Duke University

UTILITIES & ENGINEERING

Strategic Planning & Preparation for Campus Mini Microgrid

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Introduction

- Duke University and The Medical Center
- Duke Utilities & Engineering Services (DUES) – part of Facilities Management Department
- Utilities
- Preparation for Campus Microgrid

Duke University

- Located in Durham, North Carolina
- Largest Employer in the City
- 313 Buildings – Hospital, Research, Libraries, Offices, Classrooms, Dining, Residential, Athletics, Marine Lab
- 16.2 Million Gross Square Feet
- 1200+ Acres on Campus
- 48 years – Average Age of Buildings
- 15,400+ Students

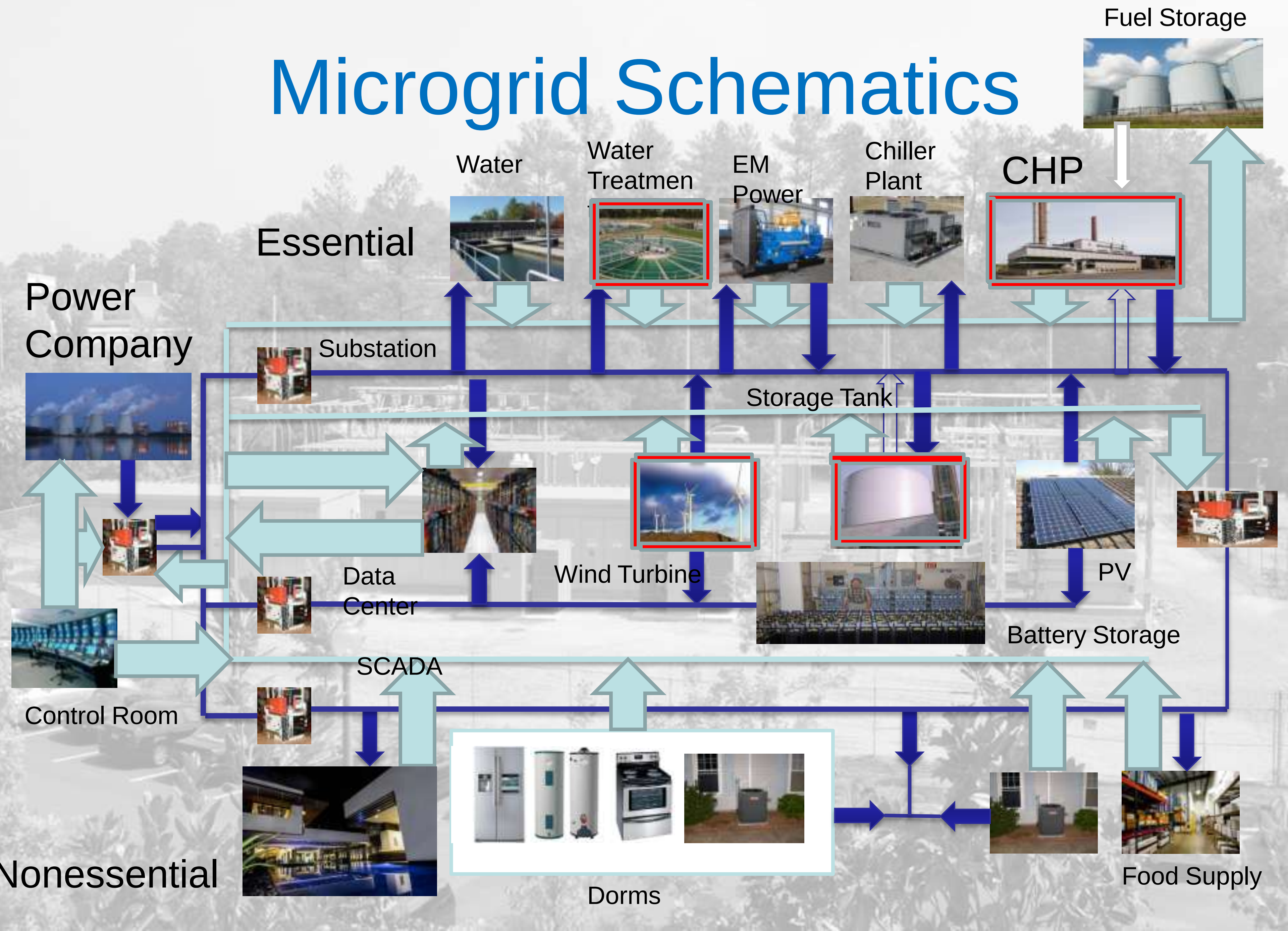
Duke Utilities & Engineering Services (DUES) Overview

