# District Chilled Water Optimization at Penn State Health Milton S. Hershey Medical Center

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# Milton S Hershey Medical Center

- Founded in 1963 through a $50 Million gift from The Milton S Hershey Foundation.

# Medical Center Overview

- 24 Academic Departments
- 6 Major Institutes
- 4 Hospitals
- 17 Hospital Affiliates
- 10,000 employees
- 35 ORs


Accredited as both adult and pediatric Level 1 Trauma Center

# College of Medicine

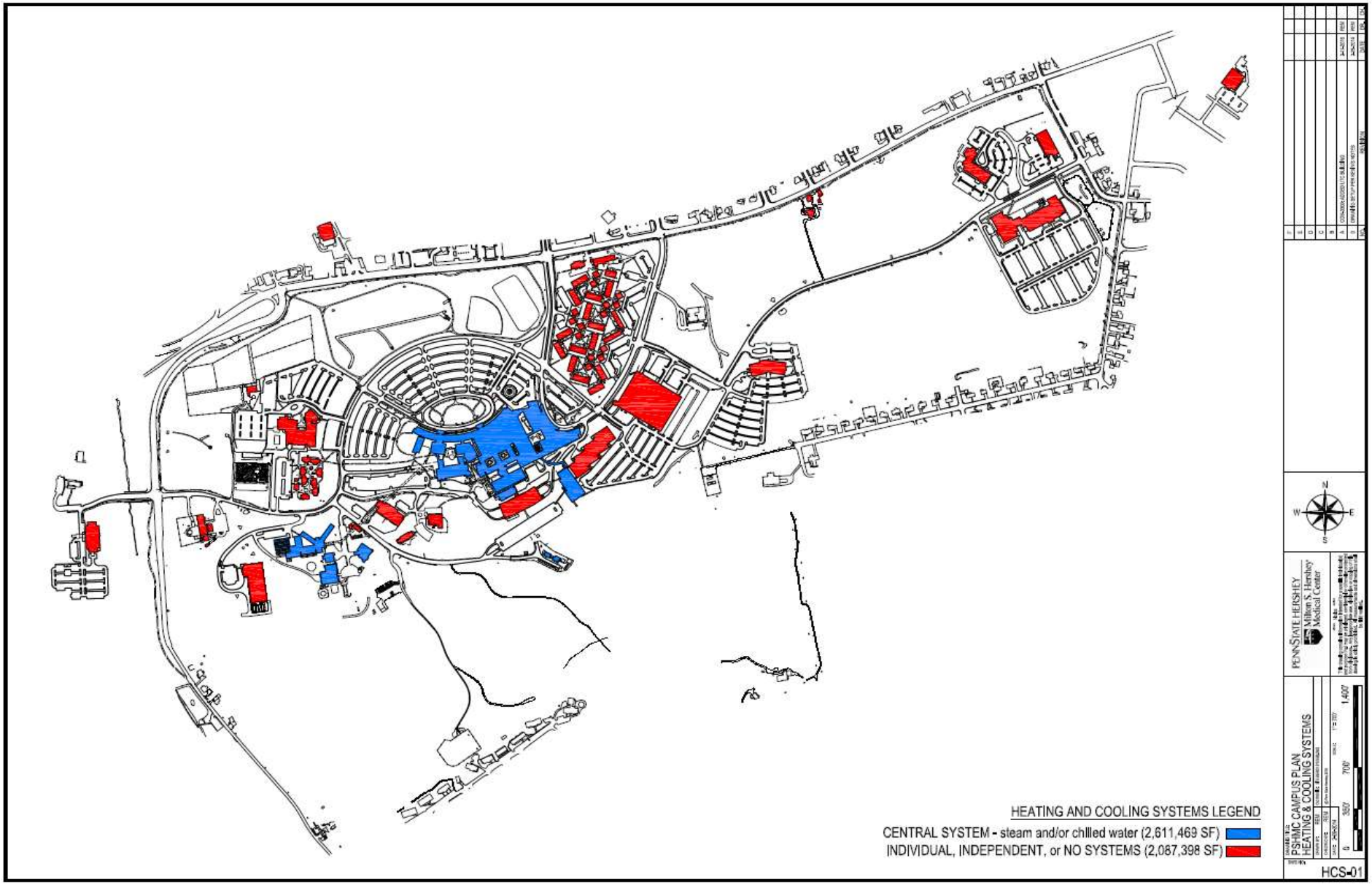
- First Students enrolled 1967; First Graduate degrees 1969; First Doctors of Medicine 1971
- Portfolio of $109M in funded research annually
- Research Equipment
- 400 Ultra Low Freezers
- Ultra Low Freezers (-80 C)

# Milton S Hershey Medical Center

- 4.5M square feet of buildings
- 3.6M square feet of conditioned space
- 112,000,000 kWh annually
- 573,000 MMBtu natural gas annually

# Infrastructure

- Central Plant provides steam and chilled water to central campus:
  - 3 Cleaver Brooks, dual fuel, water tube boilers (1967)
  - 7 chillers (1999-2017); 8,500 tons of cooling
- 2 Satellite Plants (2008, 2012)
  - 4 chillers;  4,800 tons of cooling
- 1.4 Million gallon Chilled water storage tank
- 155 air handling units across campus


HEATING AND COOLING SYSTEMS LEGEND
CENTRAL SYSTEM - steam and/or chilled water (2,611,469 SF)
INDIVIDUAL, INDEPENDENT, or NO SYSTEMS (2,087,398 SF)
PSHMC CAMPUS PLAN
HEATING & COOLING SYSTEMS
PENNSTATE HERSHEY
Milton S. Hershey
Medical Center
HCS-01

# Preventive Maintenance

- Over time the ability of the facility to meet chilled water needs of the facility become difficult.
  - Winter of 2010-11 an aggressive chilled water distribution PM program was instituted.
    - Strainer Cleaning/Replacement
    - Valve Replacement
    - Analog Thermometers added at Air Handler Coils

