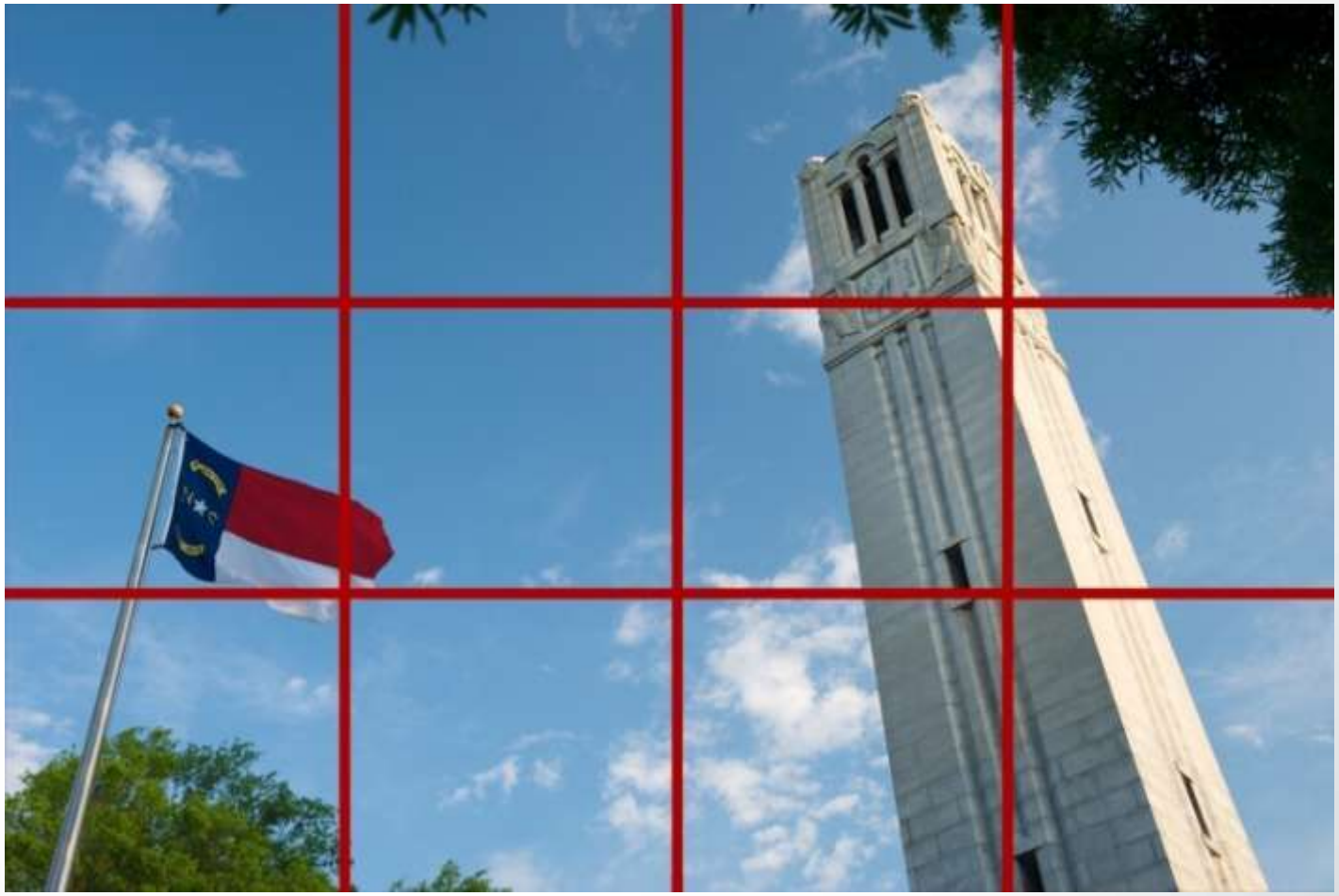
NC STATE UNIVERSITY



USING CHP TO SAVE ENERGY AND IMPROVE ENERGY SECURITY

Presentation by Alan Daeke, Jeff Hightower, Damian Lallathin and Rick Bourn | February 2014

North Carolina State University Overview

- Land Grant University
  Founded in 1887
- 12 Colleges
- 31,000 Students
- 8,100 Faculty and Staff
- 12.9 million square feet of facilities
- 2,000 acres on 3 Main Campuses in Raleigh

