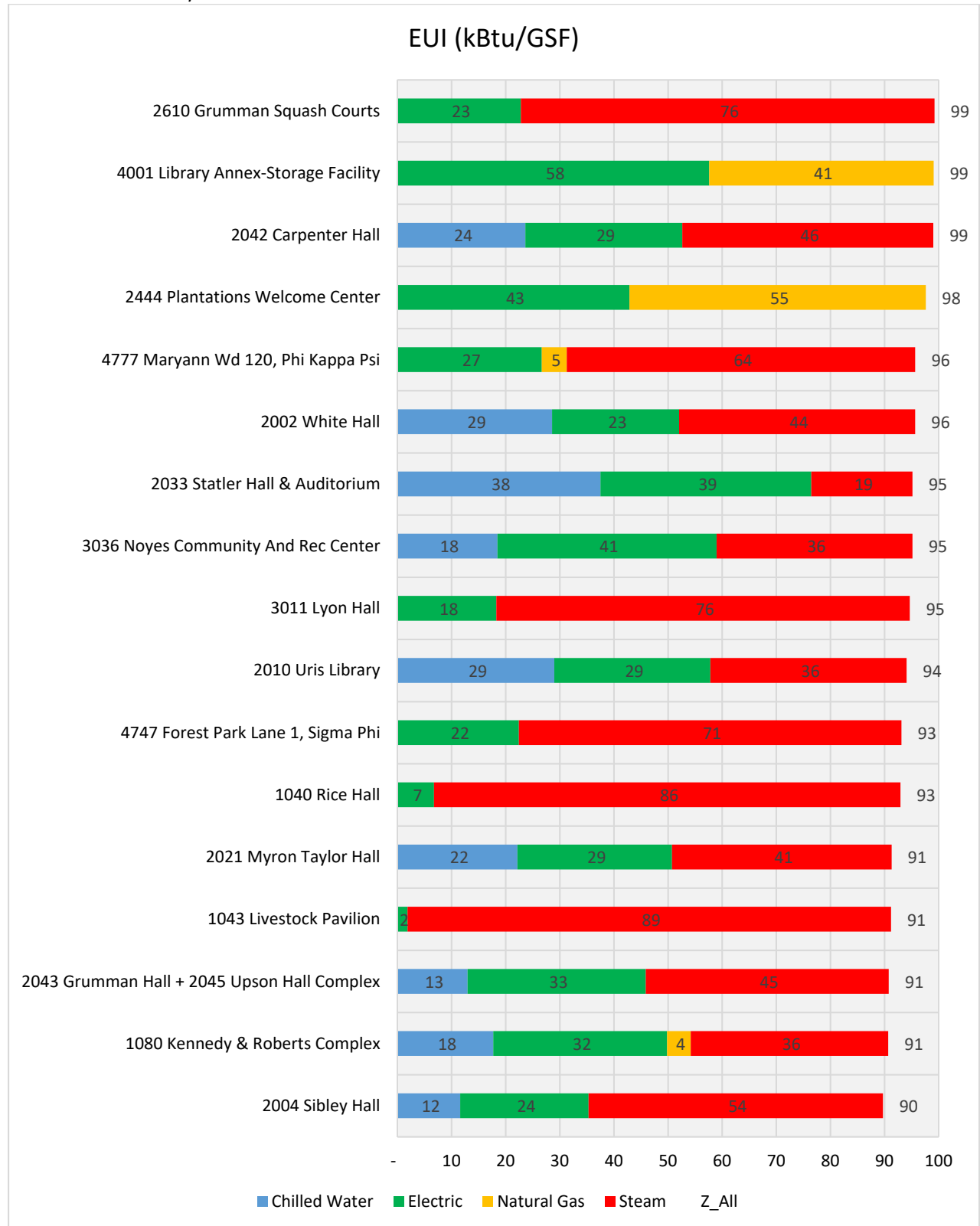


EUI: 100 to 125 kBtu/GSF