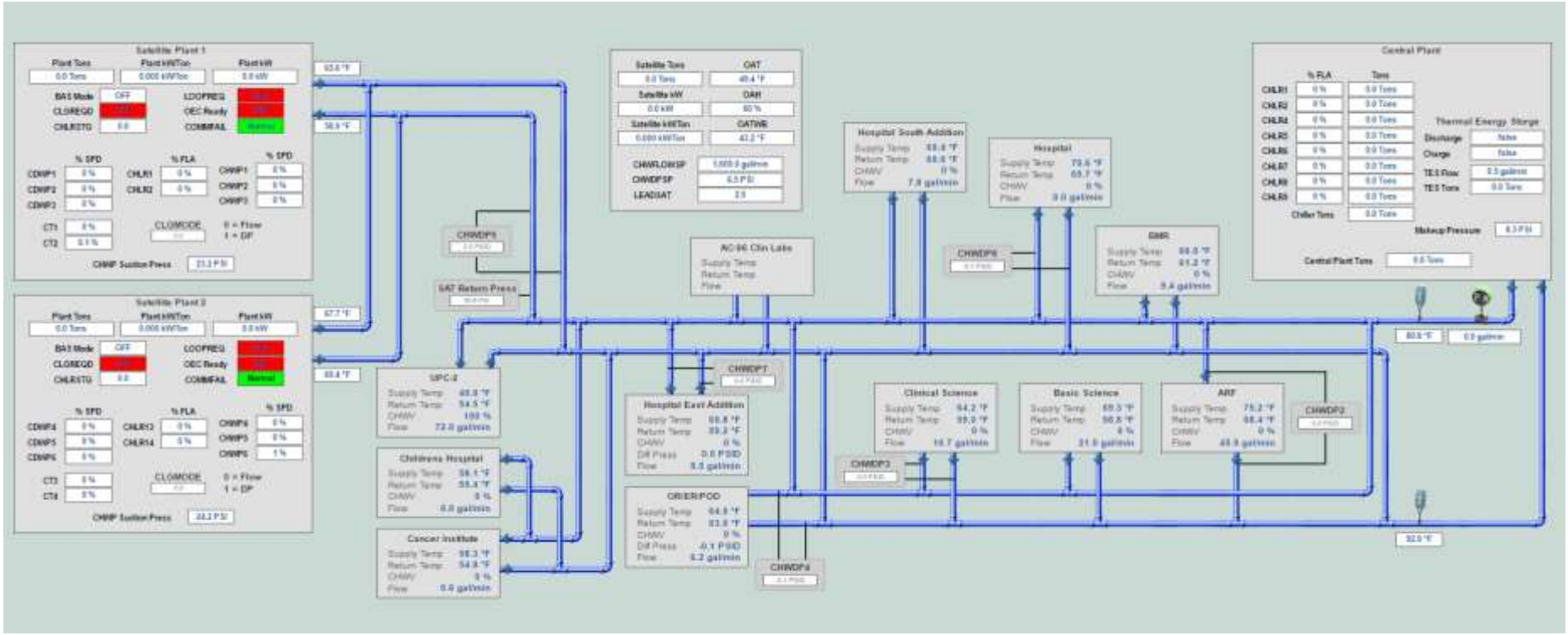
# Hydraulic Study of Chilled Water Distribution System

- Hydraulic Modeling and Analysis
  - Central Plant - Chilled Water
  - Central Plant - Condenser (Tower) Water
  - Satellite Chiller Plants 1 & 2 – Chilled Water

