

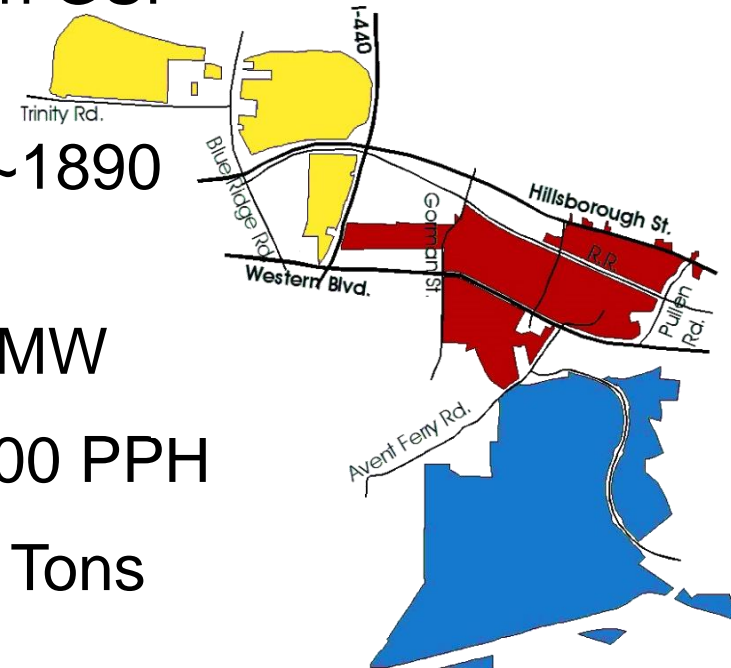


USING CHP FOR SUPPORT OF PRIVATE AND PUBLIC FACILITIES

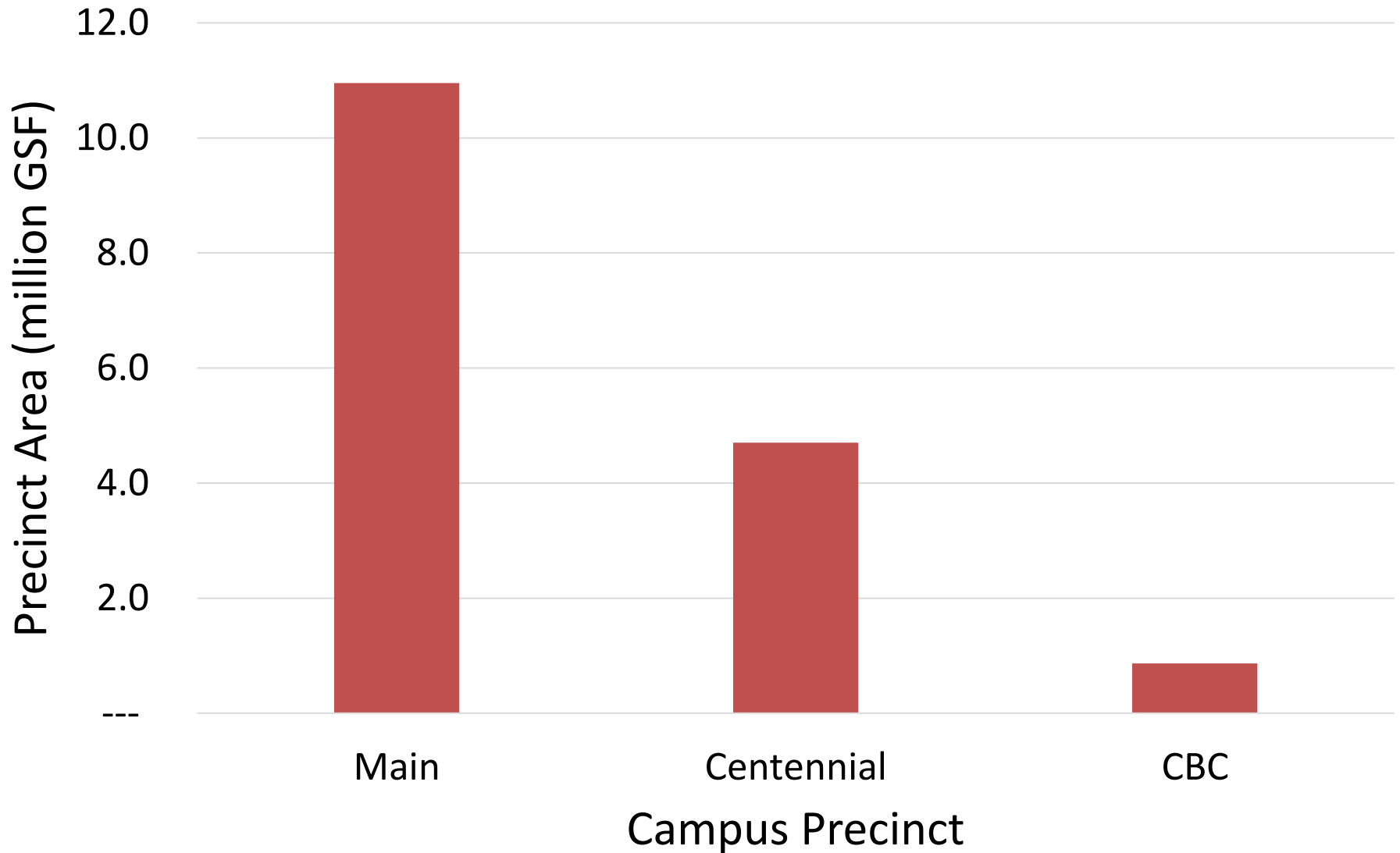
Presentation by Jeff Hightower and Jerry Schuett | February 2016

North Carolina State University Overview

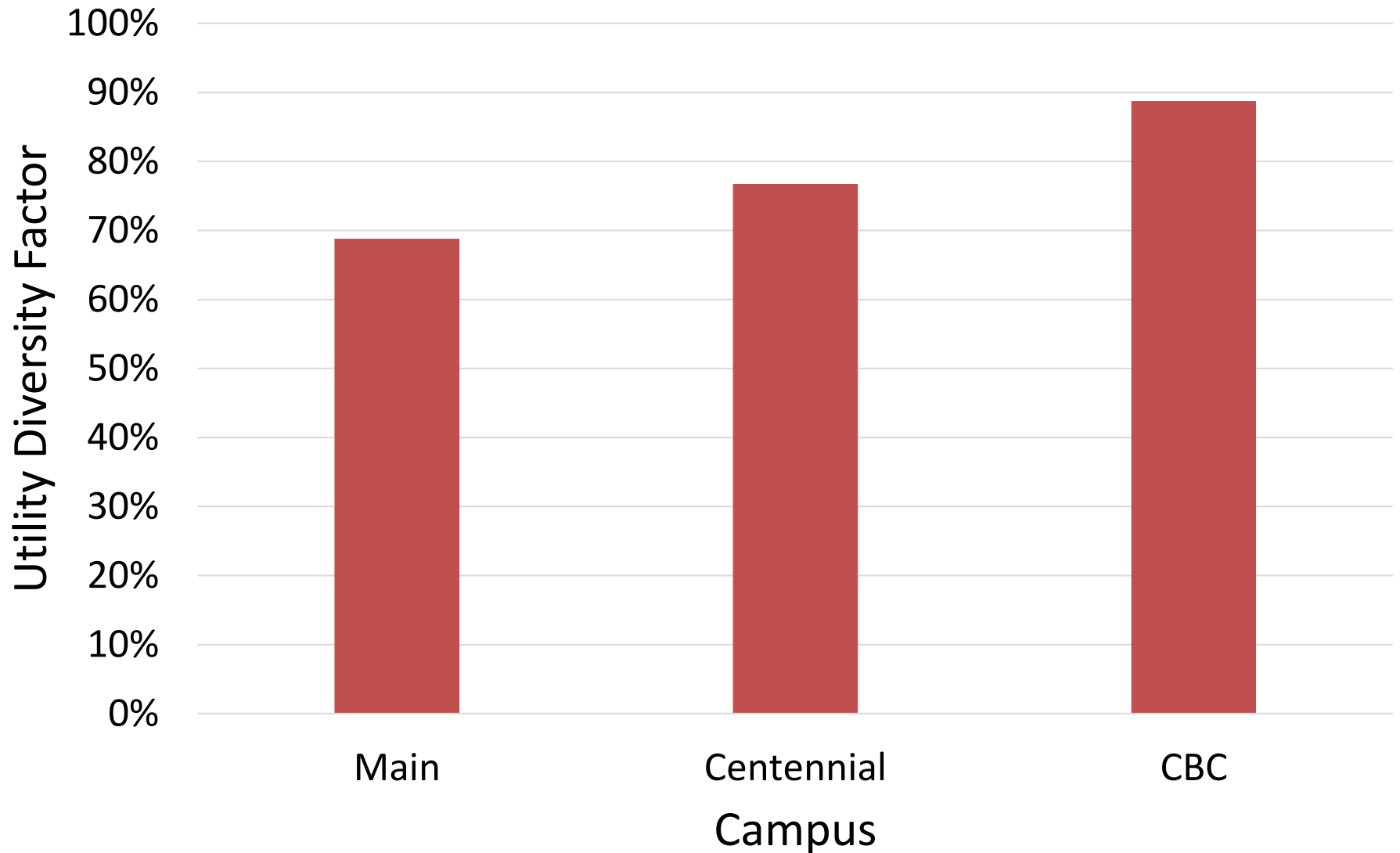
- University Founded in 1887
- Student Population: ~31,000
- Staff and Faculty: ~8,400
- Campus Building Area ~16.5 million GSF on Three Campuses
- Known Utility Ages on Campuses ~1890 to Present
- Est. Electrical Peak Demand: ~90 MW
- Est. Steam Peak Demand: ~350,000 PPH
- Est. CHW Peak Demand: ~25,000 Tons