- **DUES is a self-supporting not-for-profit utility service provider to the University with operating and capital expenditures covered by utility revenues based on utility unit costs and metered consumption**
- **Founded in 2001**
- **Capitalized with $5 million from the Strategic Initiative Fund**
  - **Capitalization as a cushion against unplanned cost variances**
- **Encompassing:**
  - **Production and distribution of steam and chilled water**
  - **Purchase and distribution of electricity and water**
  - **Sanitary and storm sewer distribution system maintenance**
  - **Services to third parties (OIT)**
  - **Charging for utilities monthly, based on metered consumption**
  - **Energy Management**
- **Serving the University and Medical Center campuses**
  - **Bringing utility distribution systems to new buildings <u>located within its service territory</u>**

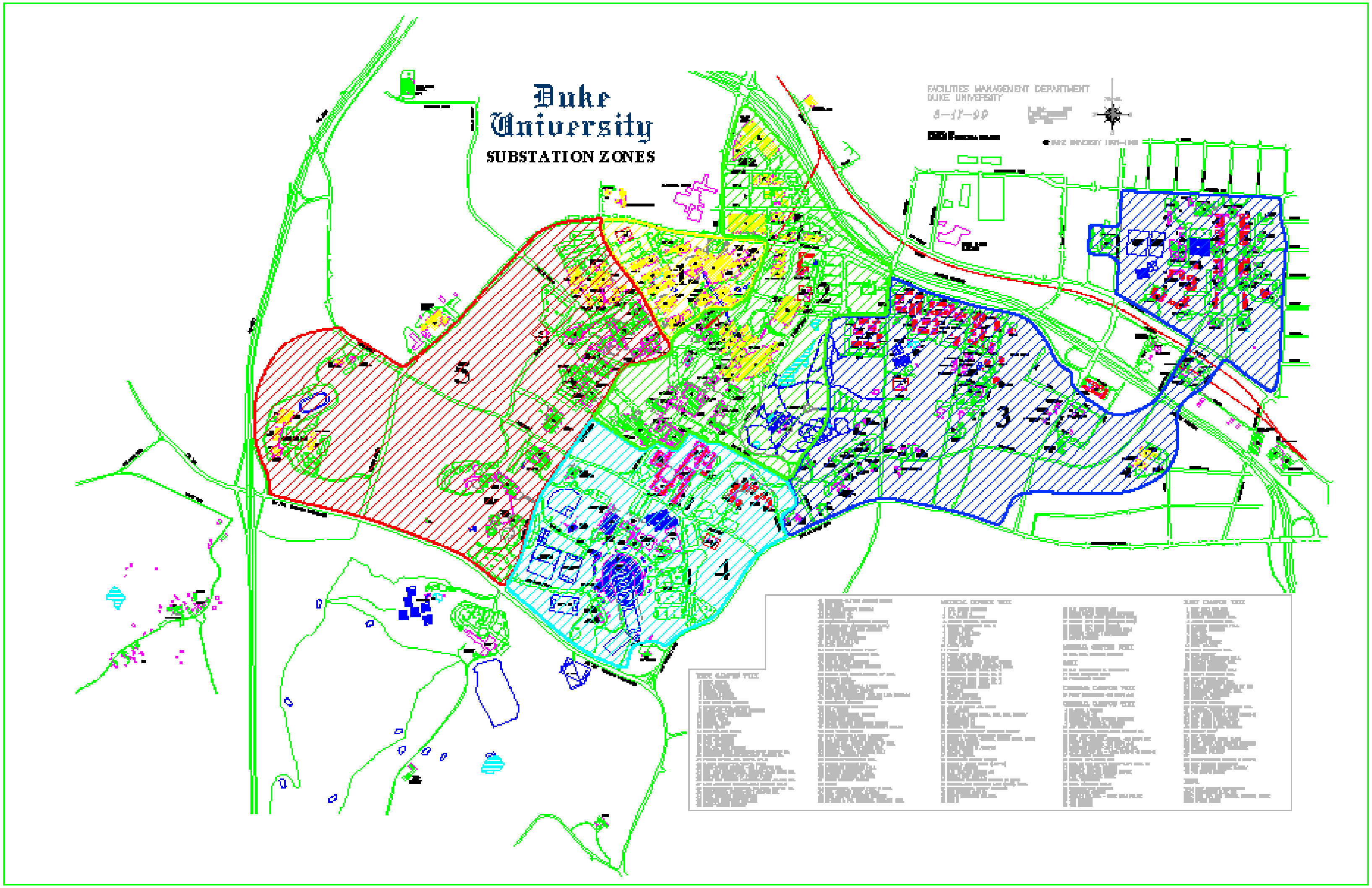
Current Facilities

- **Power purchased from local utility**
- **5 Main Substations**
- **2 Distribution Substations**
- **Current peak demand 82 Mw**
- **Two Steam Plants (340,000 # Peak Demand- Cap: 510,000 #)**
- **Two Chiller Plants (39,000 Tone Peak Demand, Cap: 44,000 Tone)**

