Effective Plant O&M:

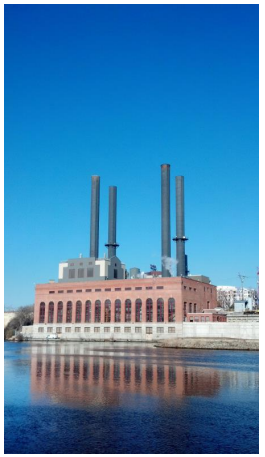
Integrating CHP at the University of Minnesota

University of Minnesota

- Established in 1851 in the Twin Cities (Minneapolis and St. Paul)
- Minnesota's flagship, land grant university
- 18 major colleges
- 30,500 undergraduate students study on the Twin Cities campus
- 16,300 graduate and professional students
- 7,000 international students, from 135 countries

University of Minnesota
Existing Steam Plant Infrastructure

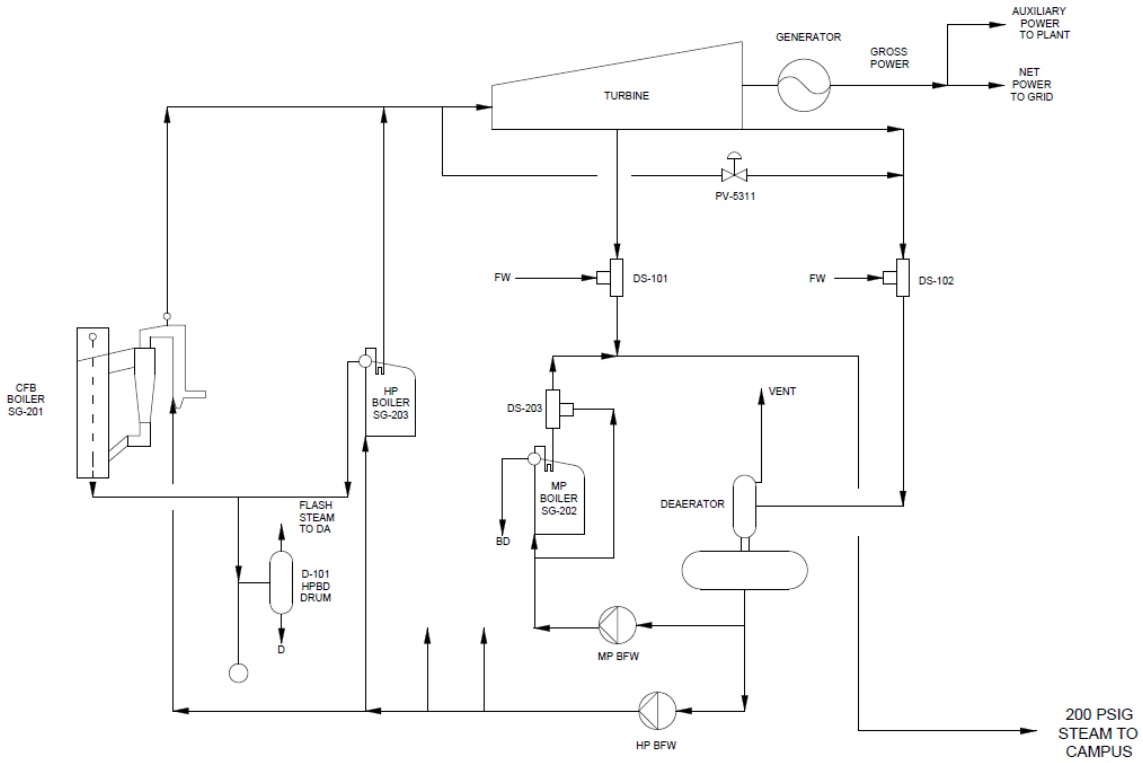
- Two Separate Steam Plants
  - Southeast Plant
    - Sole steam production facility
    - 4 boilers
    - Gas, coal, No.2 fuel oil
    - 1 steam backpressure turbine (16 MW)
  - Saint Paul Plant
    - 6 boilers
    - Gas, coal, No.2 fuel oil
  - Two separate distribution systems