Campus Building Area

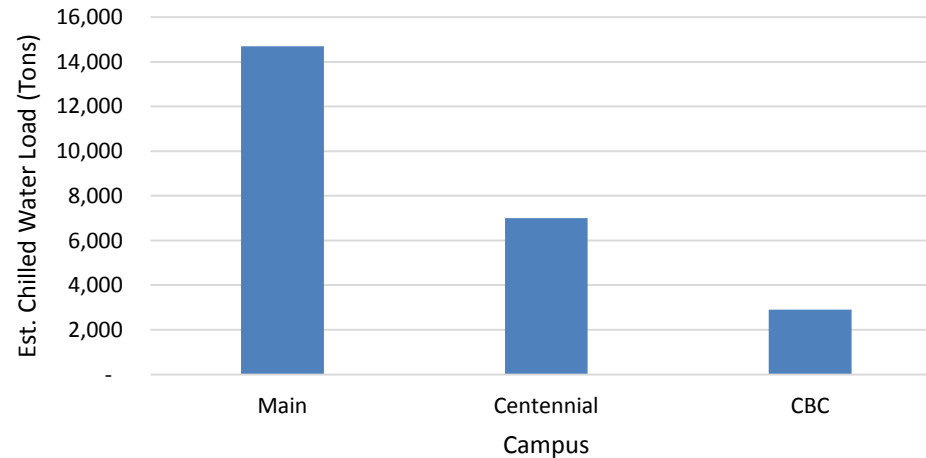


Campus Utility Diversity

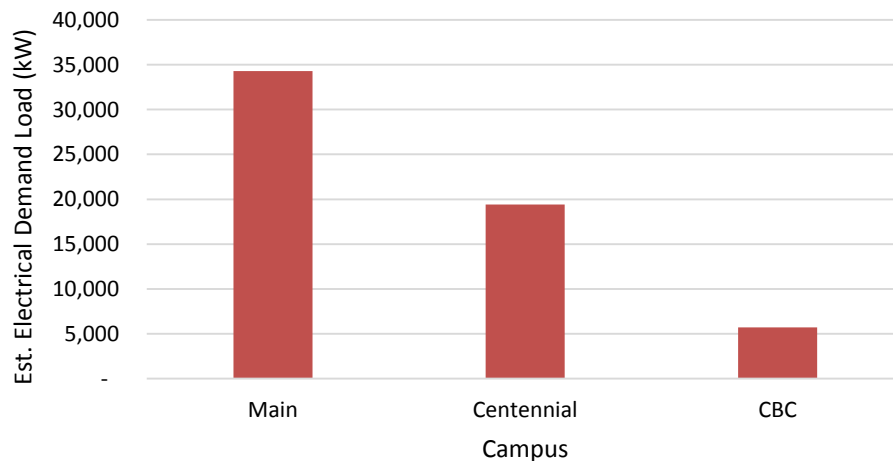


North Carolina State Utility Overview

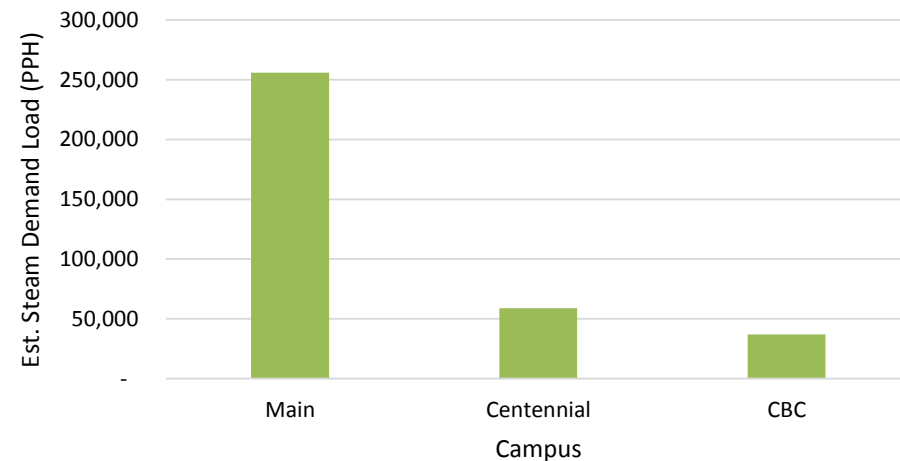
Connected Chilled Water Load by Campus



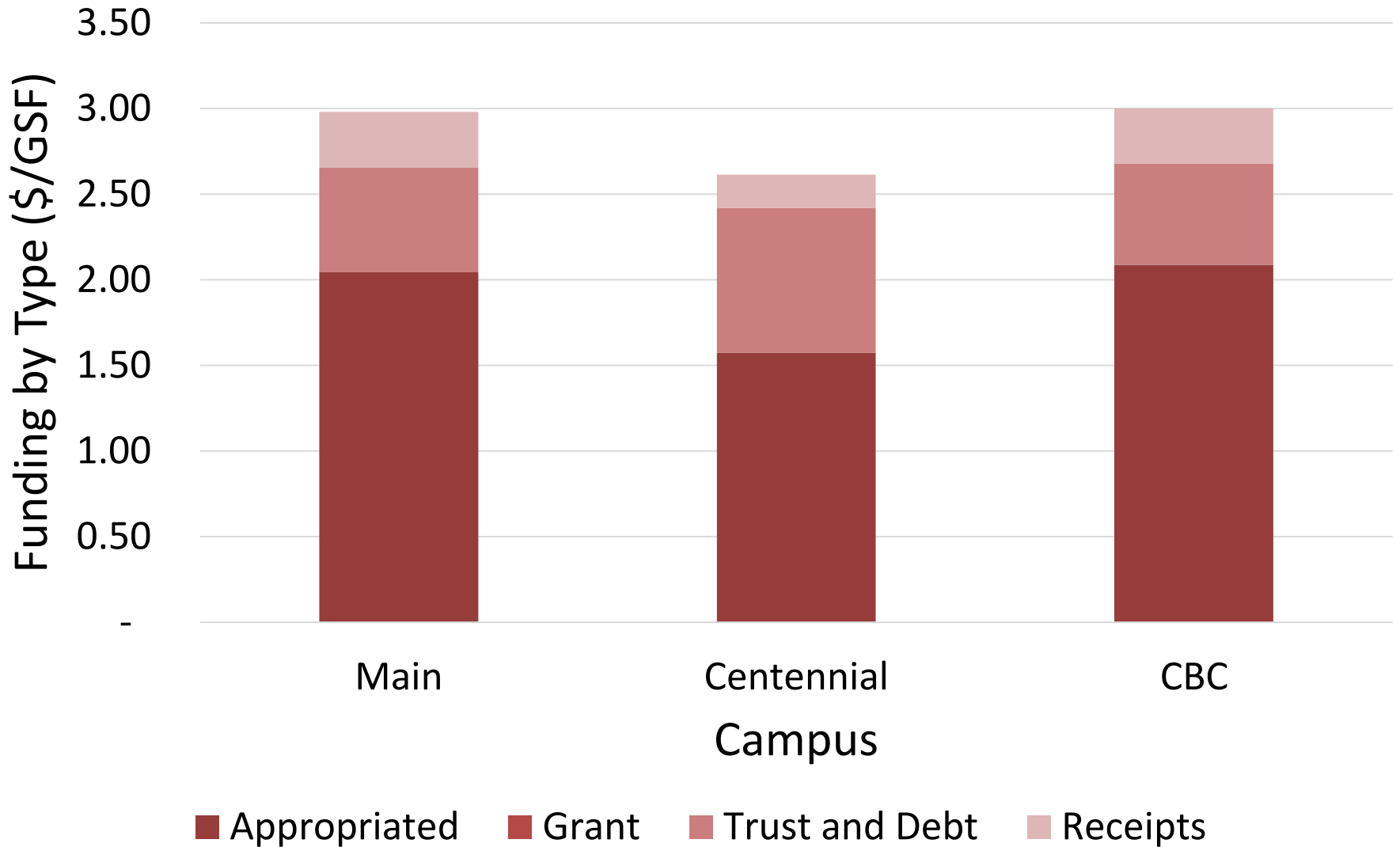
Connected Electrical Load by Campus



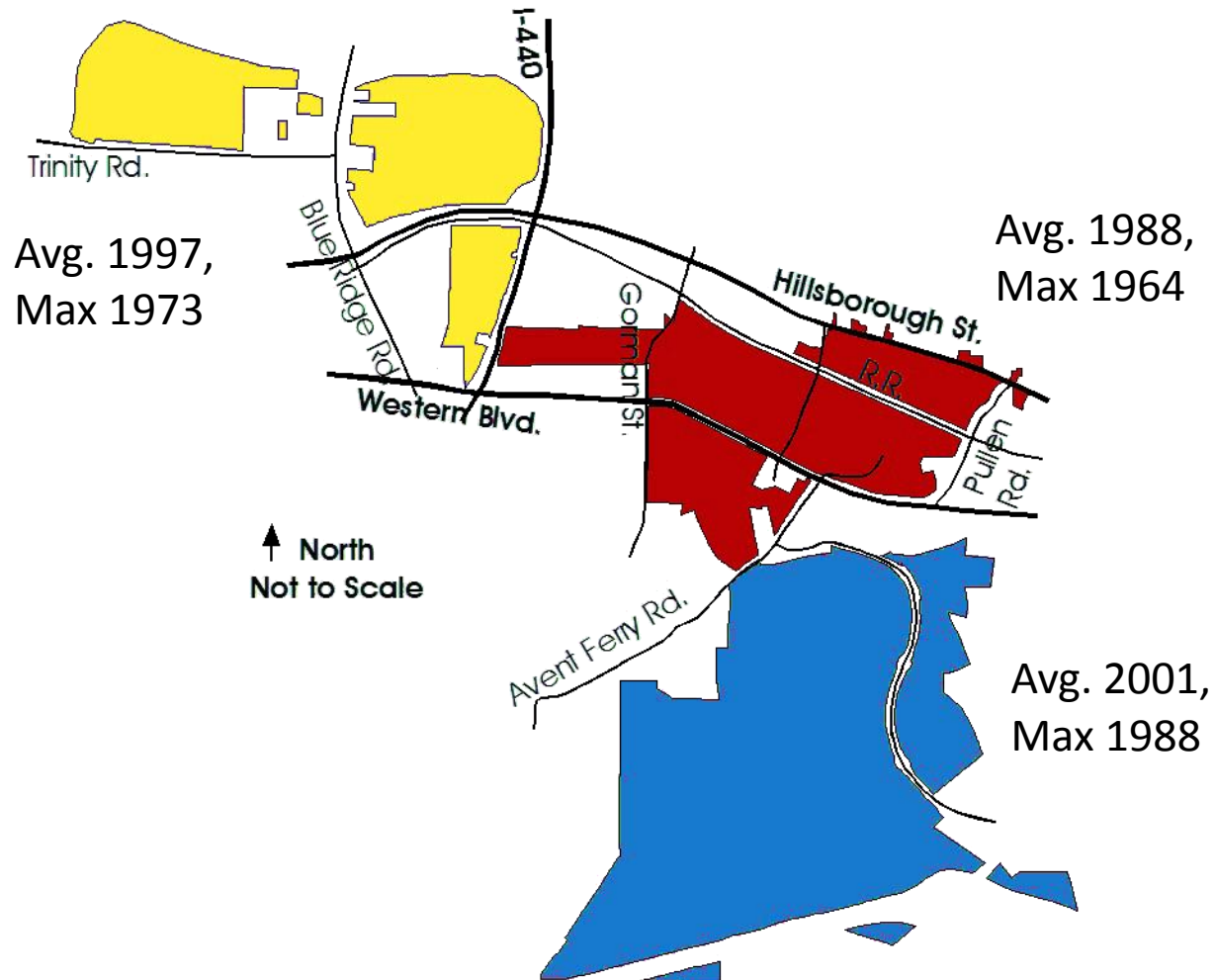
Connected Steam Load by Campus



Maintenance Funding by Campus



Transformer Ages by Campus

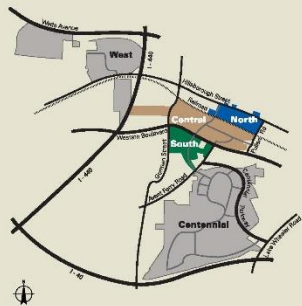


NORTH, CENTRAL, AND SOUTH CAMPUS PRECINCTS

The Precinct Plans are renderings that illustrate the vision of campus. The drawings give form to the projects highlighted in the 6-Year Capital Plan.

KEY PROJECTS

1. Broughton Hall Renovation & Addition
2. Carmichael Addition & Renovation
3. Dabney Hall Renovation
4. Western Boulevard Pedestrian/Bicycle Tunnel
5. Science Commons Building
6. Varsity Drive Recreation Fields



NC State North and Central Campus CHP

- Performance Contract
- Improved reliability and efficiency
- Two Combustion Turbines w/HRSGs (~5.5 MW/each)
 - Natural Gas and No. 2 Fuel Oil
- PSD Exemption
 - 40 CFR 51.166 (i)(1)(i) (SIP)
 - 40 CFR 52.21(i)(1)(vi) (Federal)
- Permitted CT w/HRSG 8,760 hrs/yr
- Environmental Improvement
- Operator Opportunities



Annual GHG Emissions for Main Campus

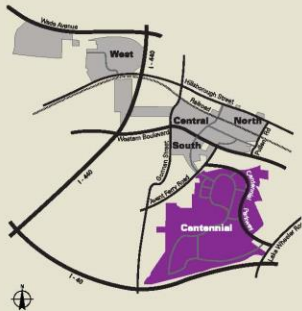
Scope	GHG Source	2010 GHG Emissions (MTCO2e)	2013 GHG Emissions (MTCO2e)	Difference GHG Emissions (MTCO2e)	Percent Diff. GHG Emissions (%)
1	Natural Gas	38,703	58,026	19,324	50%
	Fuel Oil	8,355	1,609	(6,746)	-81%
2	Electricity	92,887	46,421	(46,466)	-50%
Total	---	139,944	106,056	(33,888)	-24%

CENTENNIAL CAMPUS PRECINCT

The Precinct Plans are renderings that illustrate the vision of campus. The drawings give form to the projects highlighted in the 6-Year Capital Plan.

KEY PROJECTS

- 9. Engineering Building - The Oval
- 10. Plant Sciences Research Building
- 11. Town Center
- 12. Textile Innovation Center
- 13. Hotel and Conference Center
- 14. North Shore Residential