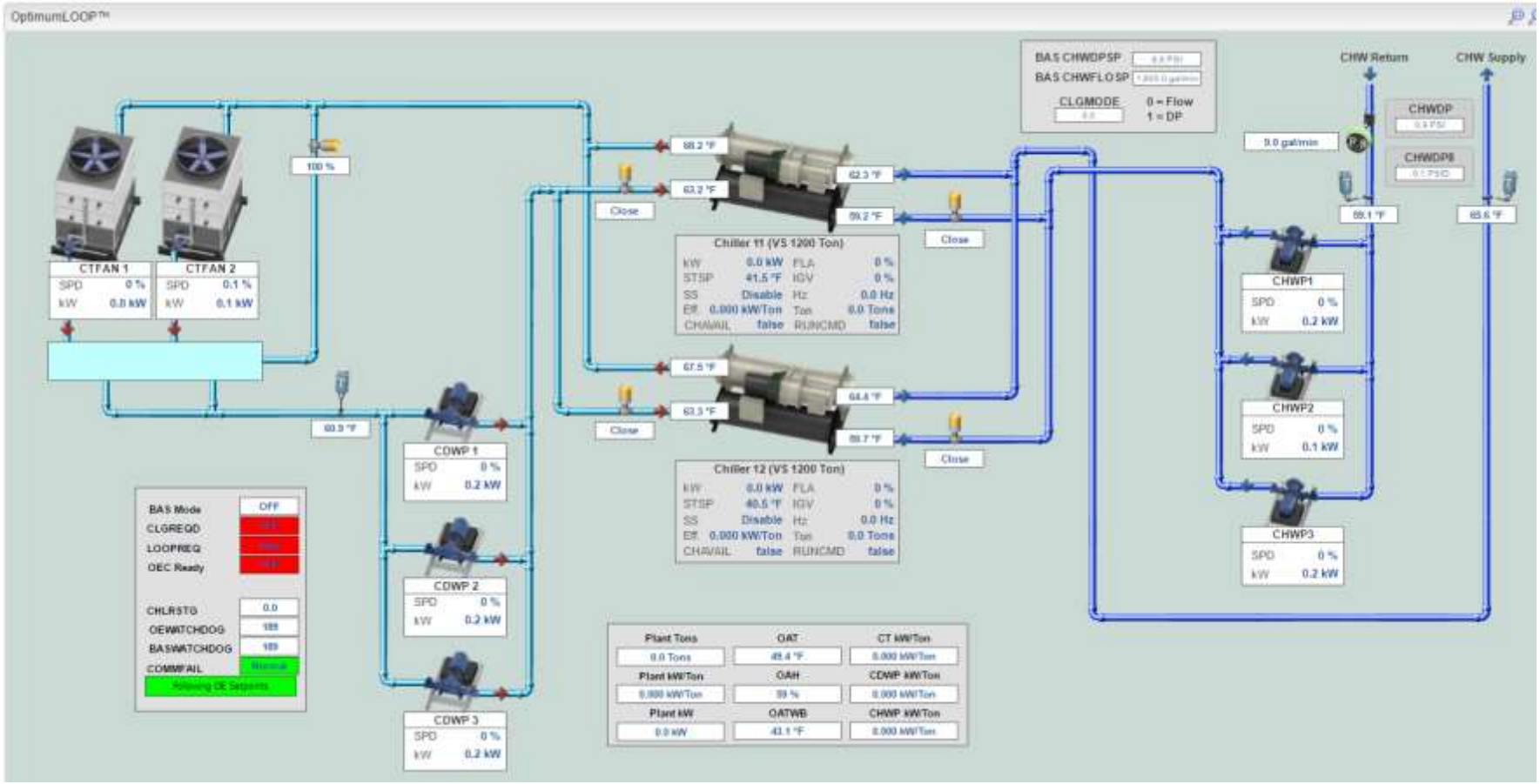
# Chilled Water Optimization

- Intelligent Energy Solution
  - Lowering Energy Consumption
  - Reducing Chiller Plant Operating and Maintenance Costs
  - Contributing to Milton S. Hershey's Corporate Energy and Sustainability Goals
- Convert three chiller plants to variable-flow plants
- Implement optimization system powered by OptimumLOOP