University of Minnesota
Southeast Plant Infrastructure

Boiler/STG	Type	Age	Conditions	Capacity (pph)	Fuel(s)
SG-201	Fluidized Bed	2000	900 psig 900 F	200,000	Gas/Coal
SG-202	LP Package	2000	265 psig 420 F	250,000	Gas/No.2
SG-203	HP Package	2000	900 psig 900 F	200,000	Gas/No. 2
Boiler 4	Stoker	1948	440 psig 600 F	80,000	Coal
TG-101	Back Pressure STG	2000	900 psig 200 psig	16 MW Net	Steam

University of Minnesota
Southeast Plant - Flow Diagram



University of Minnesota
St. Paul Plant Infrastructure

Boiler/STG	Type	Age	Conditions	Capacity (pph)	Fuel(s)
No. 1	Pulverized Coal	1956	150 psig Saturation	25,000	Gas/Coal
No. 2	Pulverized Coal	1956	150 psig Saturation	25,000	Gas/Coal
No. 5	Stoker	1970	150 psig Saturation	60,000	Gas/Coal/ No. 2
No. 6	Stoker	1978	150 psig Saturation	60,000	Gas/Coal/ No. 2
No. 7	LP Packaged	1991	150 psig Saturation	80,000	Gas/No. 2
No. 8	HP Packaged	1999	265 psig Superheated	250,000	Gas/No. 2

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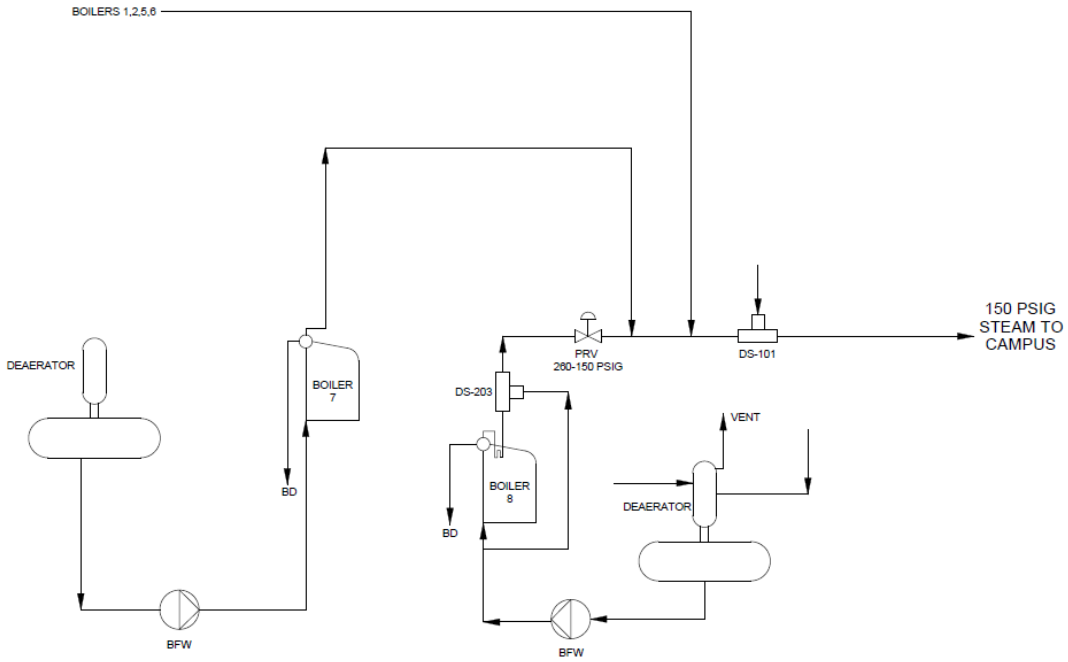
St. Paul Plant - Flow Diagram



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System Challenges

- *From the Operations & Maintenance perspective:*
  - *The campuses are 5 miles apart*
  - *Fuel flexibility creates challenges:*
    - *Natural gas is the primary fuel*
    - *Coal and No. 2 Fuel Oil are back-up fuels*
      - *Potential for natural gas curtailment (non-firm)*
      - *Coal is also limited by environmental permits (30%)*
      - *Coal use is managed accordingly*
- Plant operations are executed with the University's long term best interest in mind…..