Main Campus Central Plant Steam Infrastructure

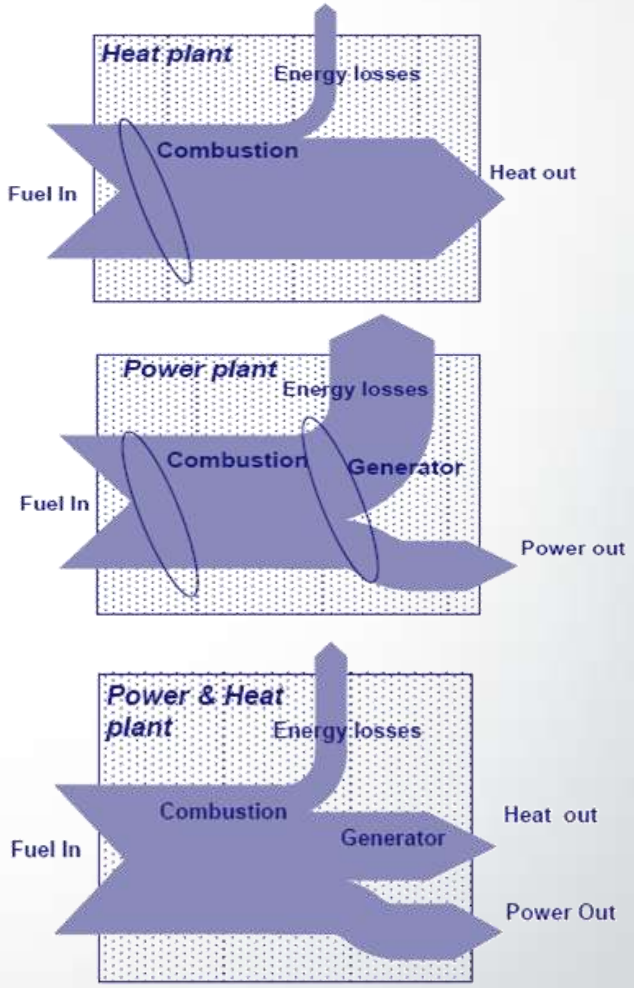
- Boilers
  - 1-100,000 pph (1974)
  - 1- 100,000 pph (1961)
  - 2 - 50,000 pph (1949)
  - Converted from coal to NG/#6 Fuel Oil
- Chillers
  - 12,200 tons capacity
  - Electric and steam driven

Project Goals

- Replace aging equipment
- Improve operating efficiency
- Provide power generation on-campus to increase reliability
- Reduce Greenhouse Gas Emissions

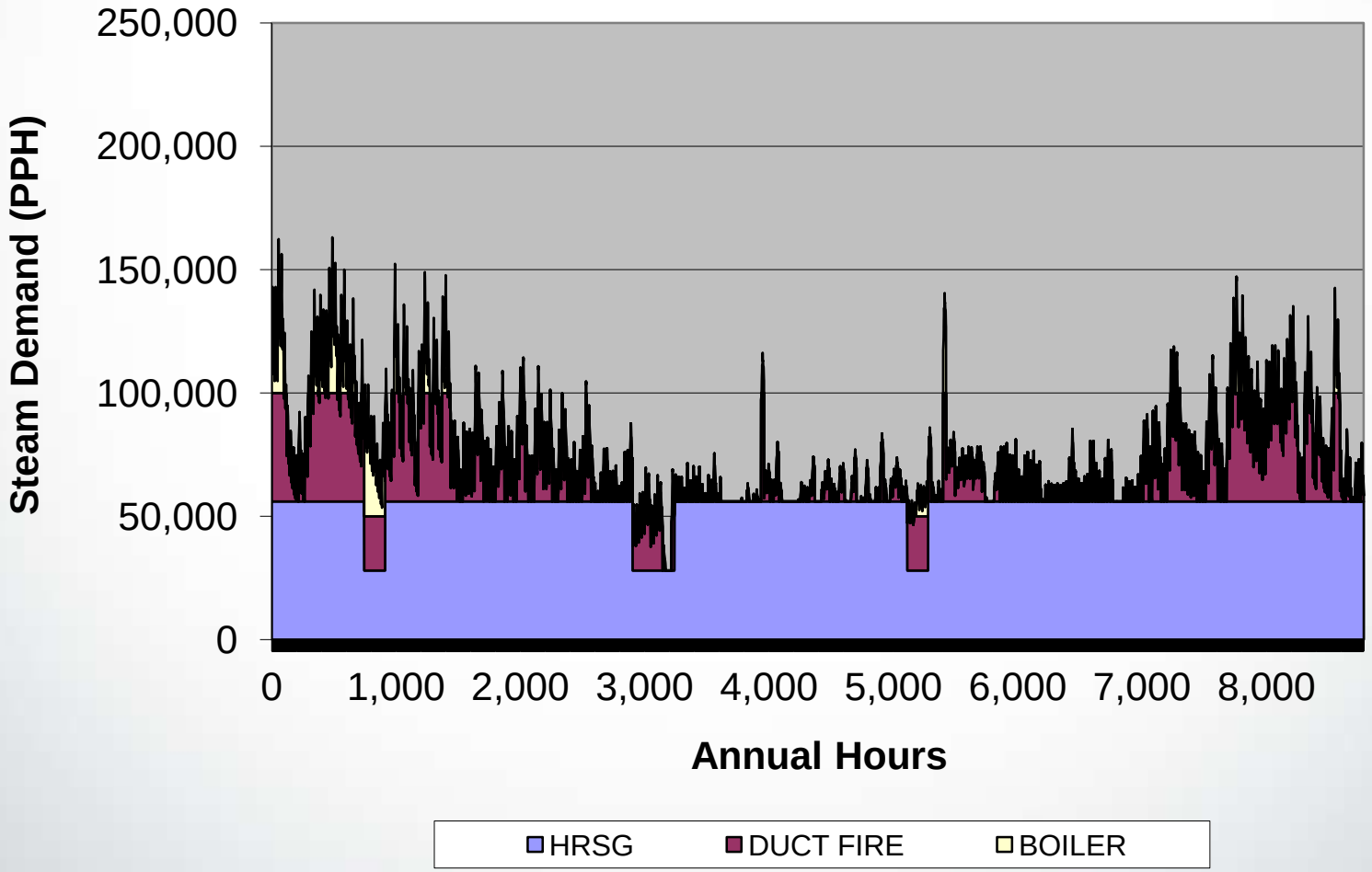
How Does CHP Help Achieve These Goals?