Similar University Campuses

AURP >700 Parks

GA Tech

UNC-G

UNC-CH

UMBC

UMCP

Univ. Oklahoma

VA Tech

Univ. City Sci. Ctr

Purdue University

Univ. New Orleans

Univ. Arizona

U of Wisc. Madison

Univ. Illinois

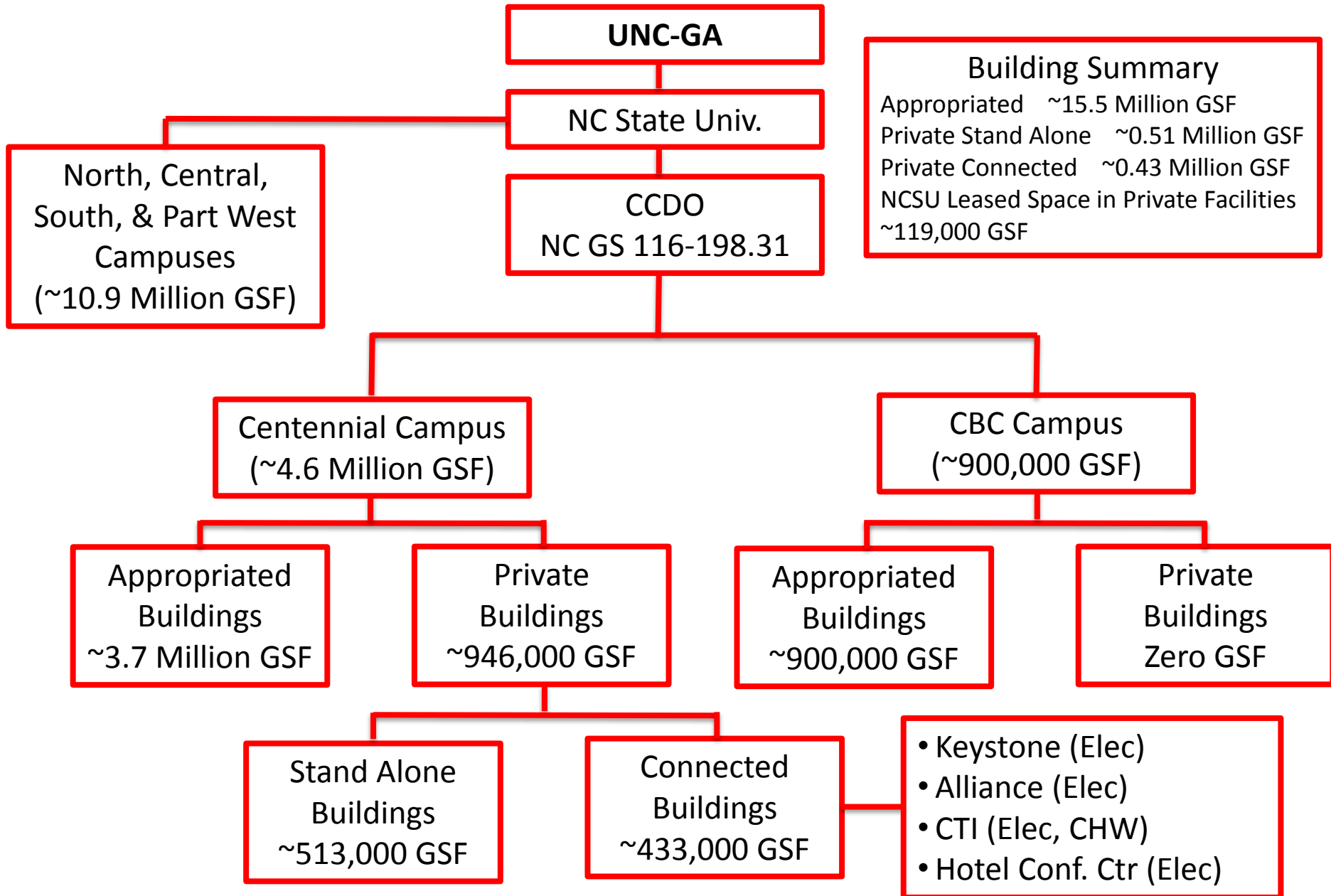
LSU

Others

NC State Regulations

- Centennial Finance Act (NC GS 116-198.31)
 - Centennial, Horace Williams & Millennial Campuses
 - Allows for Bonds with recuperation from leases & fees
- Umstead Act and Exemptions (NC GS 66-58)
 - No Competition with Private Entities
 - Except Univ. utilities operational prior to Jan. 2005
- Self Performed Performance Contracting (NC GS 143-64.17)
 - Term ≤ 20 Years (NC GS 143-64.17B)
- HB 1292
 - Reinvestment of Utility Savings

NC STATE UNIVERSITY



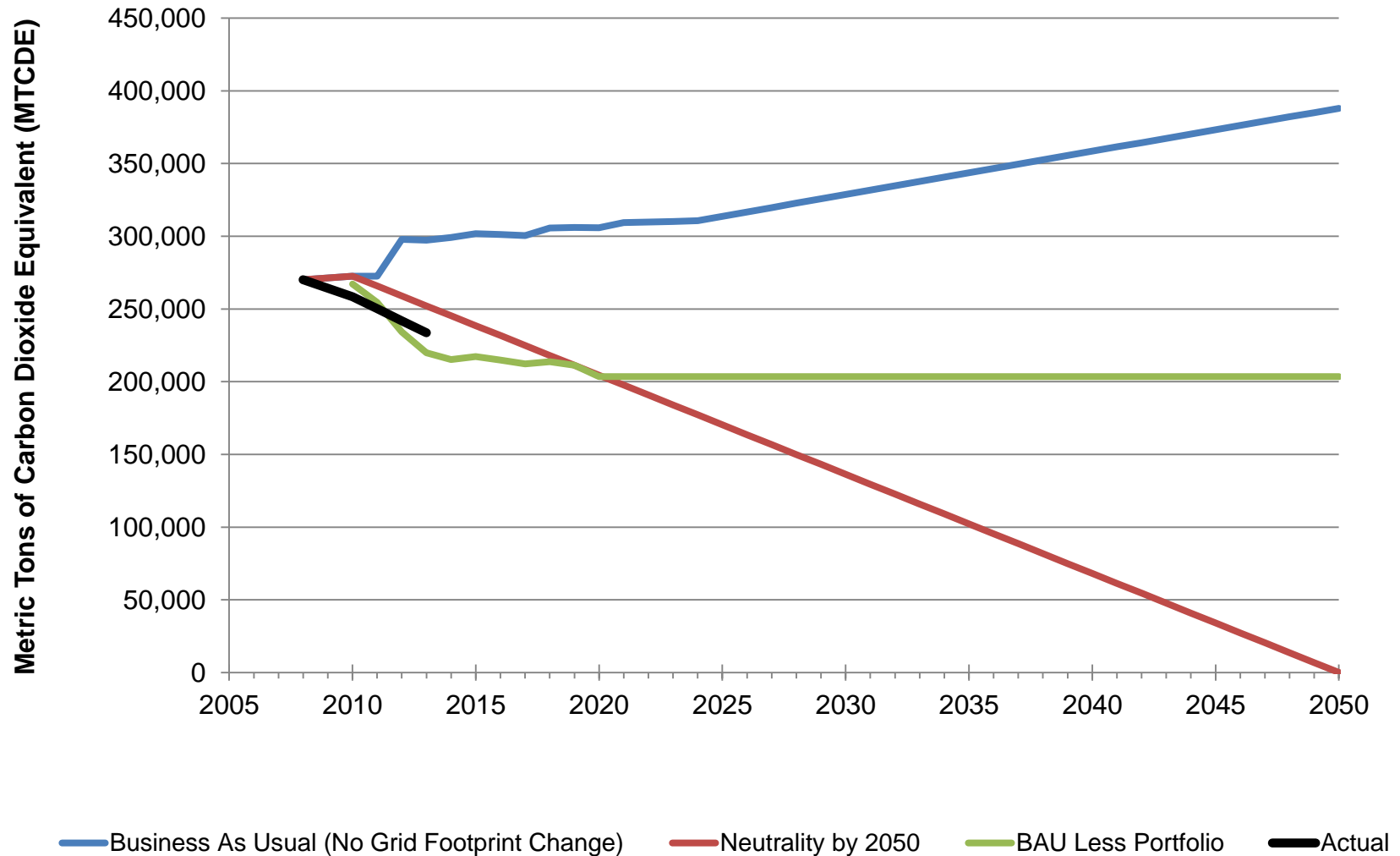
NC State Centennial Campus CHP

- Combustion Turbine w/HRSG (~5.7 MW)
 - Natural Gas and No. 2 Fuel Oil
- Convert Boiler No. 4 from No. 6 Oil to No. 2 Oil
- Remove No. 6 Fuel Oil Requirement from Air Permit
- Remove PSD Restrictions on Boiler No. 4
- Request PSD Exemp. for CC CT w/HRSG and Boiler 4
 - 40 CFR 51.166 (i)(1)(i) (SIP), 40 CFR 52.21(i)(1)(vi)
- Permit CT w/HRSG and ES-45 for 8,760 hrs/yr
- Streamline Reporting Requirements

Draft Emissions Estimate for CC Project

Criteria Pollutant	Boiler 4 No. 6 FO Actual Emissions (TPY)	ES-TES1 Actual Max Emissions (TPY)	Boiler 4 No Limit Pot. Emissions (TPY)	Cogen Unit Potential (TPY)	Project Emissions for Cogen (TPY)	Project Emissions for Boiler (TPY)
PM	0.27	0.21	9.51	17.81	26.84	18.54
PM 10	0.14	0.15	3.11	17.81	20.63	5.93
PM 2.5	0.05	0.05	2.39	17.81	20.10	4.68
SO2	2.24	0.83	204.58	24.53	226.04	406.09
NOx	1.02	1.35	57.63	93.18	148.44	112.89
CO	0.14	2.27	33.22	43.57	74.38	64.03
VOC	0.03	0.15	2.18	10.31	12.30	4.17