University of Minnesota
Recent History

- Long Range Planning has led to recent accomplishments:
  - Existing Steam Plant efficiency evaluations
    - (Boiler tests, meter upgrades, control system optimization)
  - Refined dispatch models for boilers
    - For all seasons, load profiles, and fuel choices
  - Controls upgrade projects in planning stages at both plants to support integration with the CHP Plant

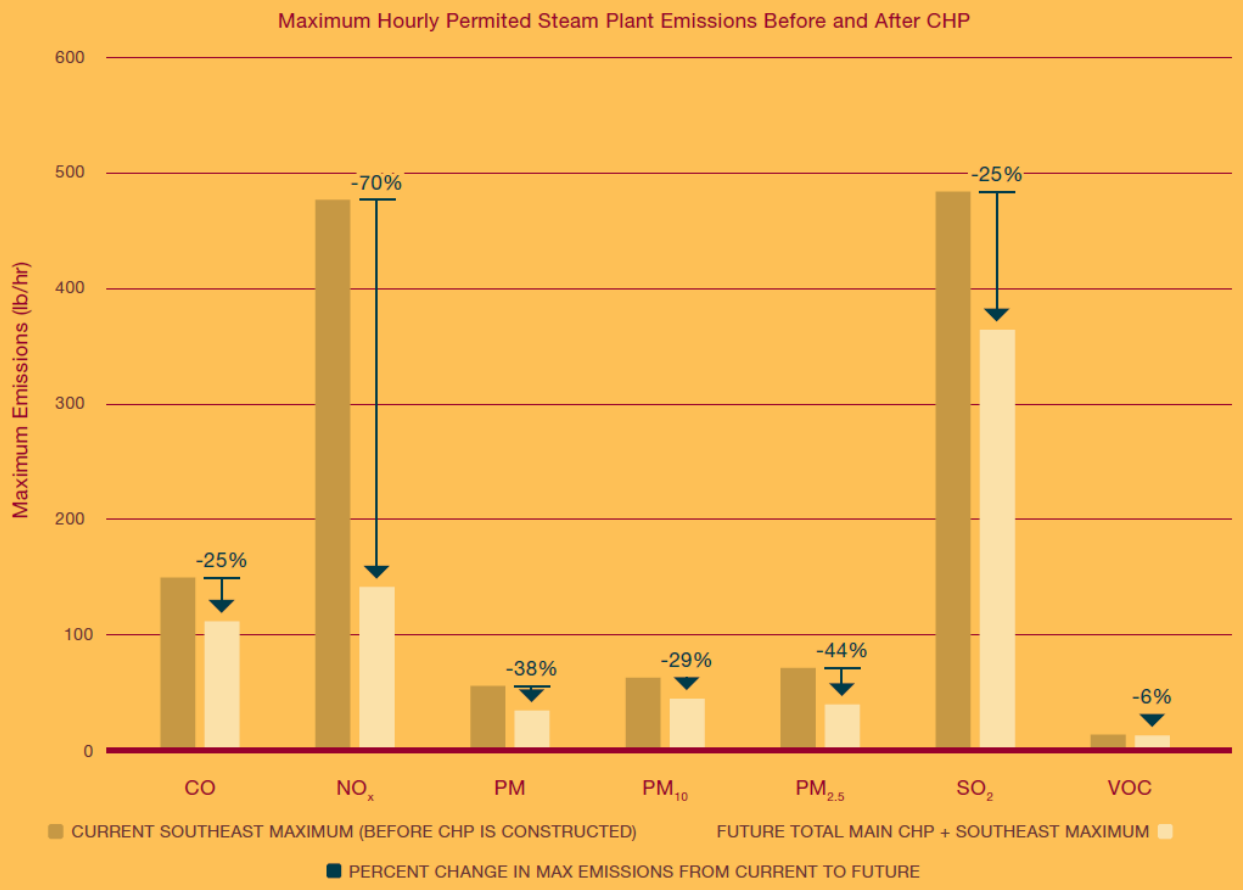
- ... and led the way for the current path …