- Improve steam production efficiency and reduce operating costs
- Increase electrical system resiliency and reliability
- Replace aging equipment
- Reduces GHG emissions

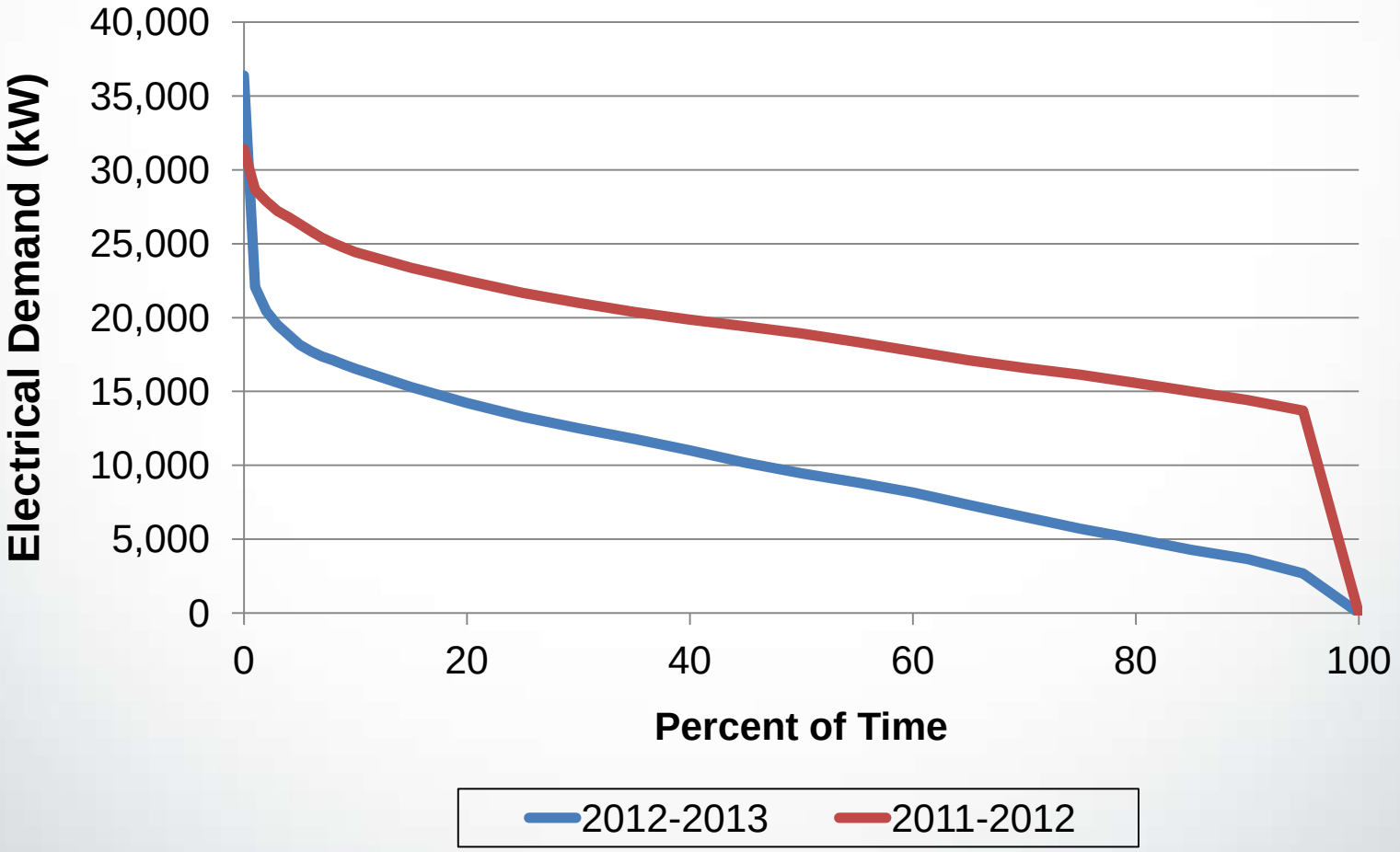


From 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Studying CHP at NCSU – Steam Curve



Studying CHP at NCSU – Electrical Curve



Studying CHP at NCSU - Success Factors

- University steam profile has good year round base load
- Low gas rates
- Minor Interconnection requirements
- Relatively high electrical loads on campus
- Reasonable stand-by charges from utility company

Studying CHP - Results

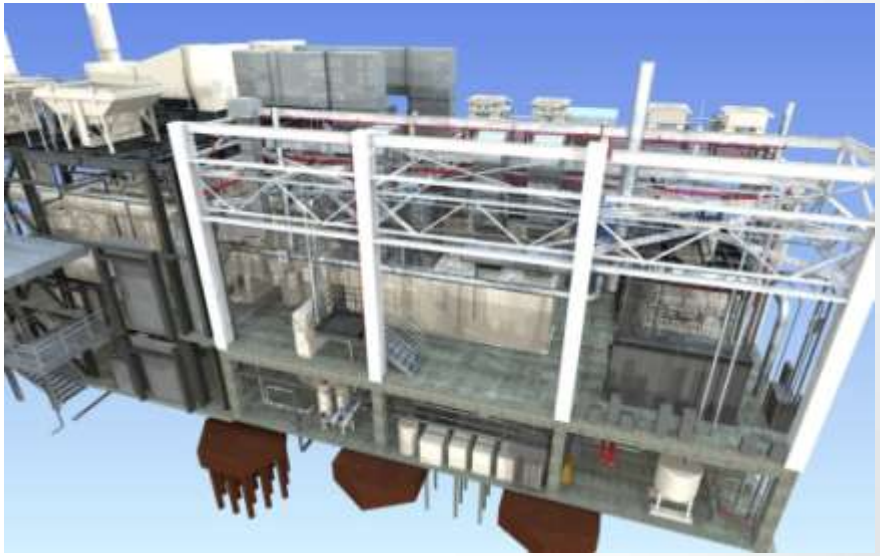
- Add two 5.5 MW combustion turbines with heat recovery steam generators (CT-HRSG) and duct burner
- Fuel conversion from residual (No. 6) fuel oil to distillate (No. 2) fuel oil and natural gas
- Improved efficiency
- Training/Advancement Opportunity