GHG Annual Emissions

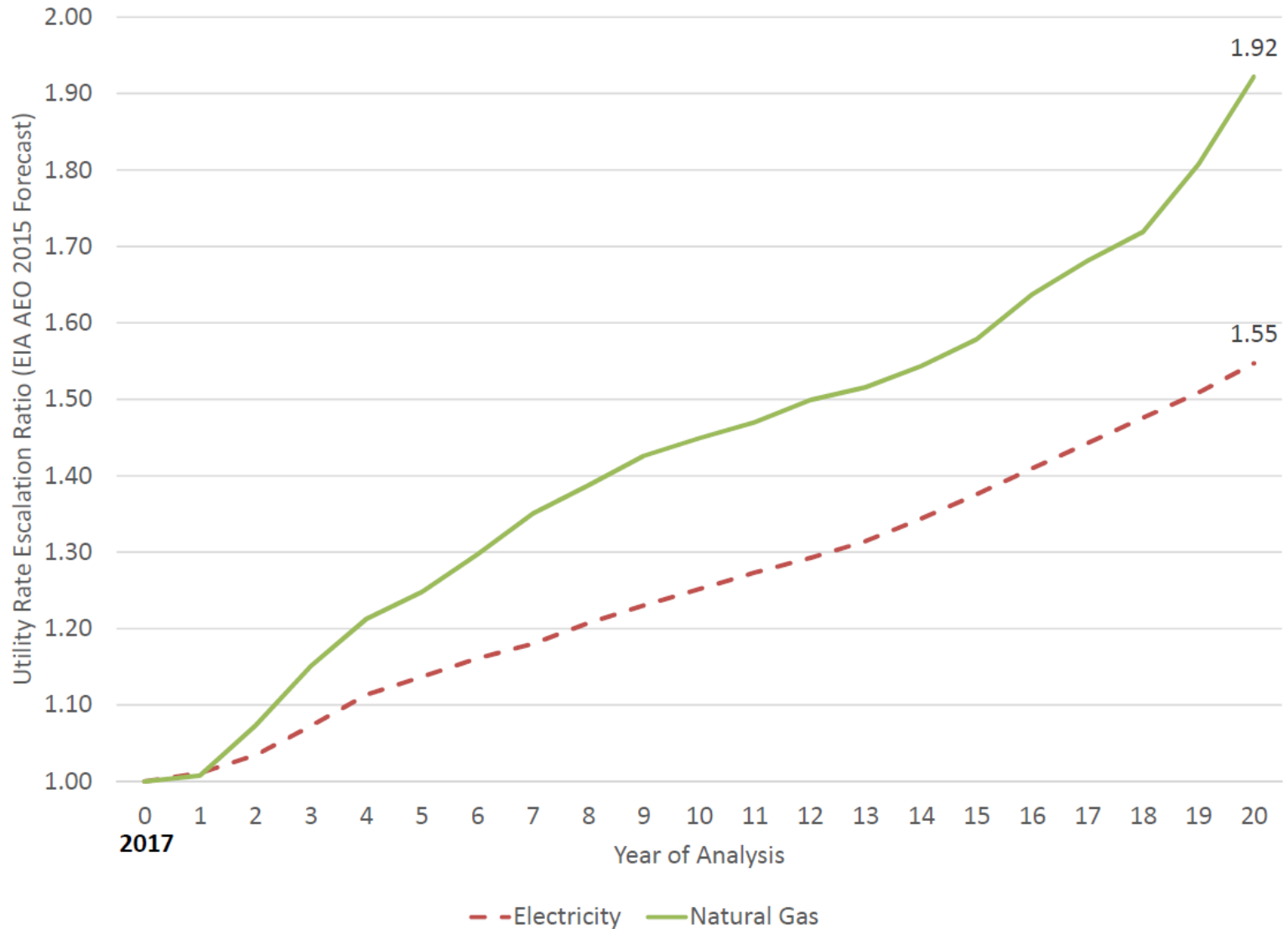


Self Financed Performance Contract

How is it different?

- Capital has a fixed limit
 - Partially self-funded, partially state/university funded
- Payback period is set
 - < 20 years per regulatory requirements
 - NC State prefers a 'buffer' - , 16-17 years
- Need to use auditable benchmarks for NG/electric escalation rates