University of Minnesota
CHP Project

- CHP Plant Description
  - GE LM 2500
    - Dual fuel
  - EIT HRSG with duct firing
    - 90,000 pph on LM 2500
    - 250,000 pph with duct firing
    - 200 psig/400 F
  - Economics
    - $7 million annual savings
    - $176 million over 30 year horizon
    - Partially shields university from increased electric rates
  - Sustainability
    - 10-13% reduction in carbon footprint

University of Minnesota
CHP Project – Environmental Benefits

Emissions Comparison



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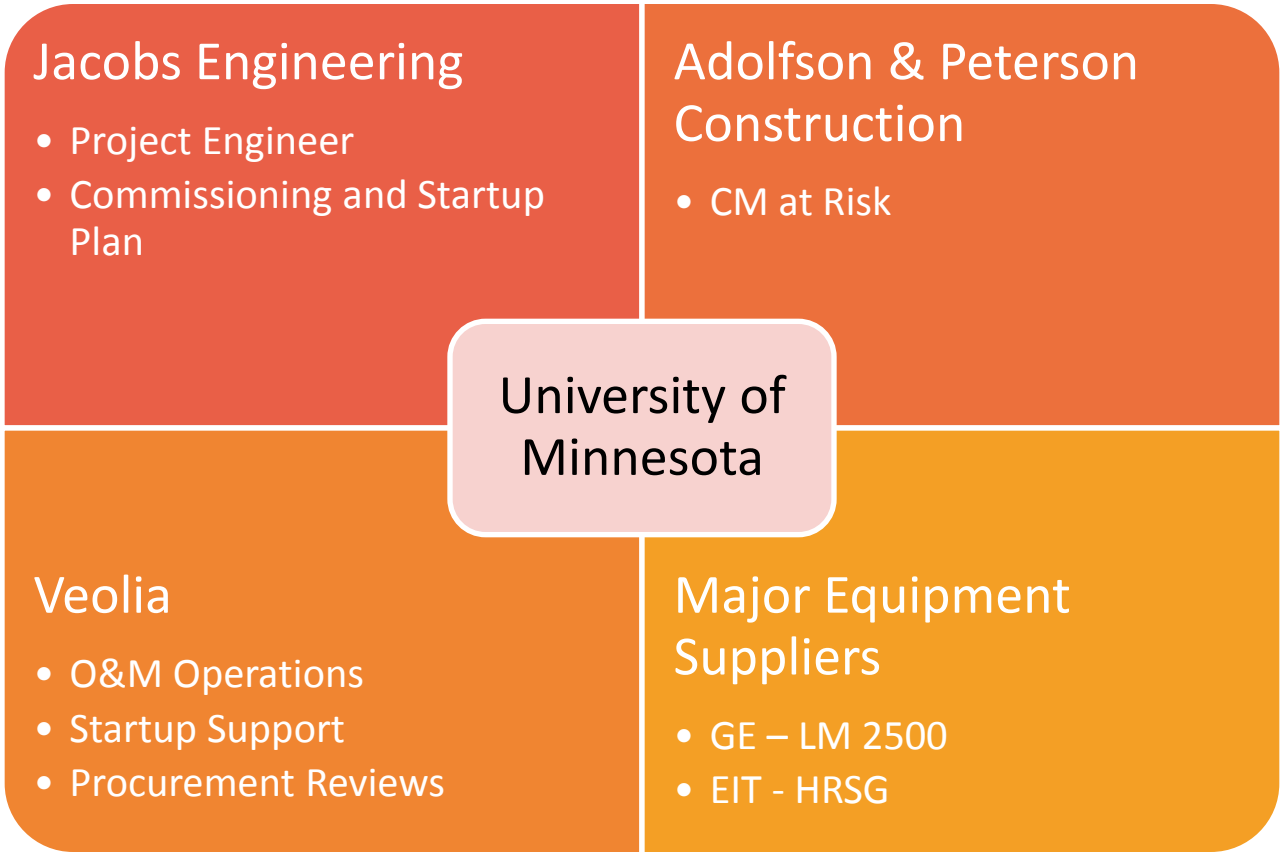
CHP Project – Project Team