Critical Development Issues

- Space – existing boiler plant not large enough
- Noise – plant is adjacent to tennis courts and residences
- Temporary utilities/Phasing Plan
- Pre-purchased Equipment with ESCO

Implementing CHP – 3D Design

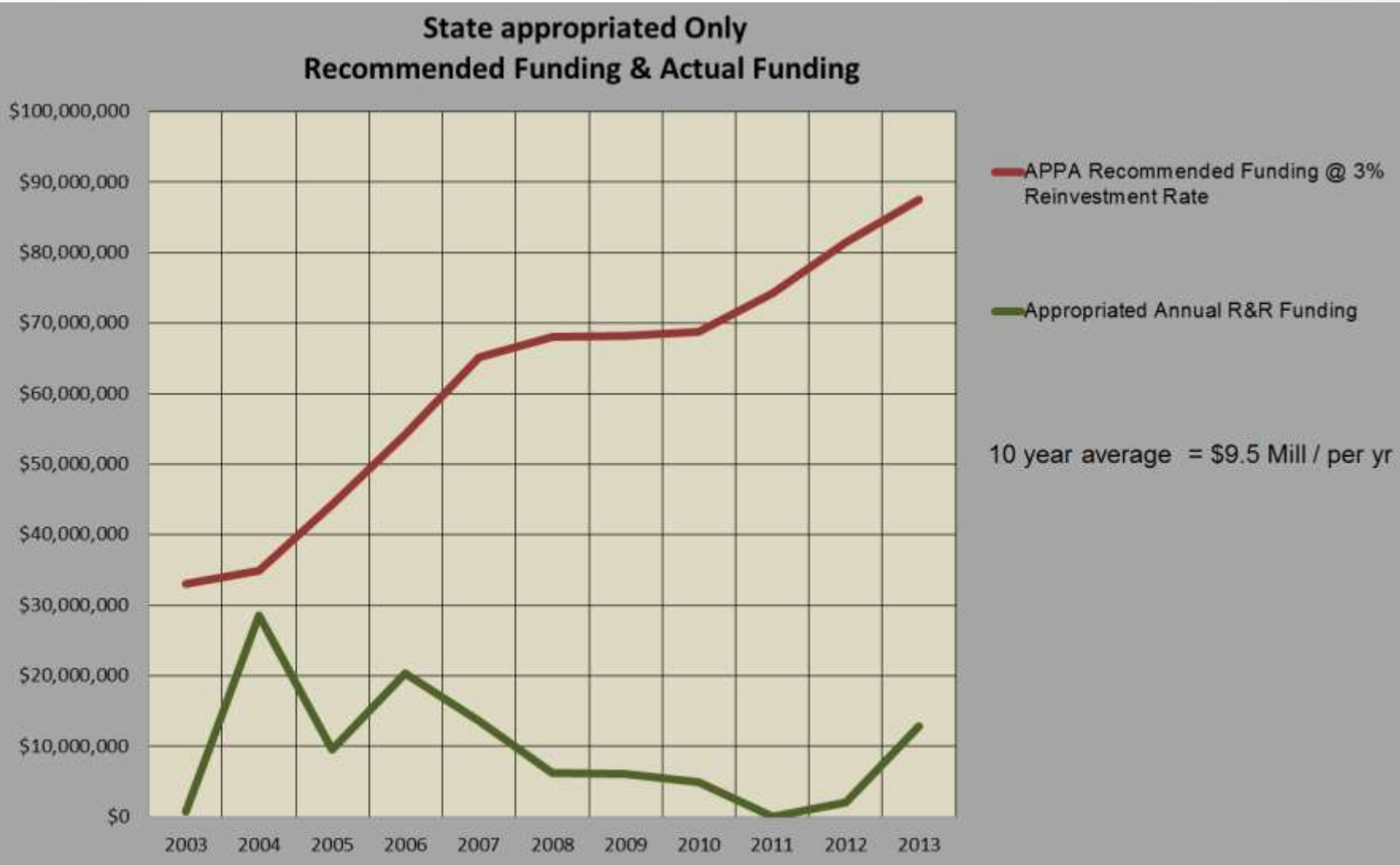
- Simplifies coordination between trades
- Allows contractor to pre-fab pipe directly from drawings
- Allows operators to “walk-thru” plant



Implementing CHP - Challenges

- Existing boiler was on second floor which would not meet vibrational acceleration requirement
- Noise Control
- Natural Gas supply

Repair and Renovation Funding



Funding CHP – Legislation & Grants

- Legislation for funding of project from savings
- Attempted reinvestment of savings
- Included normalization factors for change
- University to retain ownership
- Attempted in two sessions
- Established relationships with DOE CHP RAC (NC Solar Center)
- Improved monitoring requirements due to ASERTTI Protocols

Funding CHP – Performance Contracting

- Developed initial project for various buildings on campus as a learning tool for CHP project
- Requested owner's reserve account for construction changes
- Balancing of scope with savings
- Long approval process
- Continuous negotiations
  - With ESCO
  - With ESCO as partner