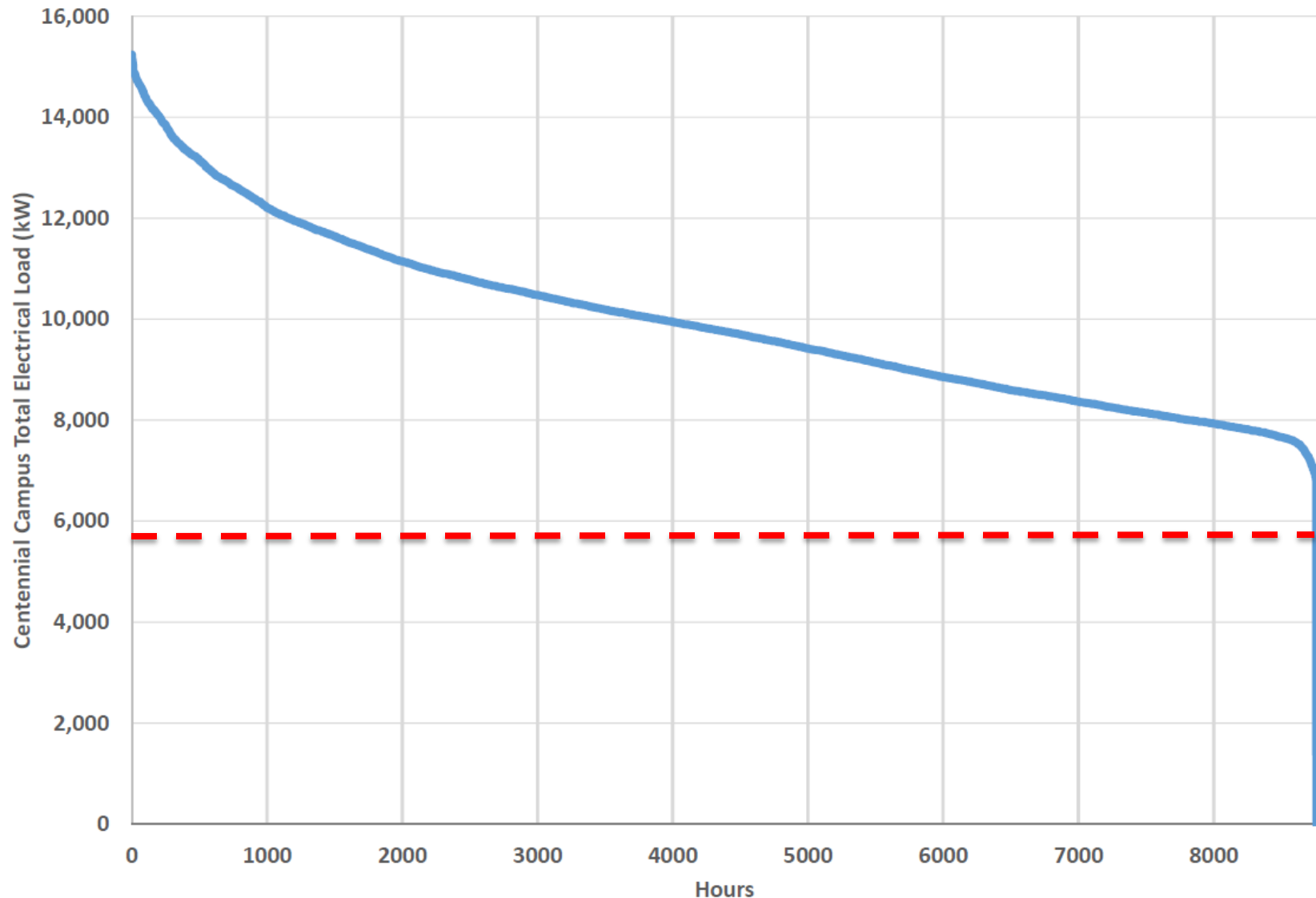
EIA Utility Escalation Projections



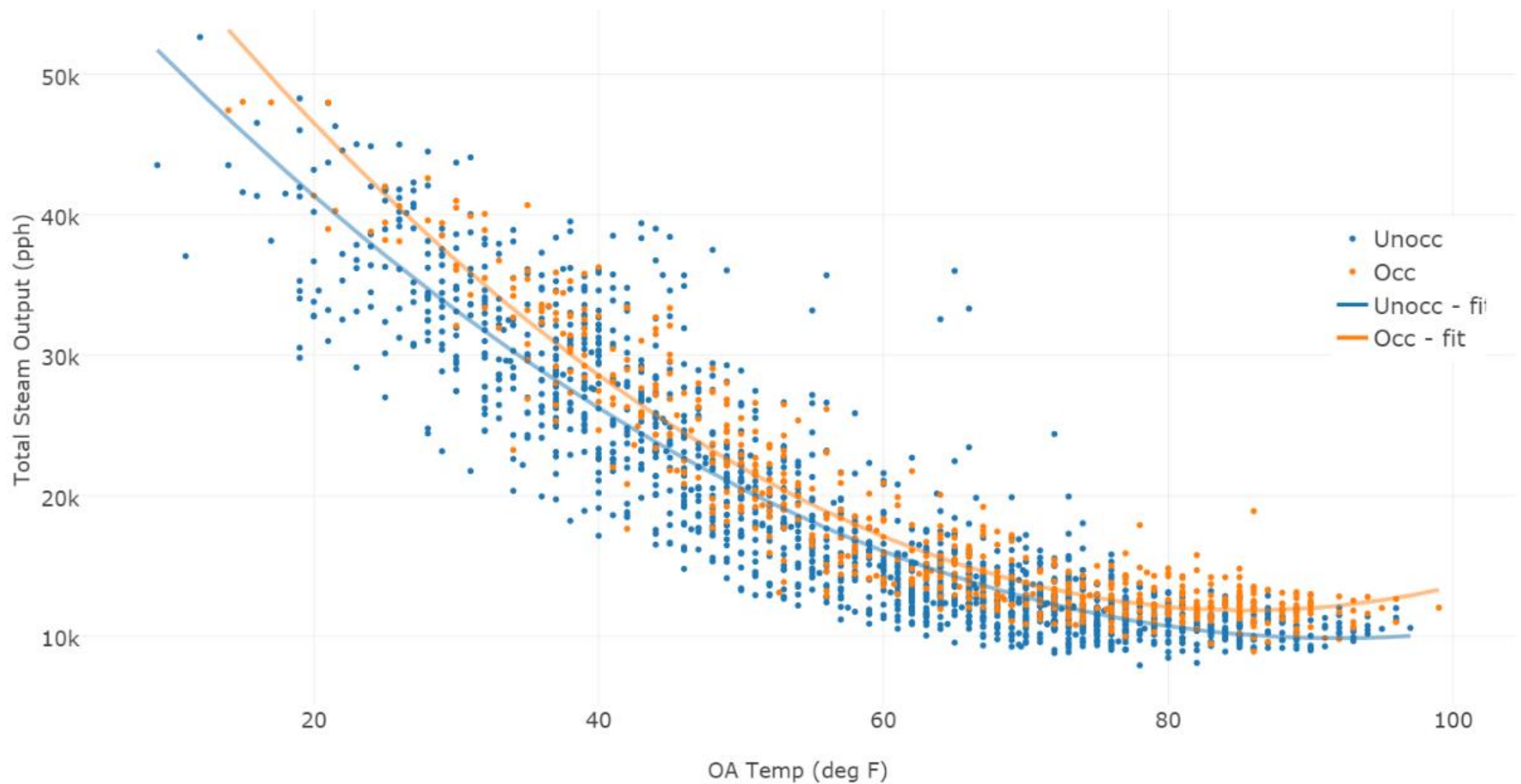
Unique CHP Challenges at Centennial Campus

- Campus developed with unitary thermal equipment – much of that still remains
- Many of the buildings are high electric, low steam demand (Electrical Engineering, Hunt Library)
- Non-automated load data acquisition system
- Low NG system pressure available (25 psi)
- No building space exists to house CHP equipment