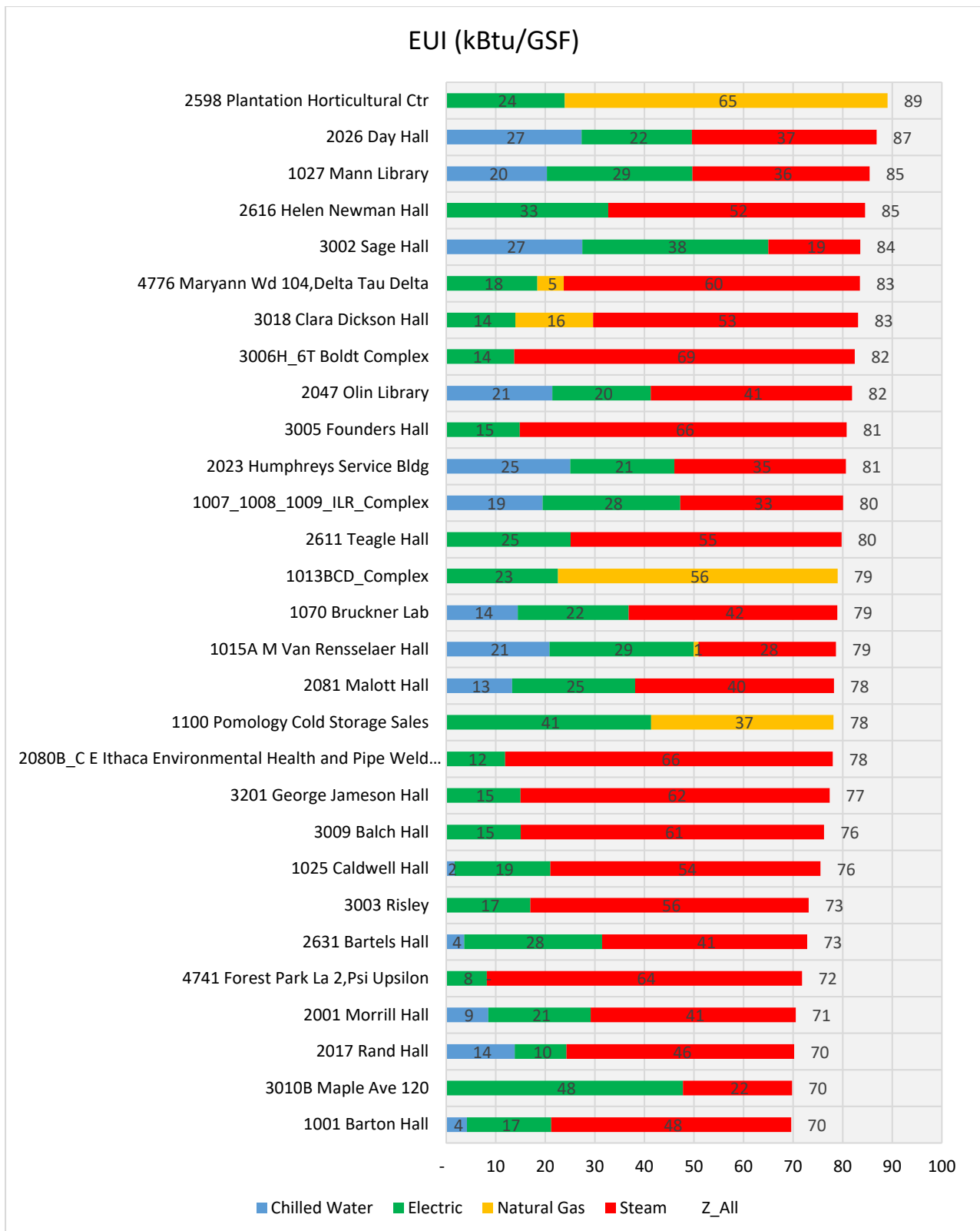


EUI: 90 to 100 kBtu/GSF





EUI 70 to 90







EUI <70