NC STATE UNIVERSITY

AiM

Hello, JEFFREY

Logout About

Master Asset Profile

Asset ⇓	Description	Asset Type	Asset Group	Status	Region	Facility	Property	Location
0003ETRX001	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) HOLLIDAY	SERIALIZED	14-E0082	ACTIVE	NCSU	MAIN CAMPUS	U003	
0004ETRX001	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) WINSLOW HALL	SERIALIZED	14-E0082	ACTIVE	NCSU	MAIN CAMPUS	U004	
0008ETRX001	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) PEELE	SERIALIZED	14-E0082	ACTIVE	NCSU	MAIN CAMPUS	U008	
0008ETRX002	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) PEELE	SERIALIZED	14-E0082	ACTIVE	NCSU	MAIN CAMPUS	U008	
0008ETRX003	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) PEELE	SERIALIZED	14-E0082	ACTIVE	NCSU	MAIN CAMPUS	U008	
0010ETRX001	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) WATAUGA	SERIALIZED	14-E0082	ACTIVE	NCSU	MAIN CAMPUS	U010	
0011ETRX001	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) BROOKS	SERIALIZED	14-E0082	ACTIVE	NCSU	MAIN CAMPUS	U011	

Page 1 of 9 Display: 25 50 100

Records Found = 218

NC STATE UNIVERSITY

AiM

Hello, JEFFREY

Logout About

Financial Information

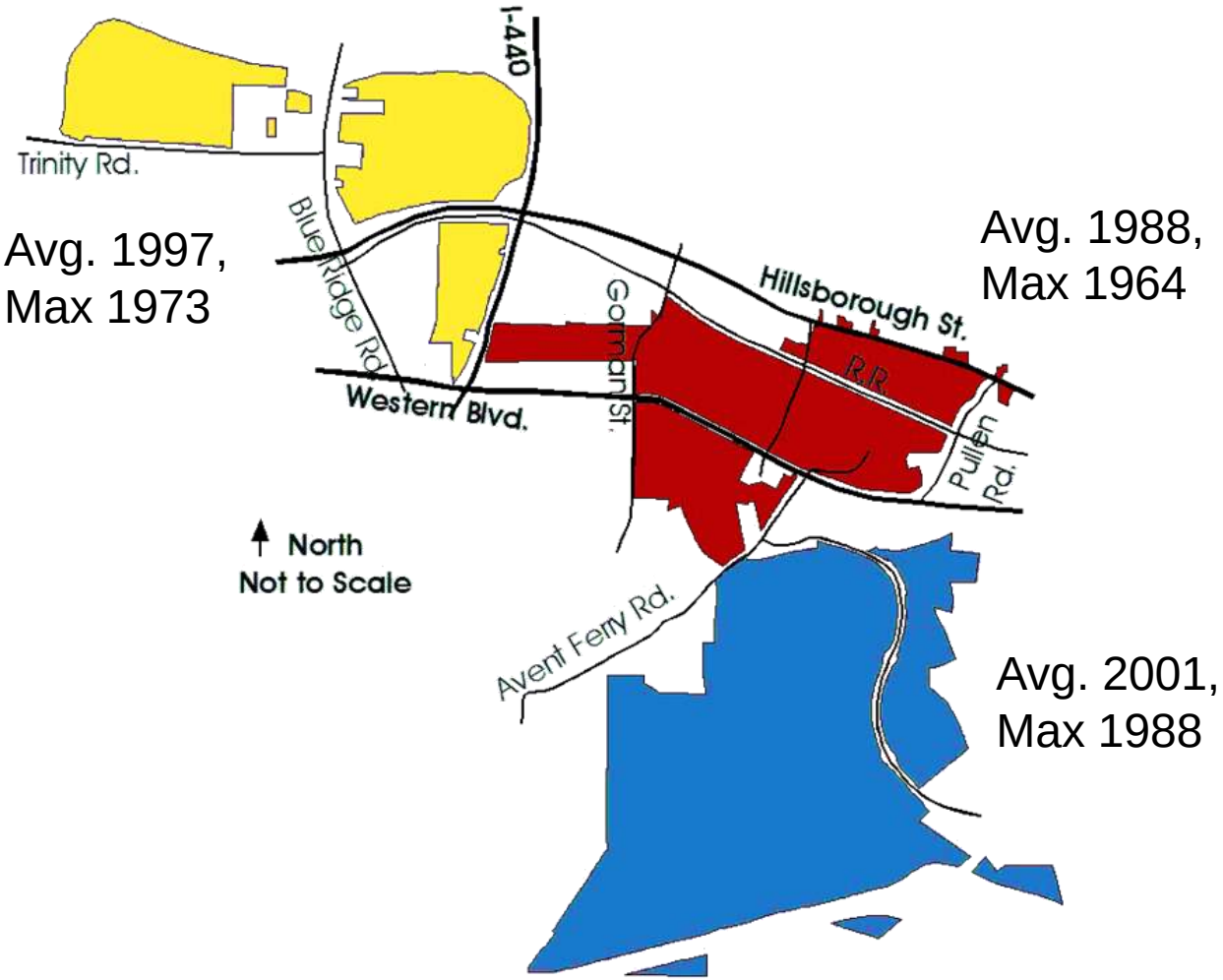
View: Select

Asset	0003ETRX001	Editor	MPLYTLE	Asset Class	UE POWER DISTRIBUTION
		Edit Date	Jun 18, 2013 11:44 AM		UE POWER DISTRIBUTION
				Start Date	
Description	MEDIUM VOLTAGE TRANSFORMER (OVER 600 VOLTS) HOLLIDAY			Prior Depreciation	