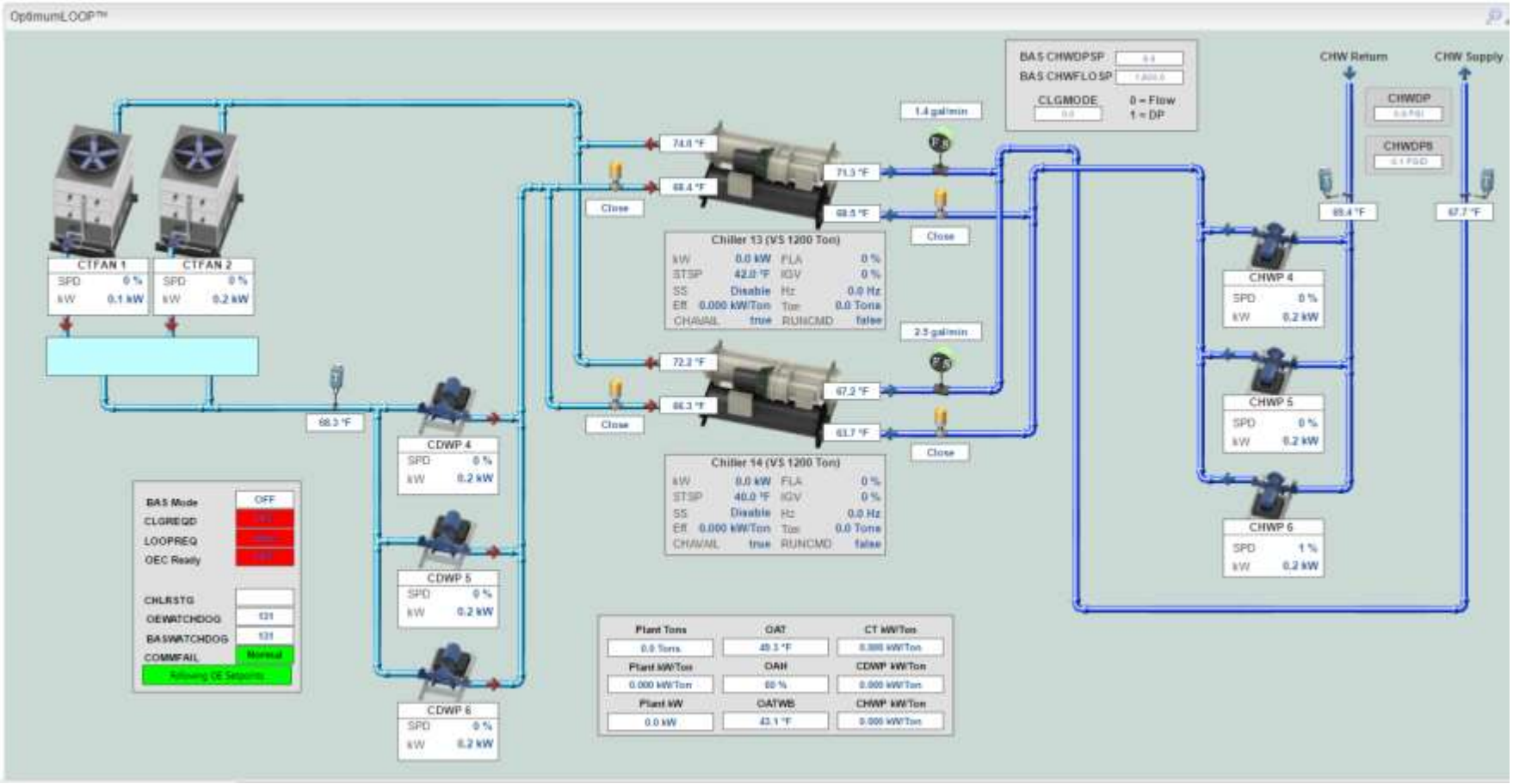
# Plant Layout - Site



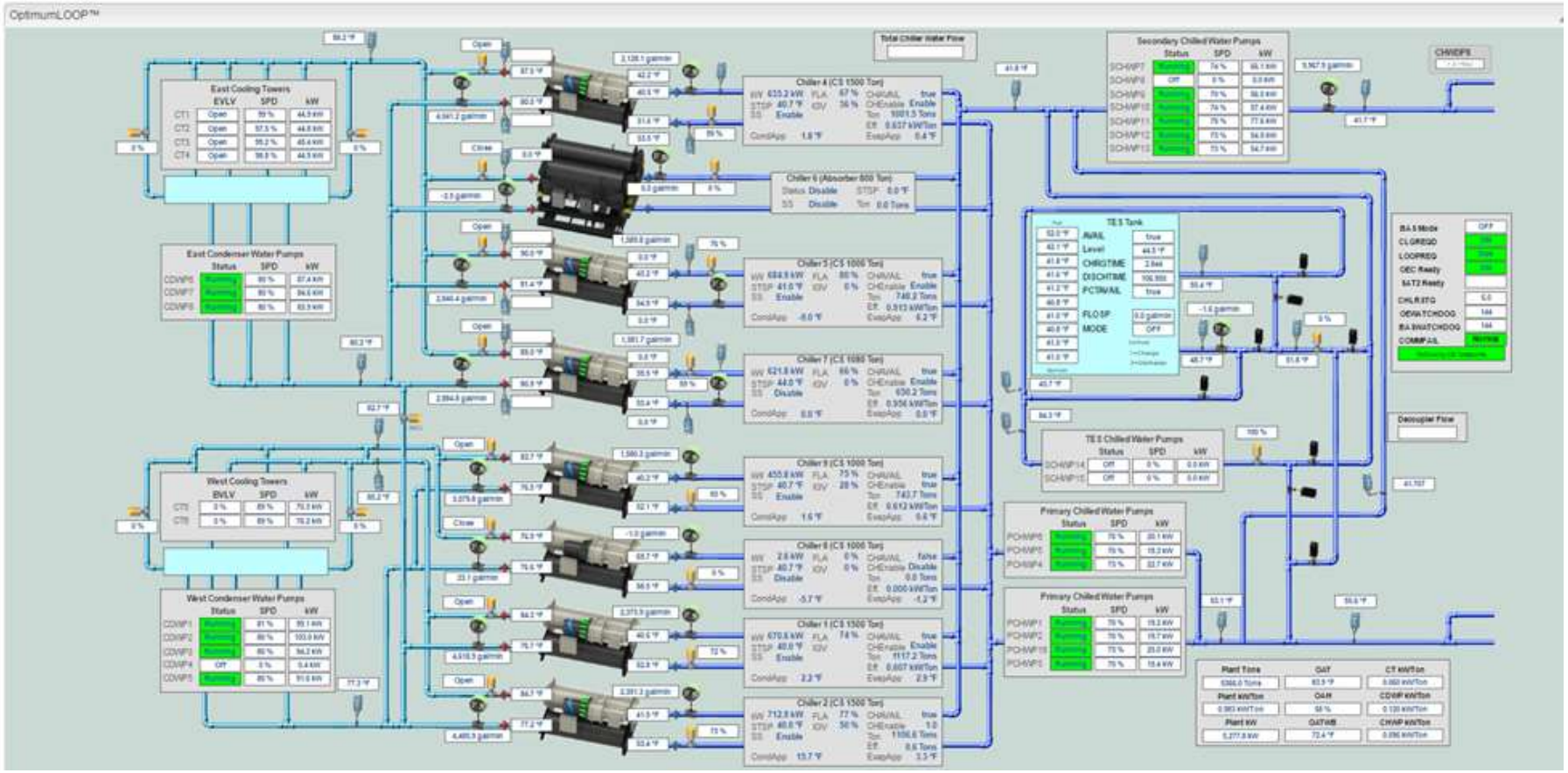
# Plant Layout – Satellite Plant 1



# Plant Layout – Satellite Plant 2



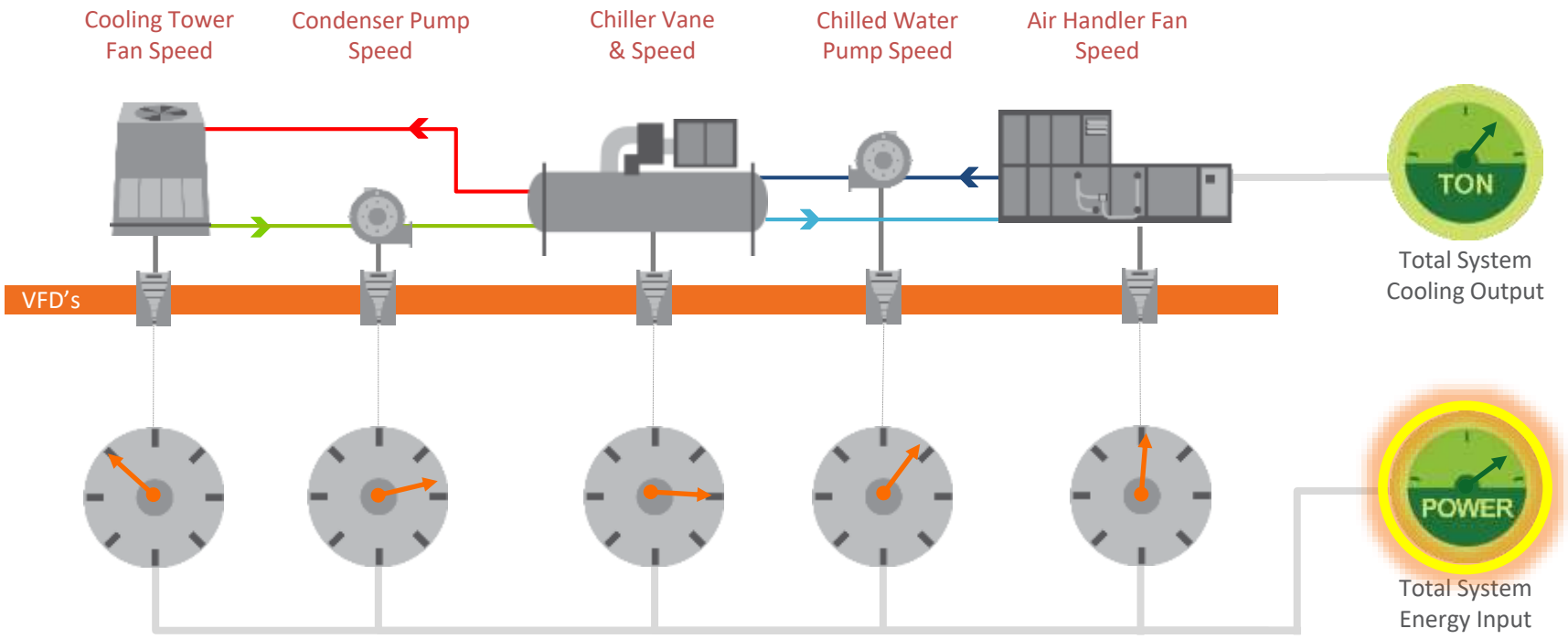
# Plant Layout – CUP (Commissioned mid-June 2016)