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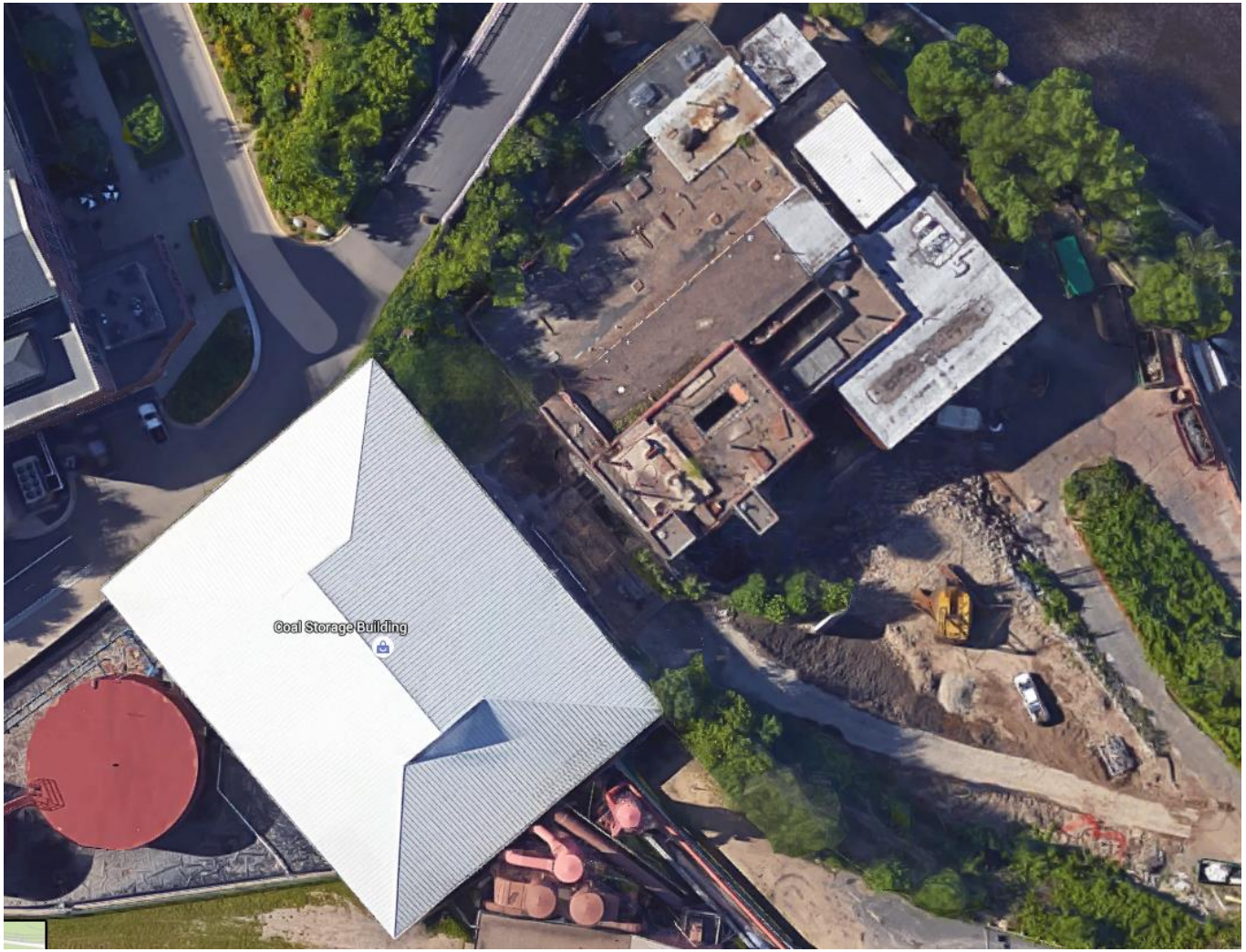
CHP Project – Project Site