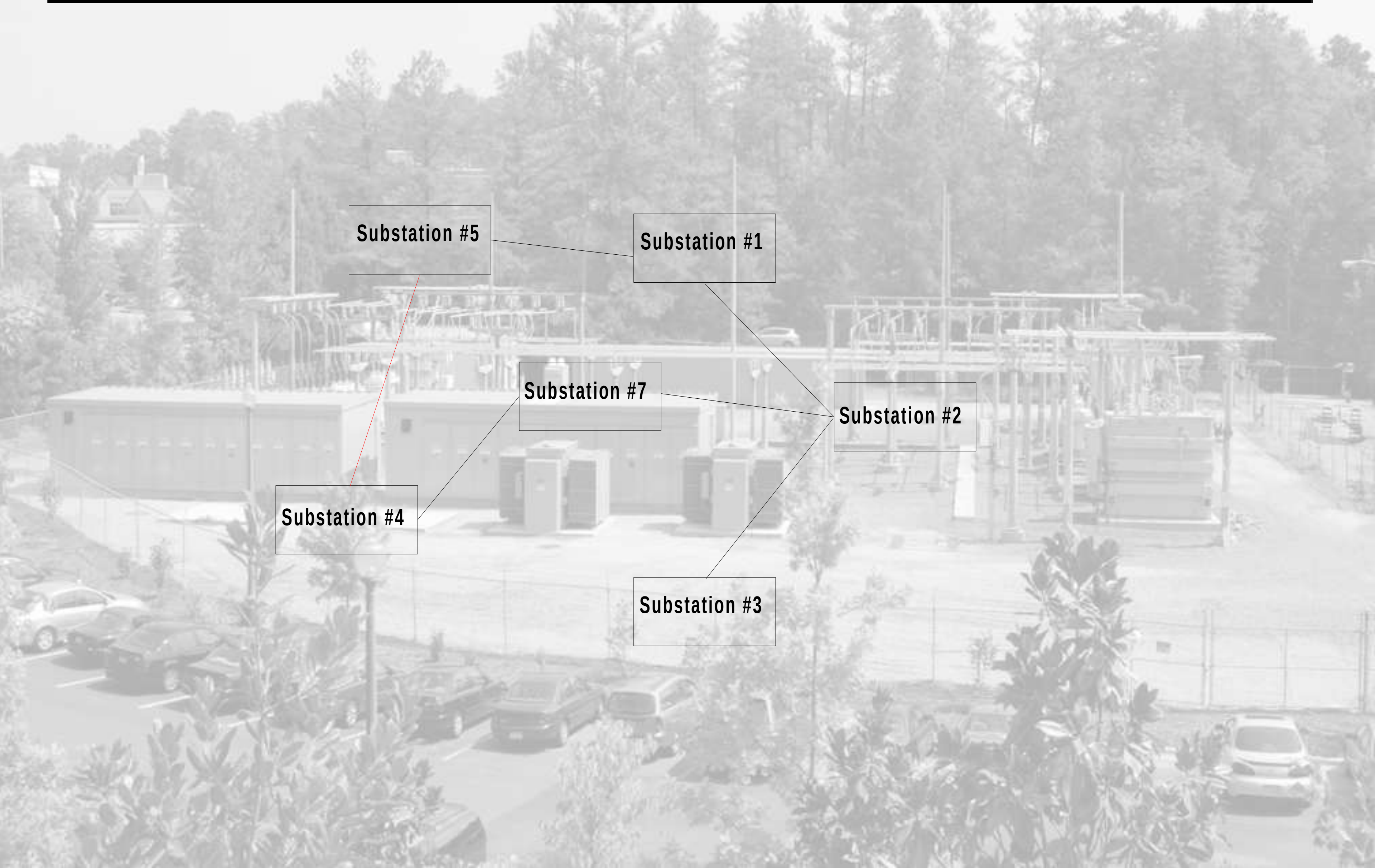
Microgrid Schematics



Duke University



Substation TIES



Strategic Planning

- Storage Tank for Chiller Plant (2017/2018)
- Small CHP – 5 MW (2015/2016)
- Additional Solar Panels (PV)
- Additional Solar Panels (Hot Water)
- No plans for wind generation or batteries storage