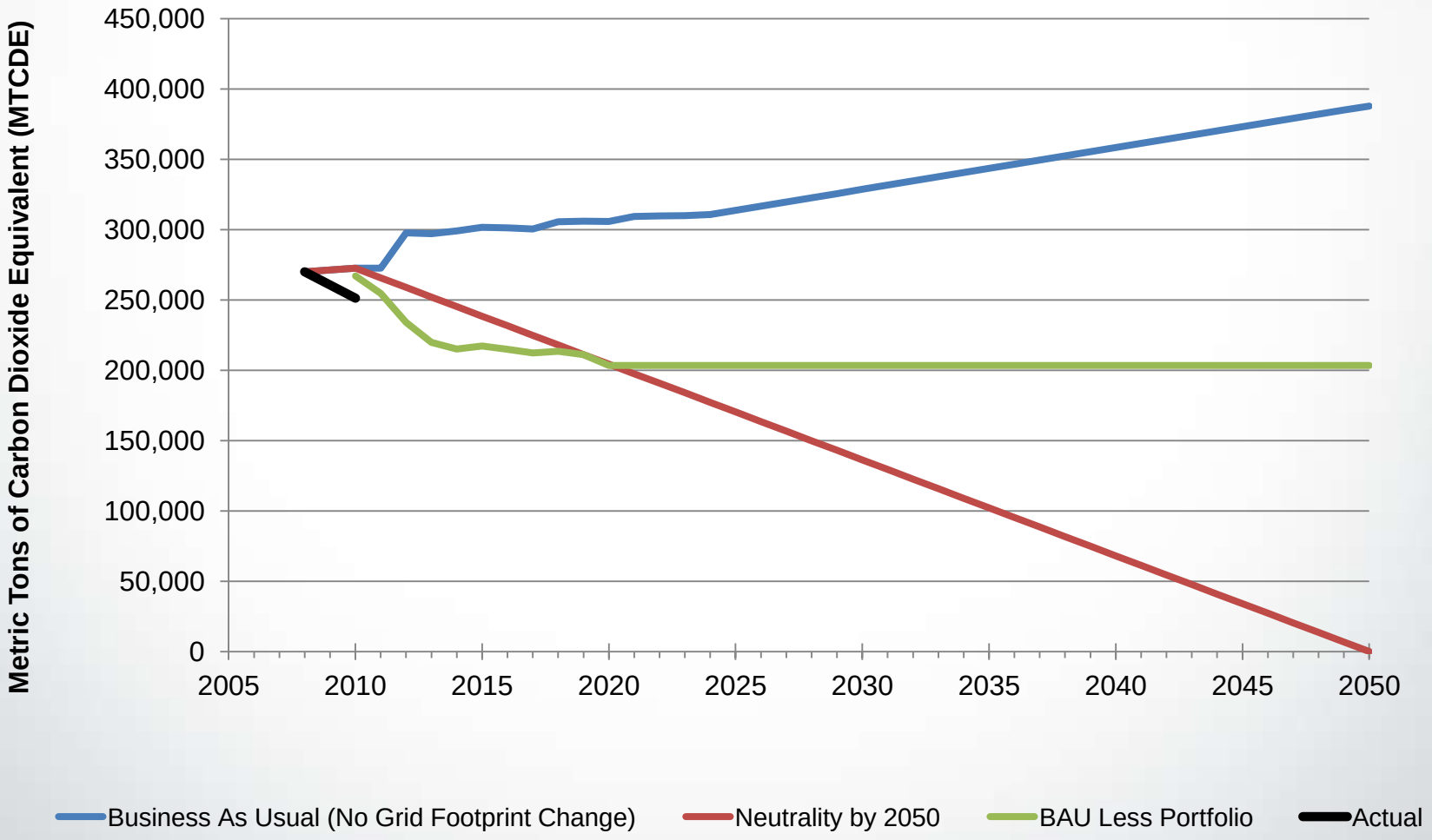
Depreciation Information

Purchase Date	Jun 30, 1973
Acquisition Method	
Useful Life (Months)	420
Purchase Cost	$11,924.00
Replacement Cost	$57,500.00
Salvage Value	$2,875.00
Disposal	0.00%

Transformer Ages by Campus



Results - GHG Emissions



Lessons Learned

- Planning and internal marketing was critical
- Financial tools
  - ESCO
  - Self Performed PC
- Utilize tools to illustrate project benefits to campus