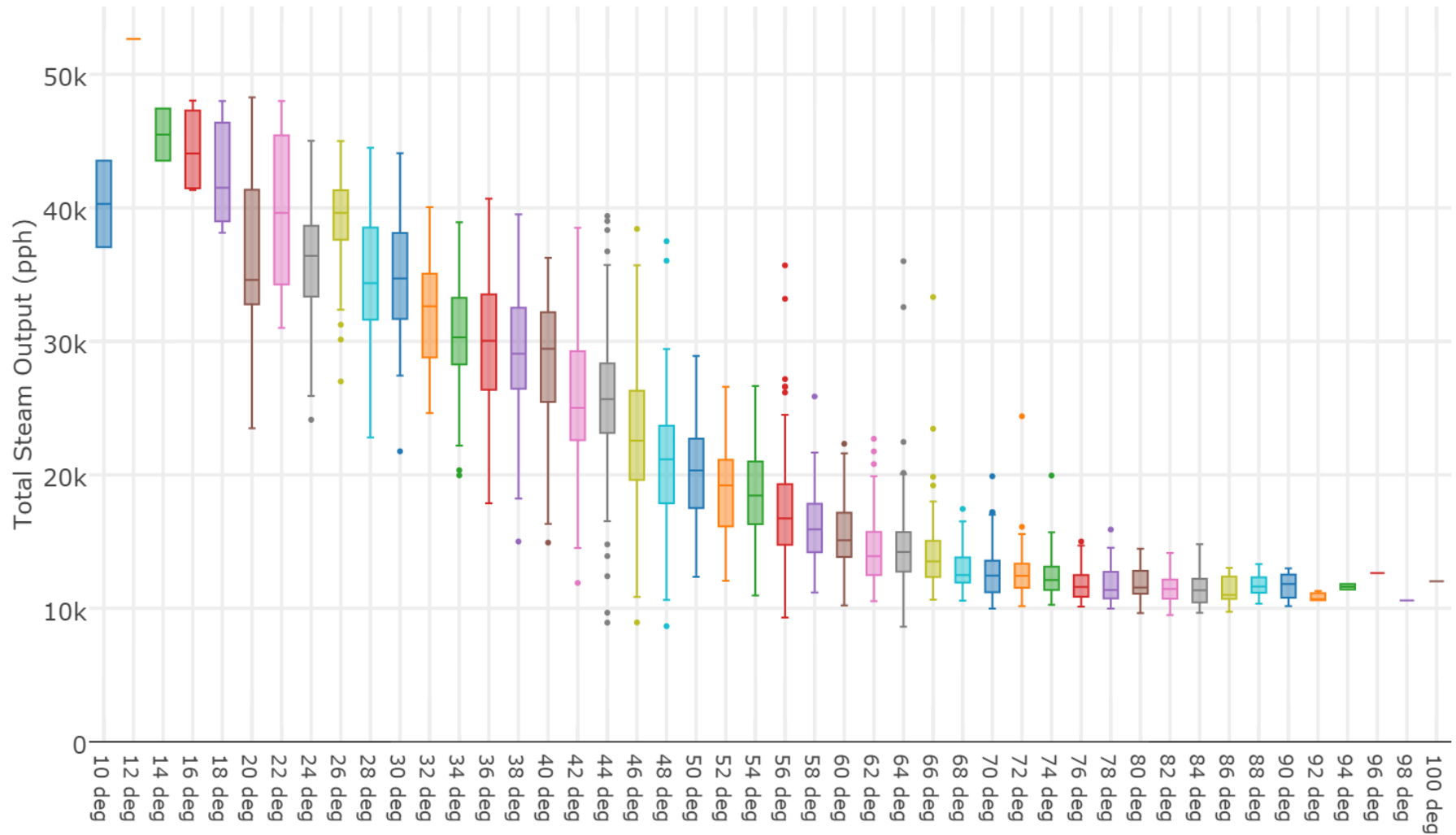
Electric Load Duration Curve



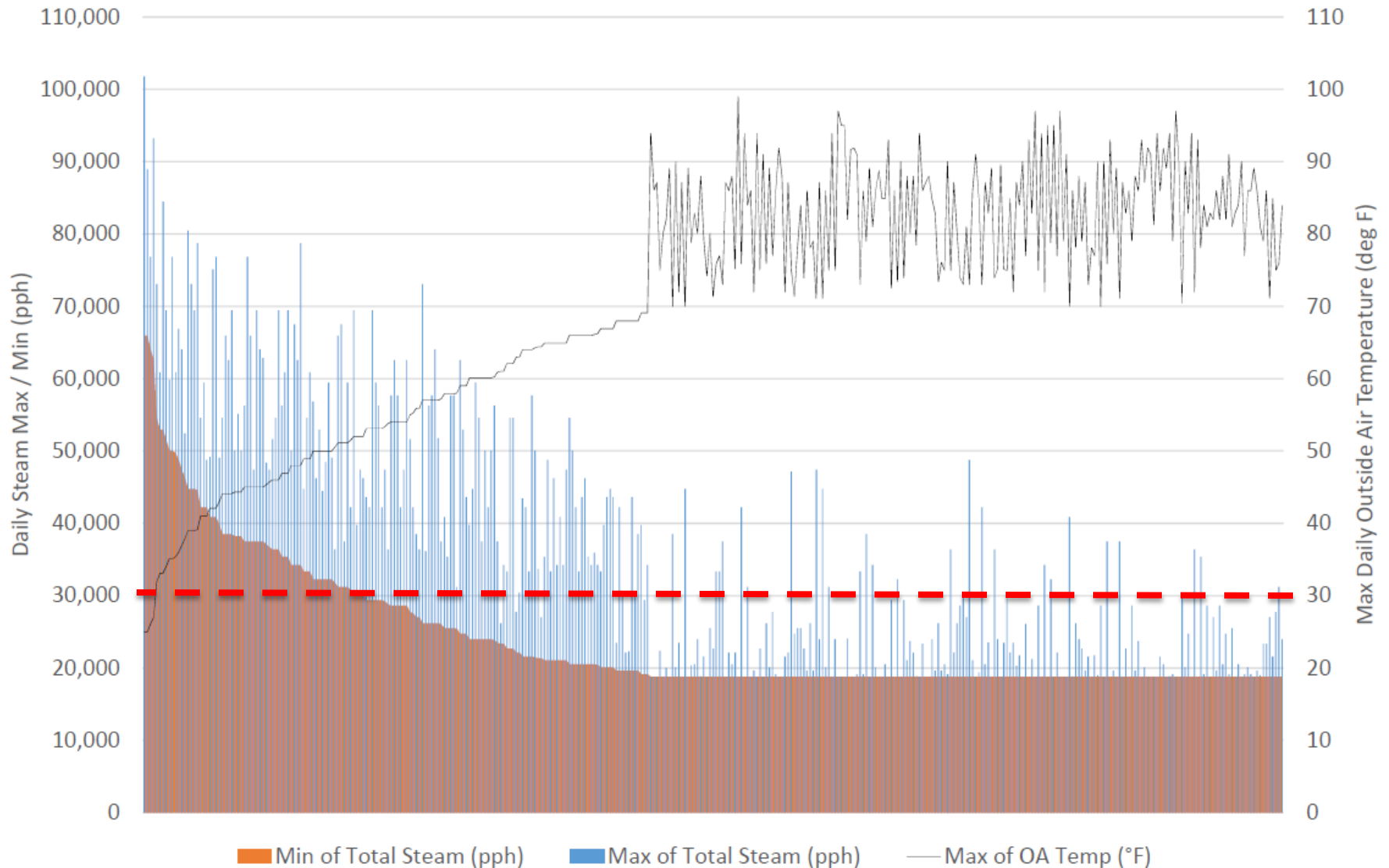
Steam Load Data



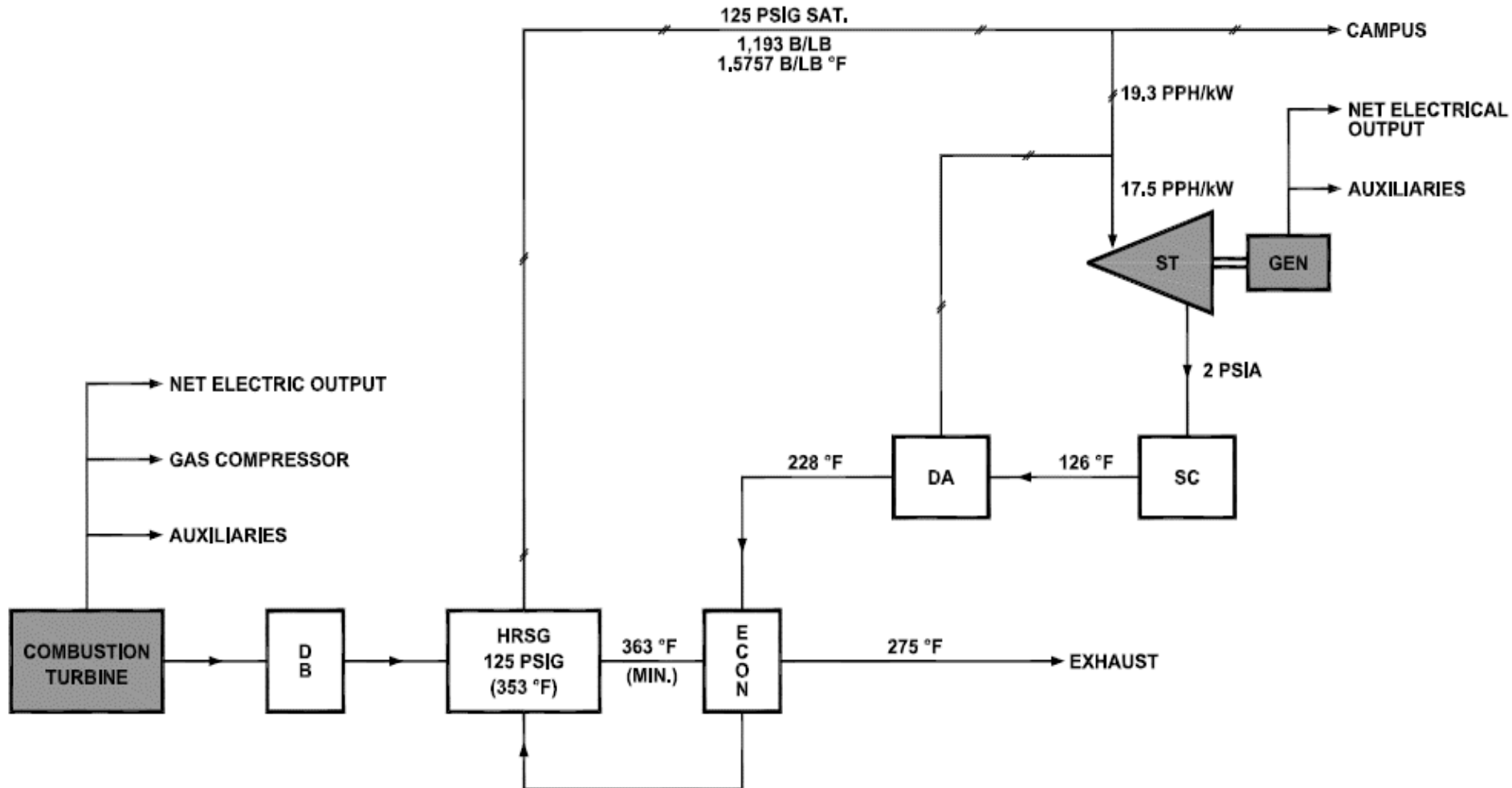
Steam Load Data



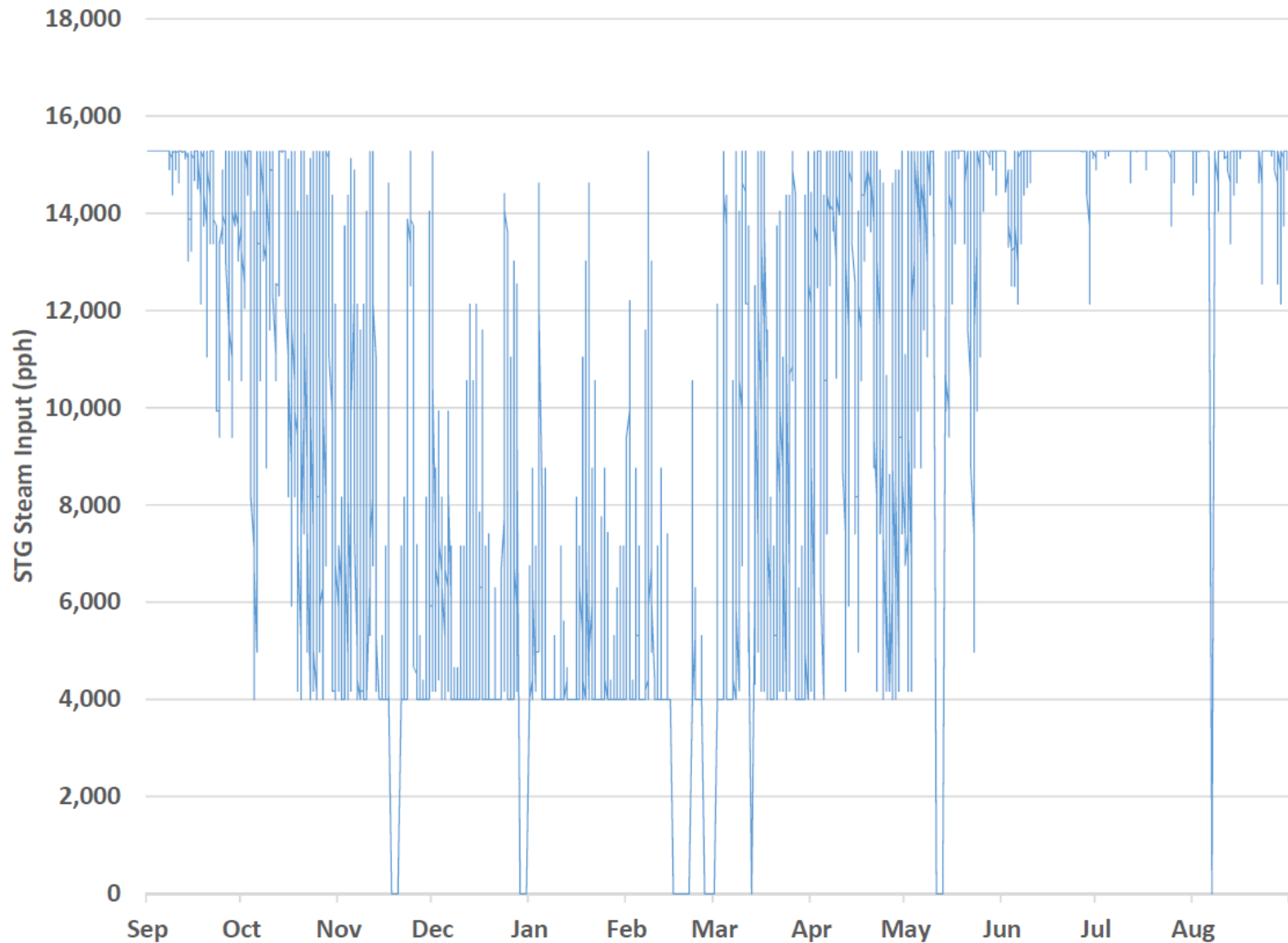
Steam Load Duration Curve



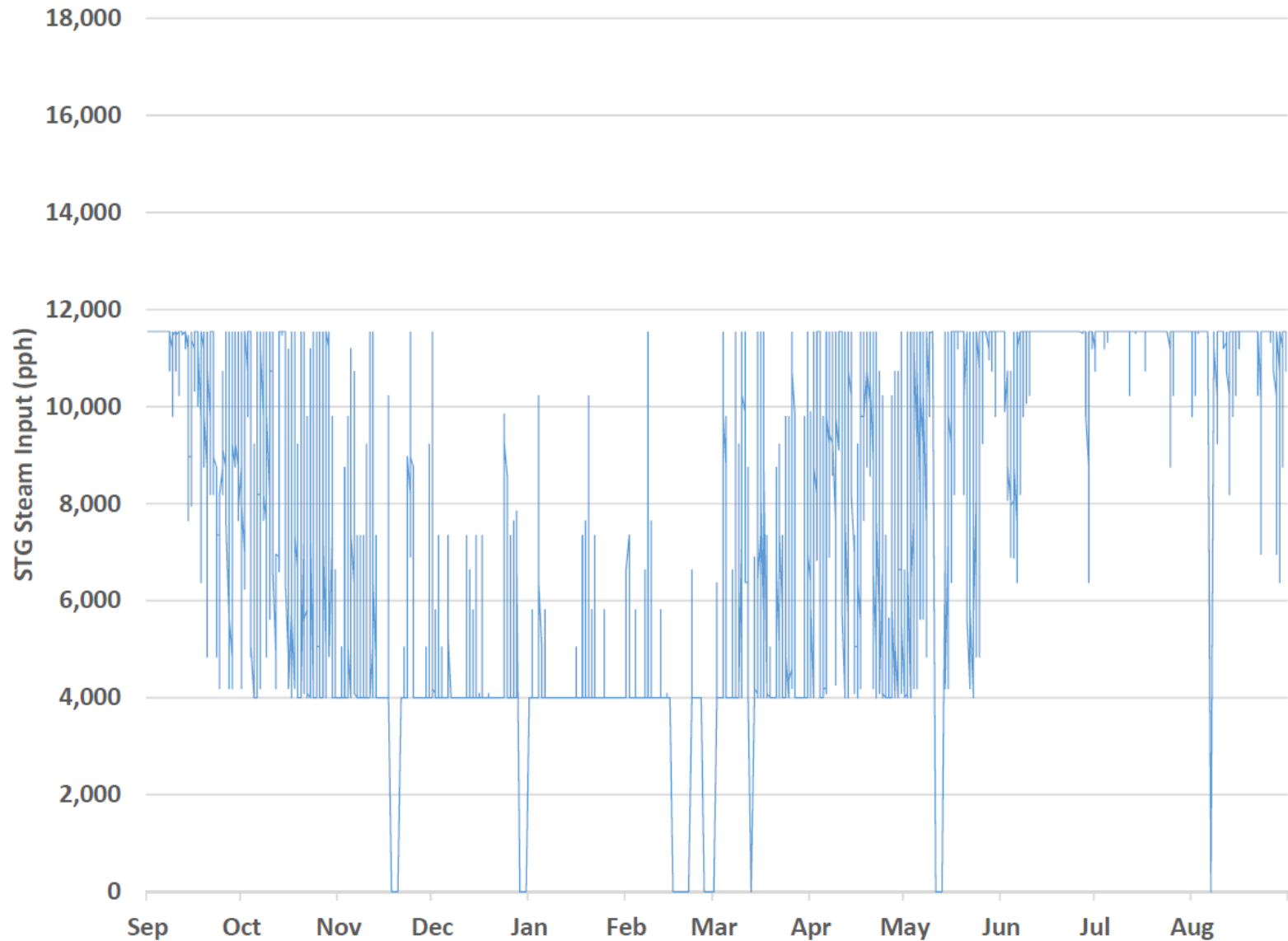