# Optimization Foundation – Scope of Work

- VFDs added to 375 HP of primary chilled water pumps
- VFDs added to 1000 HP of secondary chilled water pumps
- VFDs added to 750 HP of condenser water pumps
- Power Monitoring for all chillers and auxiliary equipment
- Distribution Flow Meter and Temperature Sensors
- Deploy Optimum Energy Optimization Control Algorithms and Monitoring Platform

# All Variable-Speed HVAC System




Total System Schematic

# Additional Operational Requirements

- TES Must Remain available for Demand Response
  - Strategy Included hybrid mode of Optimization and Manual Demand Response Action.
- SAT plants elevation created negative return pressure conditions at high SAT plant flows.
  - Resolved through adjusting TES transition sequence changes and limiting SAT plant range
- Changing the Mindset
  - Shift from constant primary flow to variable primary flow
  - Variable chilled water temperatures
  - Variable distributions pressures
  - Variable condenser water flow through chillers
  - Wide range of tower water temperatures

# Chilled Water Optimization

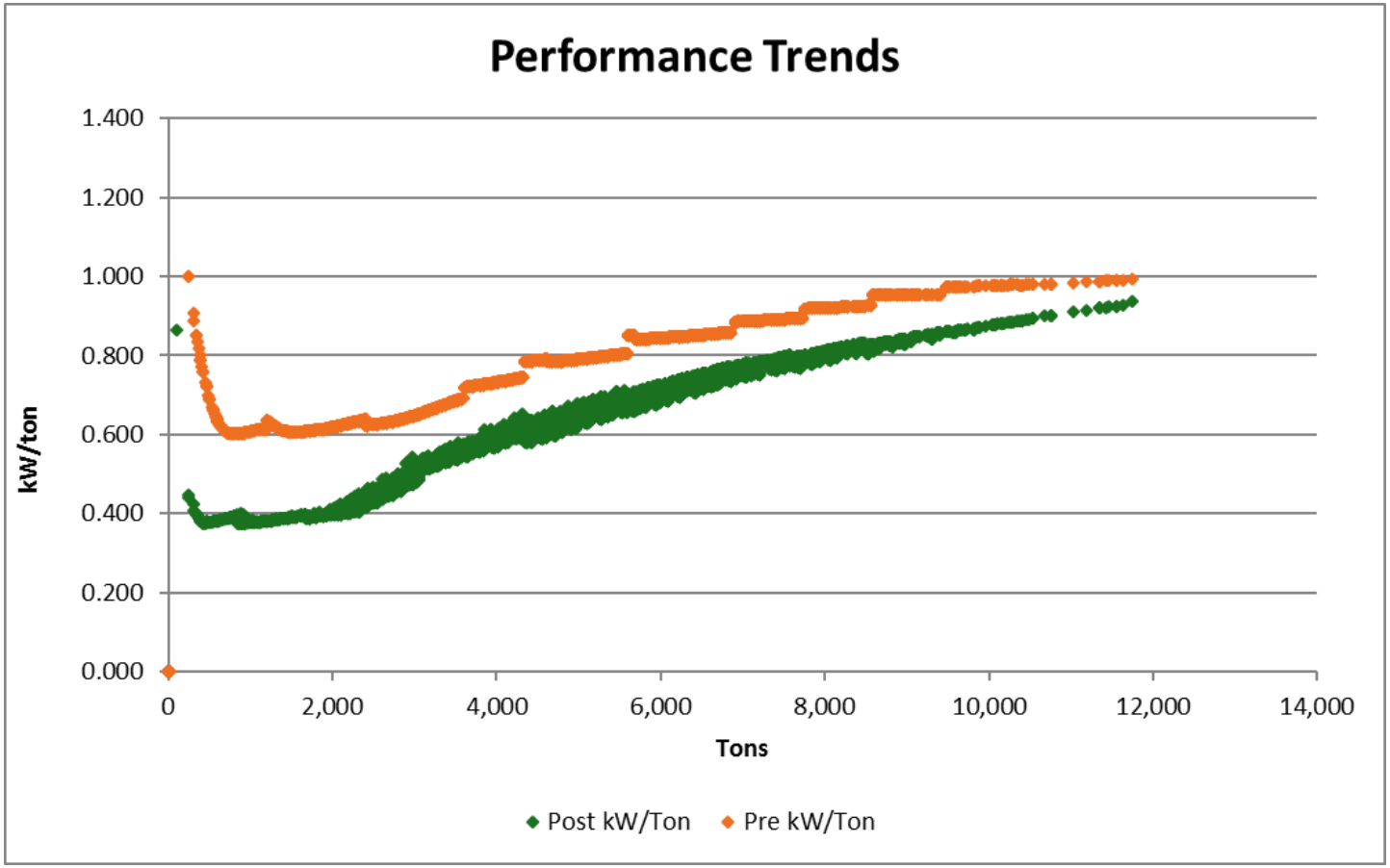
Table 1: Optimization Utility Savings

| OPTIMIZATION UTILITY SAVINGS | |
|---|---|
| Electrical Energy Savings | 3,406,337 kWh/year |
| Electrical Demand Reduction | 183.7 kW |
| Cooling Tower Water Savings | 1,444,831 gal/year |
| $CO_2$ Emission Reduction | 6,101,087 lbs/year |