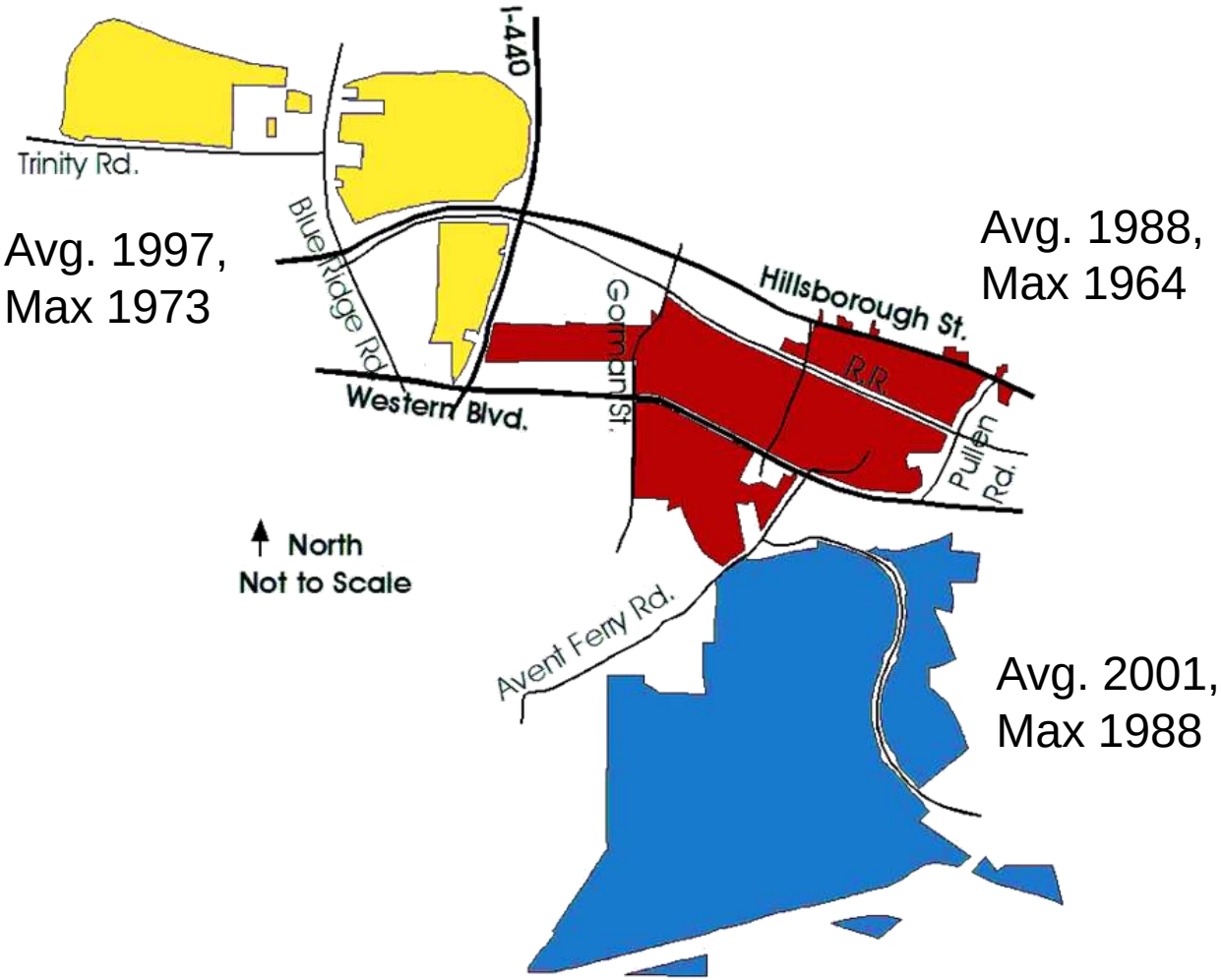
Results

- Increased efficiency of Cates plants by approximately 35%
- Reduced the University's GHG by 8%
- Provided 11 MW of power generation that will meet 1/3 of peak electrical load during outages.
- Reduced operating costs
- Reliability improvements - Upgraded plant infrastructure
- Student Opportunities