CHP / STG Configuration Diagram



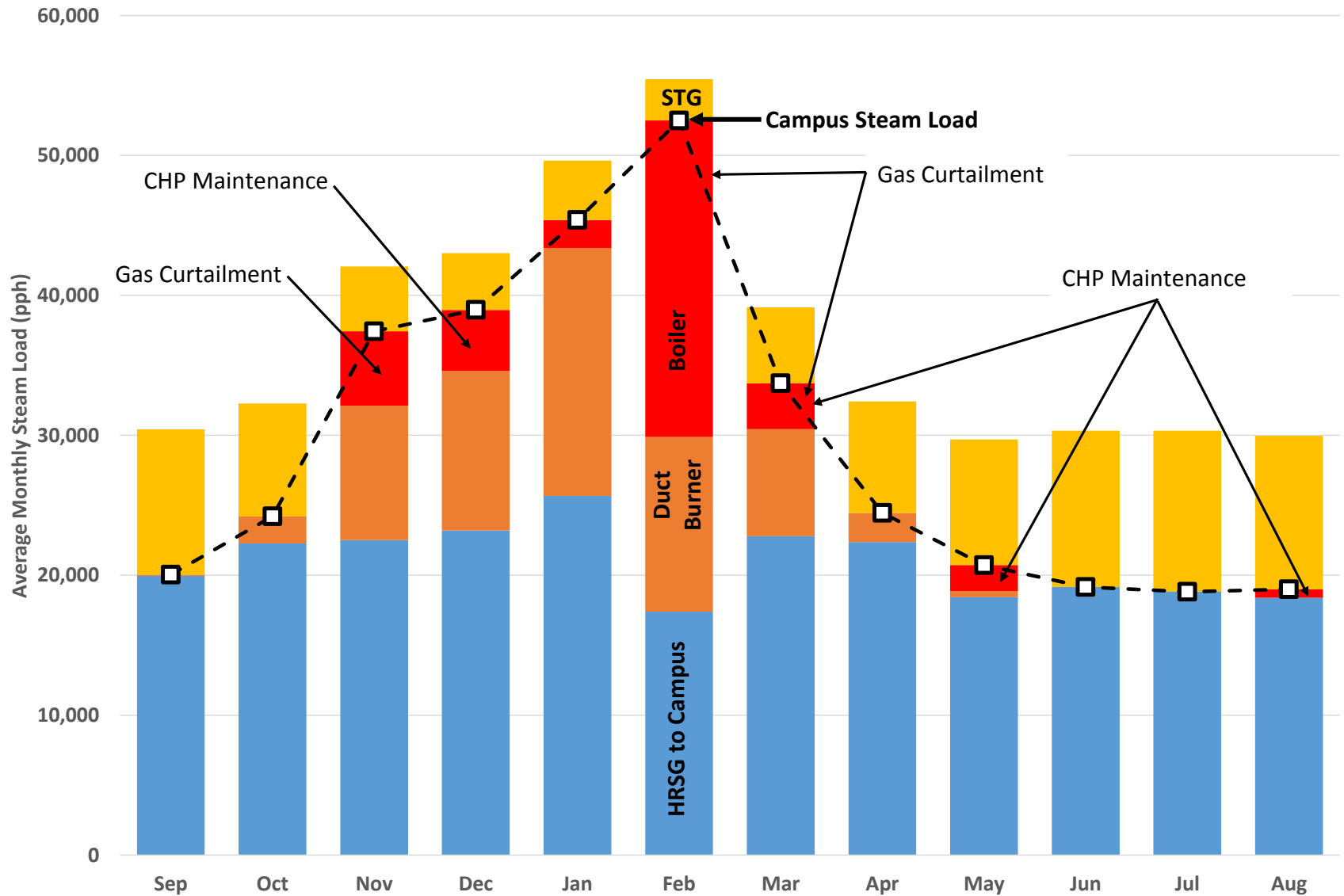
STG Steam Input - 2018



STG Steam Input - 2028



CHP Monthly Steam Usage - 2028



Economic Summary and Project Schedule

- Net Annual Savings = **\$1,130,000**
- Project can support debt of **\$14.5 million** (17 year)
- Funding for remaining costs will be obtained from other State/University sources
- Project Schedule
 - Complete Investment Grade Audit – 1Q 2016
 - Order Equipment – 3Q 2016
 - Start Construction – 1Q 2017
 - Construction Complete – 1Q 2018
 - Commissioning Complete – 2Q 2018