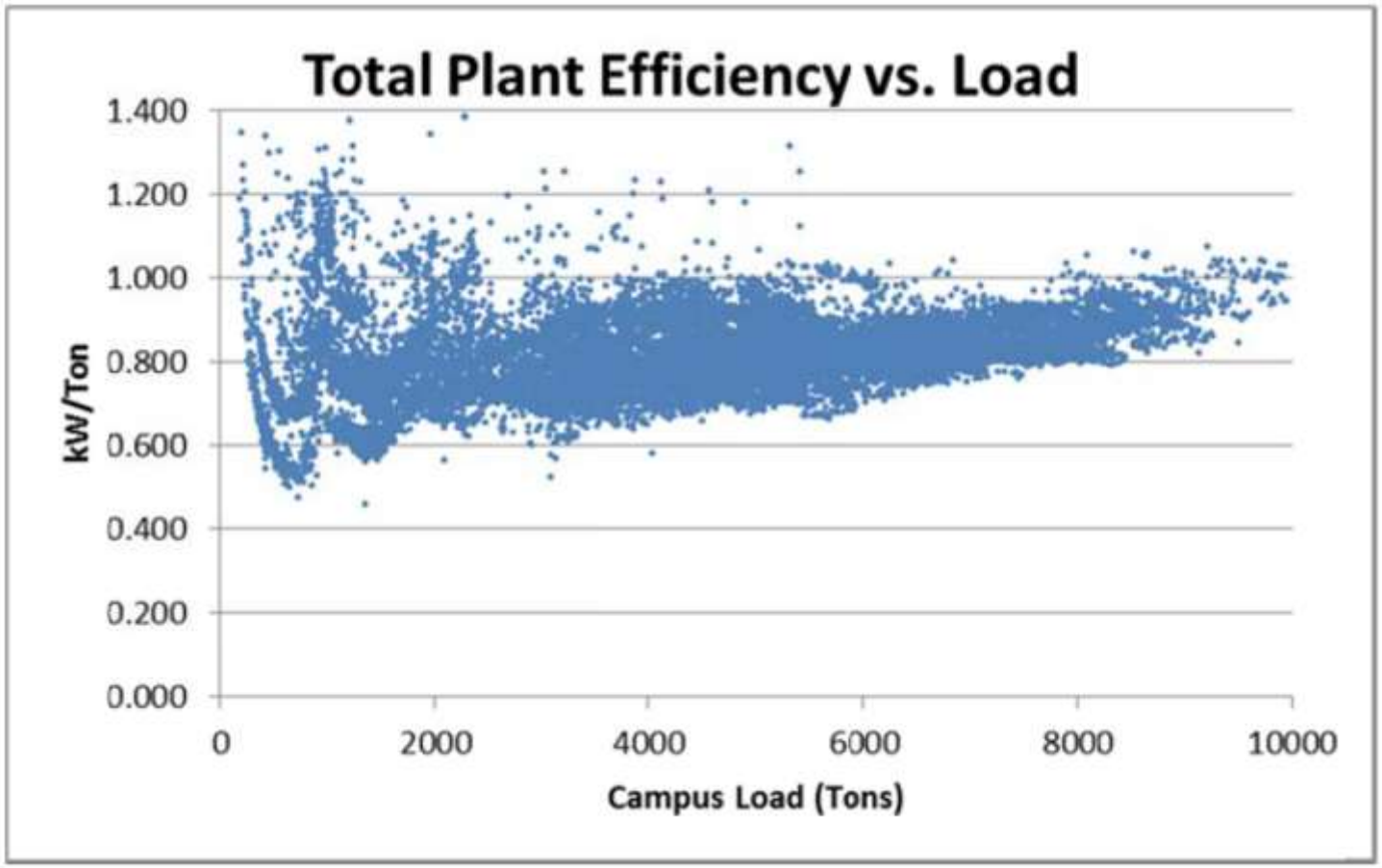
Table 2: Optimization Financial Savings

| OPTIMIZATION FINANCIAL SAVINGS | |
|---|---|
| Utility Rebates and Incentives | $340,634 |
| Annual Operations Cost Reduction | $260,656 |

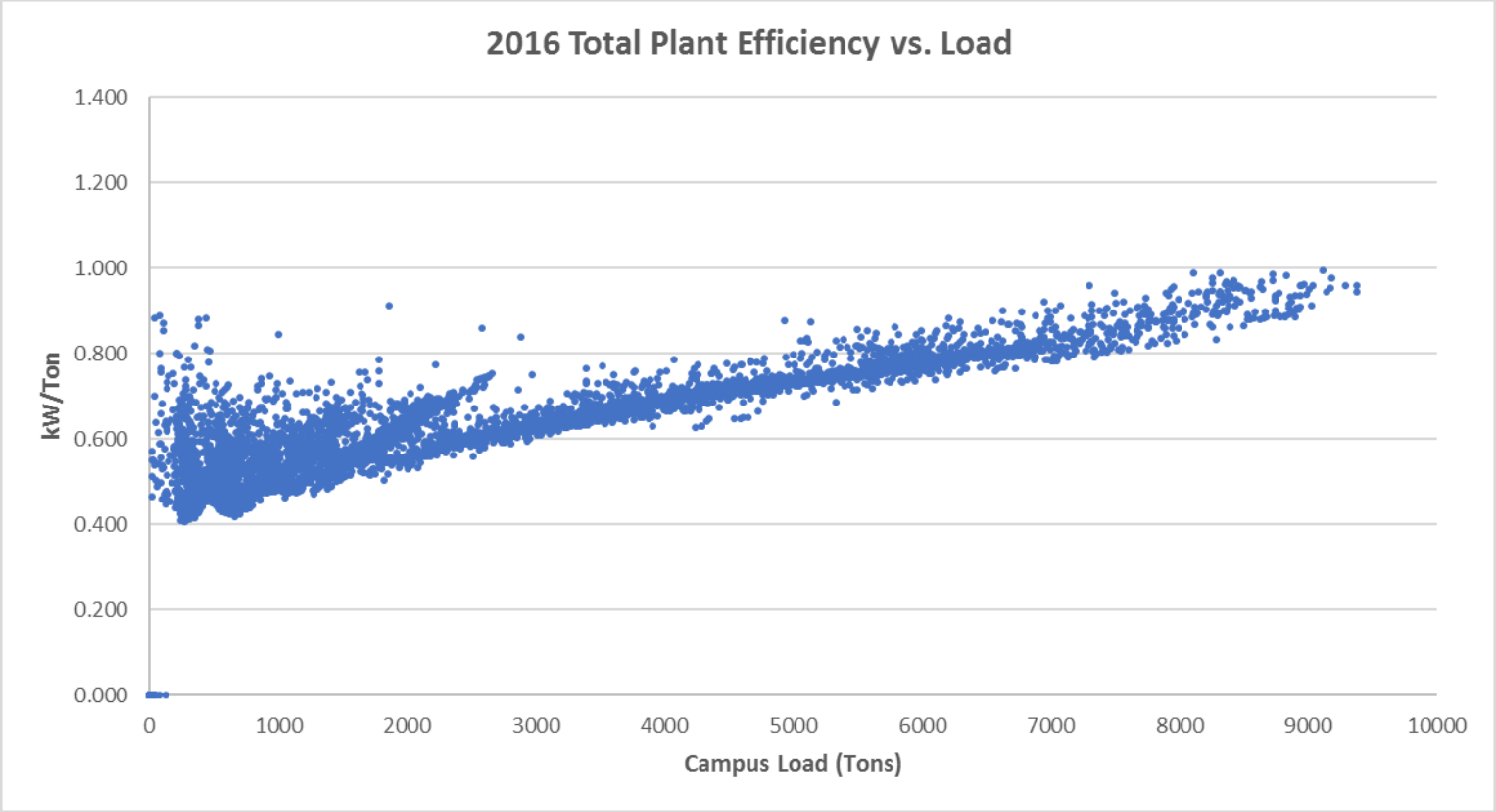
# Efficiency – Simulation during Analysis Phase