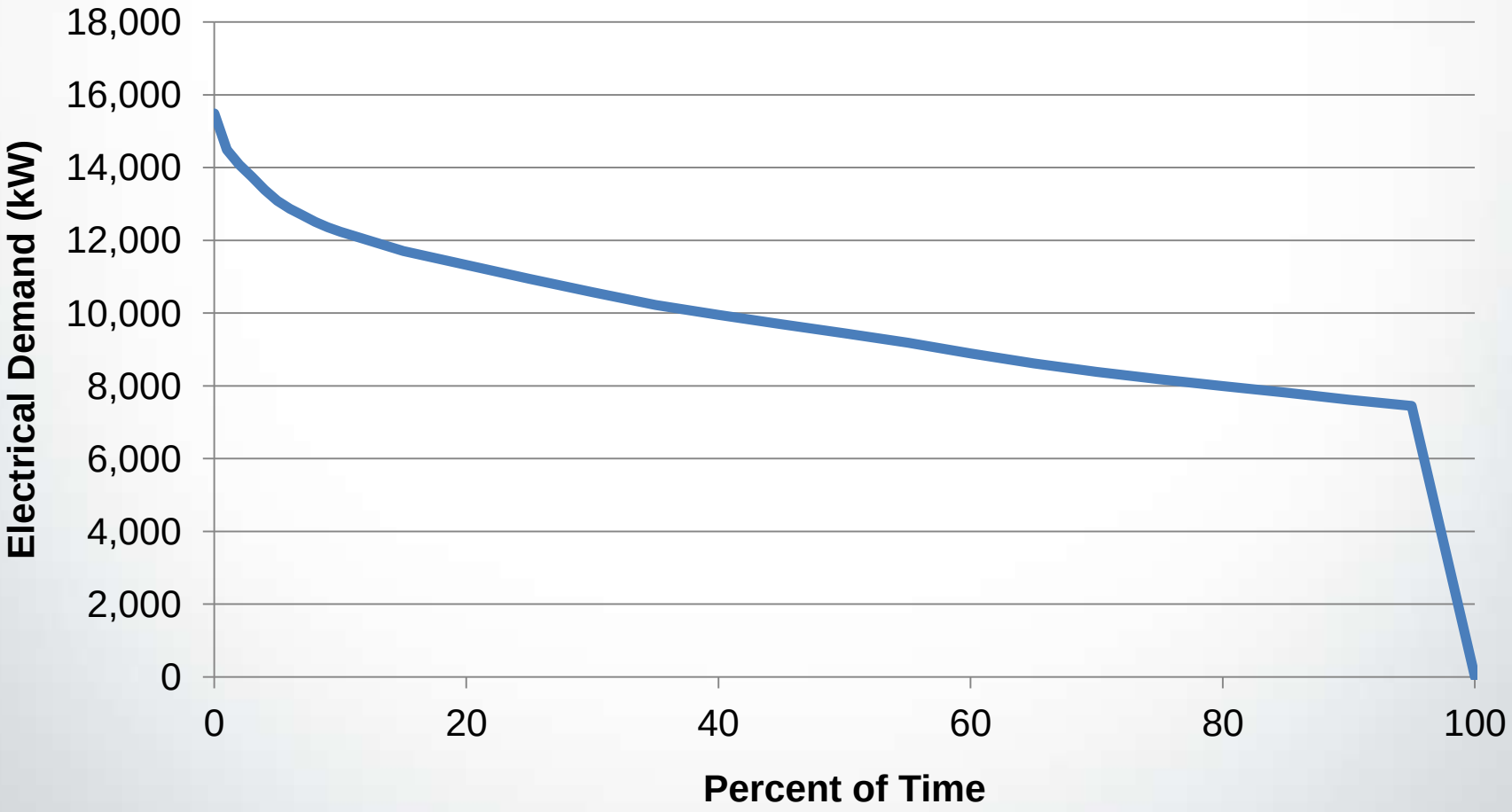
Next Step,

onward to Centennial Campus!

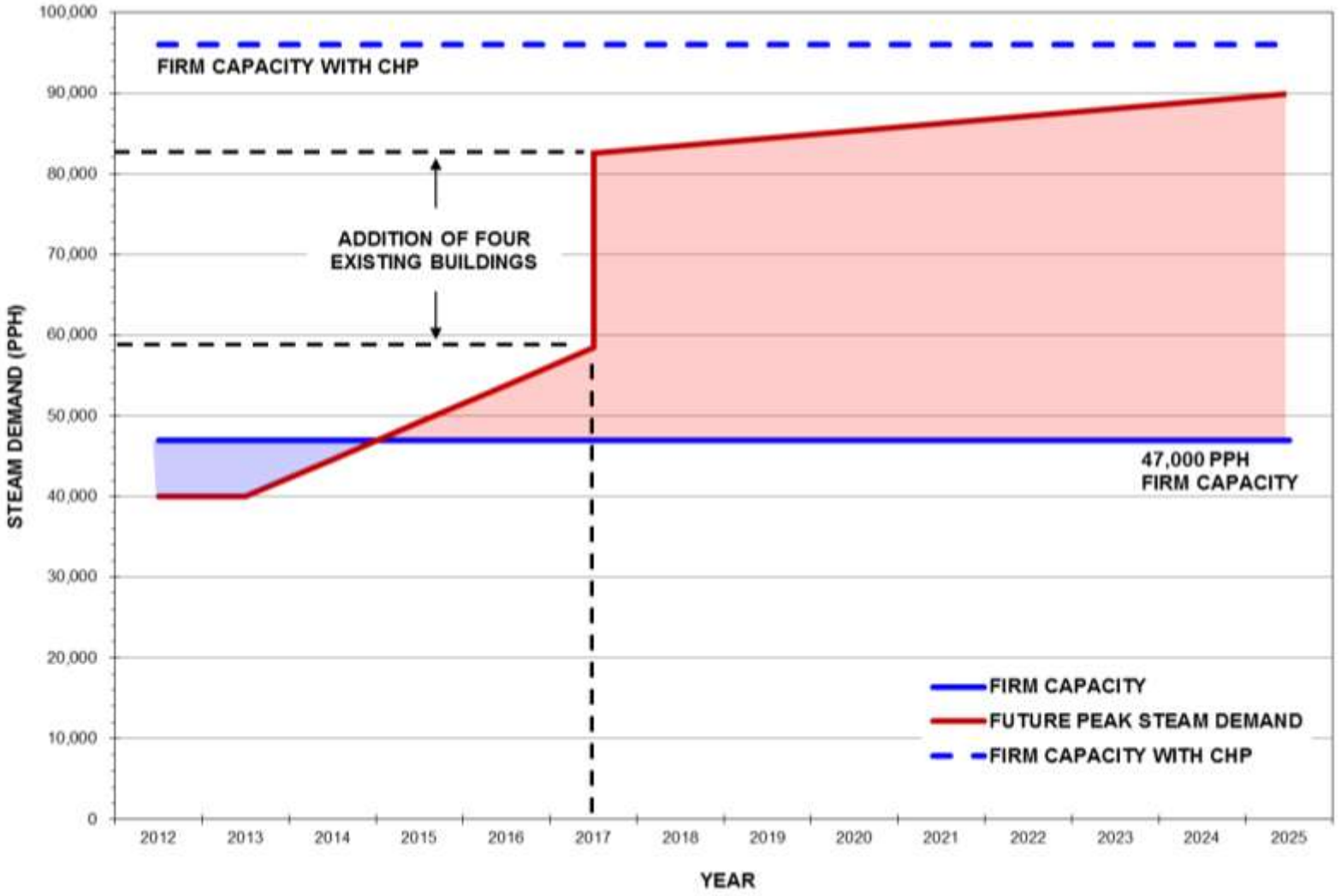
Transformer Ages by Campus



Future CHP at NCSU - Centennial Campus Electric Demand



Future Steam Load vs. Boiler Capacity



To be continued…..