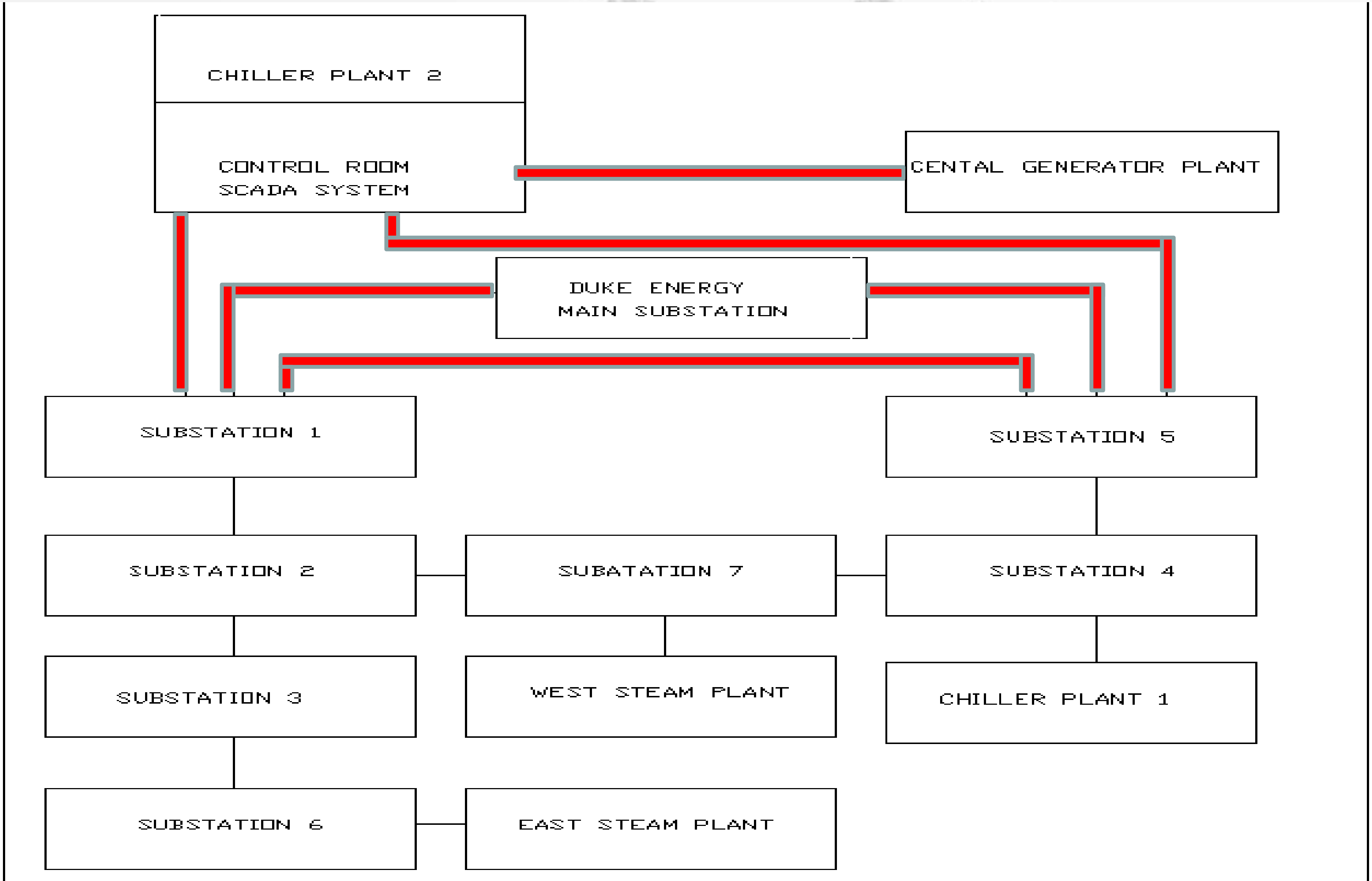
Strategic Planning

- **Smart grid system requires a reliable and secure IT network**
- **Equipment available to handle the interruption and reconnection to the power company supply**
- **Devices to monitor power flow in the system**
- **Coordination studies for all relays involved in switching**
- **High Speed data connection between power company equipment and customer substation(s)**
- **SCADA has a great impact on a successful smart grid system and microgrid**

Smart grid system requires a reliable and secure IT network

- Have a fiber optic network that interconnects substations
- Interconnect the power company system with our substations
- Connect to the fiber network system Steam and Chiller Plants
- Have software and hardware fire walls for security
- Avoid connecting to Campus private network
- Bring the data to Utilities Control Room but have the flexibility to control the system from other locations

Fiber Optic Project



Equipment available to handle the interruption and reconnection to the power company supply

- Compare equipment from several manufacturers and look for service, parts supply and availability
- Equipment firmware upgrades and how long the manufacturer will provide technical support
- Check for other similar products and how fast they become obsolete
- Look for equipment that could be easy upgraded and able to provide minimum 10 - 15 years of service
- Try to stay with one manufacturer to eliminate the extra cost for spare parts

Devices to monitor power flow in the system

- Fault current devices connected to SCADA system
- Reverse power relays
- Overcurrent/directional/differential relays
- Smart metering

Coordination studies for all relays involved in switching

- Coordination challenge is “power flow”
- Compare the “Normal” and “Islanding” settings

High Speed data connection between power company equipment and customer substation(s)

- Fiber optic connection
  - Duke case – single mode fiber optic
- Radio connection
- Power line

SCADA has a great impact on a successful smart grid system and microgrid

- Use the data for forecasting system loads
- For systems with less than 100% demand, adjust the load to meet production
- Monitor the system during a catastrophic event

Prioritization Process

- Better understanding of what projects are most important
- Shows where capital improvement needs to be made first
- Being able to see the big picture
- Shows where there is an immediate need for improvement

Project Challenge

- Work with Engineering, Energy Management, and IT groups to obtain funding
- Work with the power company to make the IT project possible (fiber optic connections)

Q & A