# Efficiency – Prior to Optimization (2014)

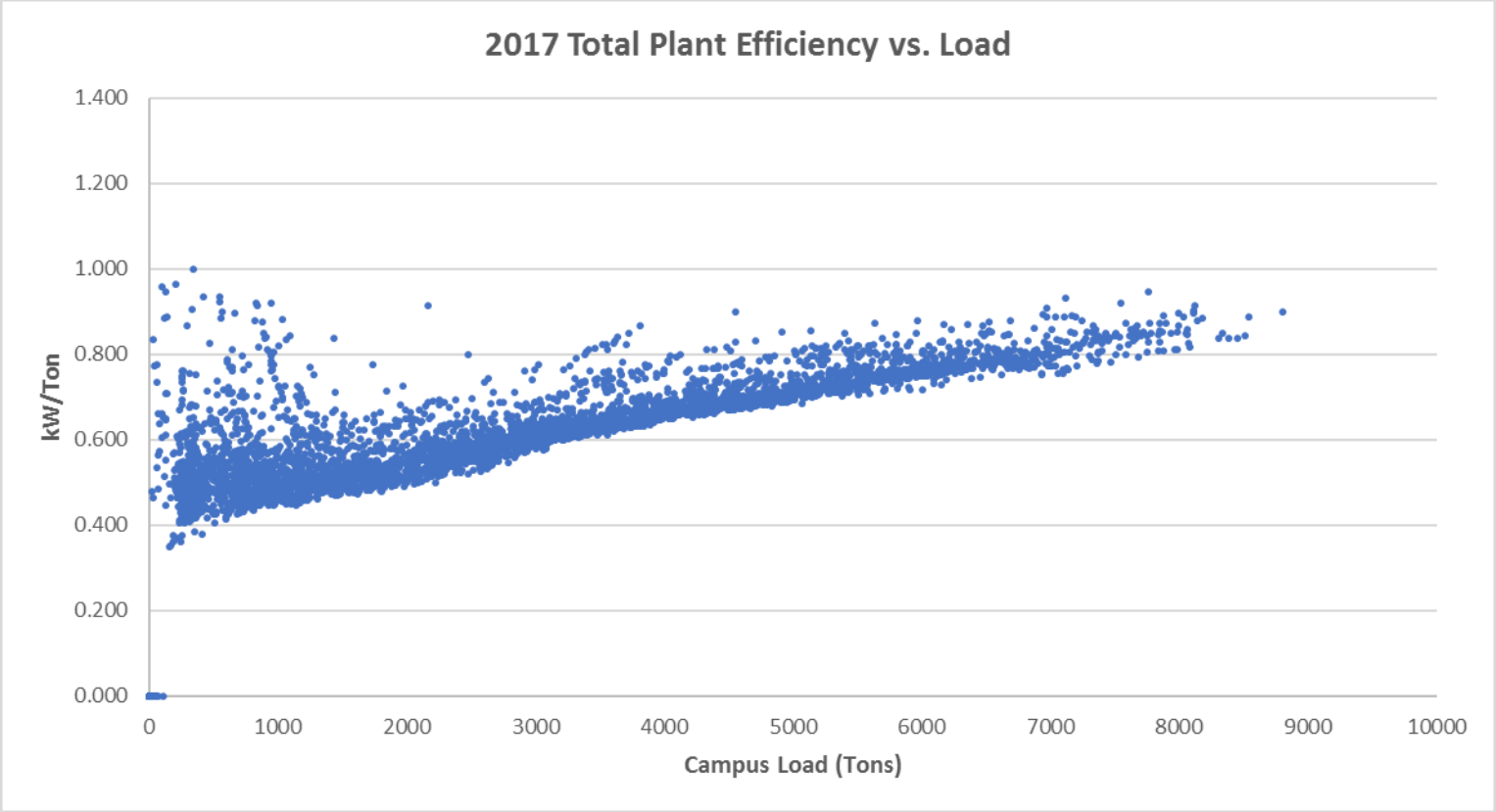


# Efficiency – Post Optimization (2016) - 0.709 kW/Ton

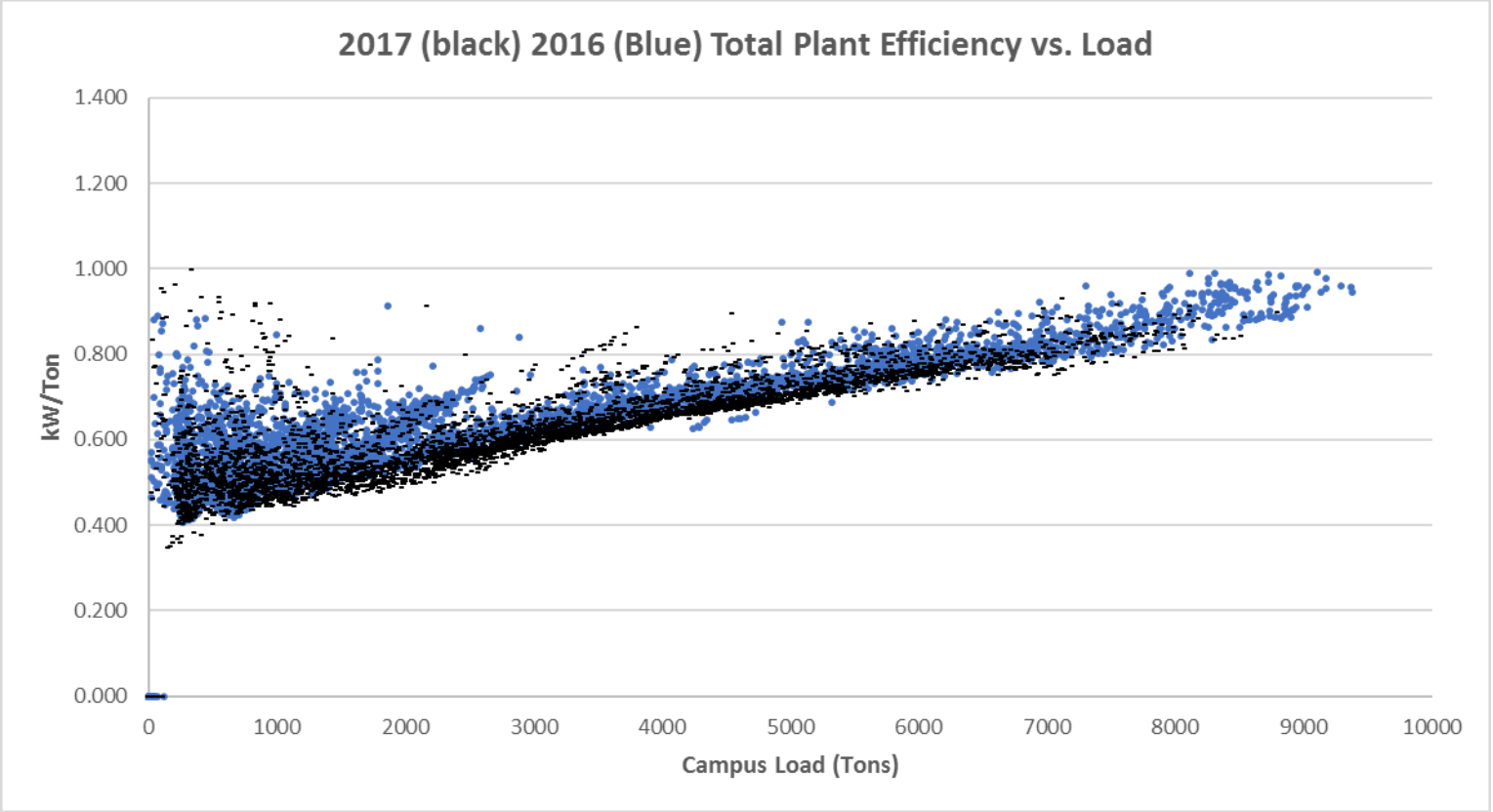



- Total annual savings of 4,156,991 kWh (2016)

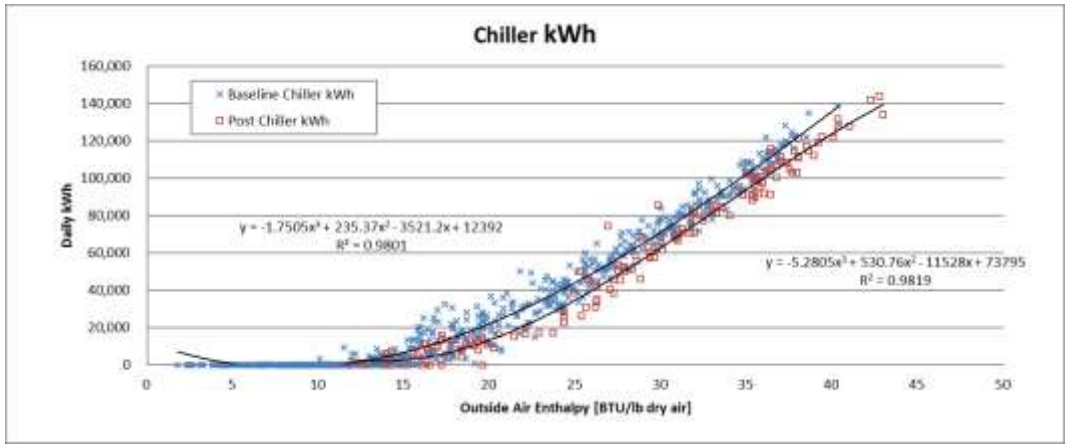
# Efficiency – Post Optimization (2017) - 0.675 kW/Ton

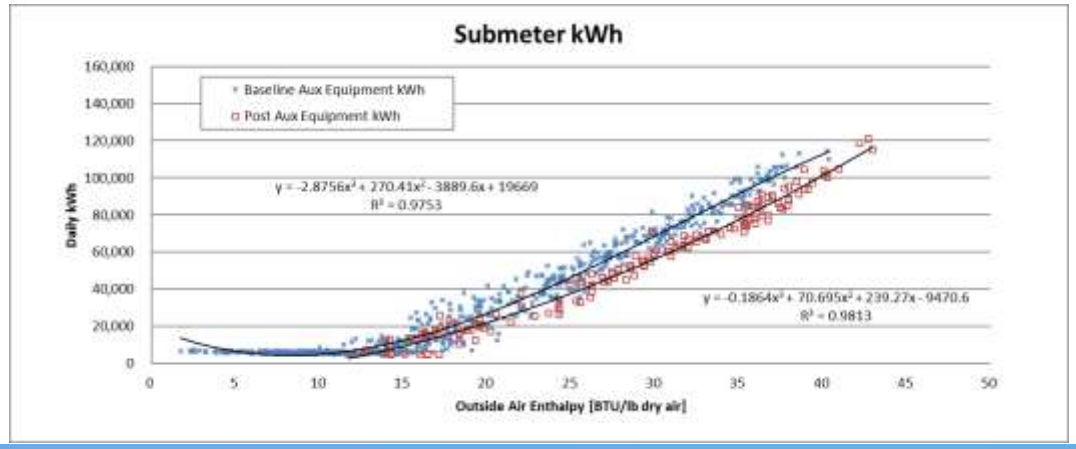


# Site Efficiency – Post Optimization



# Utility Efficiency Analysis – Pre/Post (2016)




- Utility verified savings of 4,156,991 kWh ($310,000) for 2016
  - $415,699 Utility Incentive

# Chilled Water Optimization – Phase 2

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- Replace oldest 2 chillers with Magnetic Bearing Chillers
- Projected additional Savings
  - 1,624,040 kWh
  - $124,000/yr
  - One-Time Additional Incentive $94,000 (approx.)

# Questions?