University of Minnesota – Key Performance Indicators
System Pressure Maintenance

- KPI(s)
  - Less than 4 preventable pressure drops per plant (< 90% of system rated pressure)
- Action Plan
  - Updated P&IDs, as built drawings, equipment numbering
    - Much of the work being performed by University engineering students
  - Maintaining N+1 redundancy on most major equipment
    - Major equipment is spared and planned maintenance is well scheduled
  - Responsive controls and monitoring systems
    - Upgraded controls with common systems
    - Cross-trained operators
    - The ability to monitor the CHP and SE Steam Plant from each control room

University of Minnesota – Key Performance Indicators Plant Maintenance

- KPI(s)
  - Critical Asset Maintenance Plan within 6 months of taking over
  - 90% on-time completion rate of Critical Asset Maintenance
- Action Plan
  - Utilizing Maximo to execute outages efficiently

University of Minnesota – Key Performance Indicators
Key Equipment Availability

- KPI(s)
  - Veolia to conduct a material assessment of existing equipment within 6 months
  - 95% availability of boilers, generators and air compressors
- Action Plan
  - Maximo efficiently planning scheduled maintenance
  - Stocking needed spare parts
  - Scheduling equipment outages effectively
  - Utilize OEM and Veolia Technical resources

University of Minnesota – Key Performance Indicators
Plant Operational Efficiency

- KPI(s)
  - Veolia will complete a plant efficiency review with 6 months of taking over
  - Veolia will propose an operational profile for University approval that establishes a plant dispatch profile and theoretical operational profile
  - Maintain overall plant efficiency within 15% of theoretical values
- Action Plan
  - Phase 1 of the plant efficiency plan is complete with dispatch profiles and energy conservation improvements
  - Control system upgrades are underway
  - Defining dispatch based on season loads
  - Plant energy and utility reports are issued monthly

University of Minnesota – Key Performance Indicators Safety and Housekeeping

- KPI(s)
  - Maintain an acceptable level of cleanliness based on walkthroughs by a University Representative, the Plant Manager and Veolia Representative
  - Maintain a reportable injury rate at no more than 4 per calendar year for both plants
- Action Plan
  - EH&S polices are thoroughly enforced including ongoing training opportunities
  - Cleanliness is practiced and embraced
  - Root Cause Analyses (RCA) are performed as needed

University of Minnesota – Key Performance Indicators Operational Analysis

- KPI(s)
  - Veolia will conduct an event critique for each unplanned event that results in a reportable safety infraction and any reduction in pressure to less than 90%
  - Same critique for any event as agreed to between Veolia and the University
- Action Plan
  - Maintain stand by equipment in ready condition to minimize startup
  - Control system upgrades
  - Common control architecture at all plants to facilitate cross training
  - Backup fuel systems ready in case of curtailment or supply loss

University of Minnesota
Integrating Future Infrastructure

- Integrating the New CHP Plant enhances:
  - The intention is to operate the CHP plant to the greatest extent practical
  - Dispatch planning incorporates
    - Seasonal load profiles
    - Fuel choices
    - Enhanced reliability
    - Timely execution of planned maintenance activities
    - Economics
  - Controls upgrades at the SE and St.Paul plants promote improved interface between plants, data gathering, and efficiency
  - Cross training O&M staff provides operating flexibility as well as staff growth and satisfaction

University of Minnesota
Integrating Future Minneapolis Campus Infrastructure

Existing Capacity:

Boiler	Steam Capacity
SG-201	200,000 pph
SG-202	250,000 pph
SG-203	200,000 pph
Boiler 4	80,000 pph
Total	730,000 pph

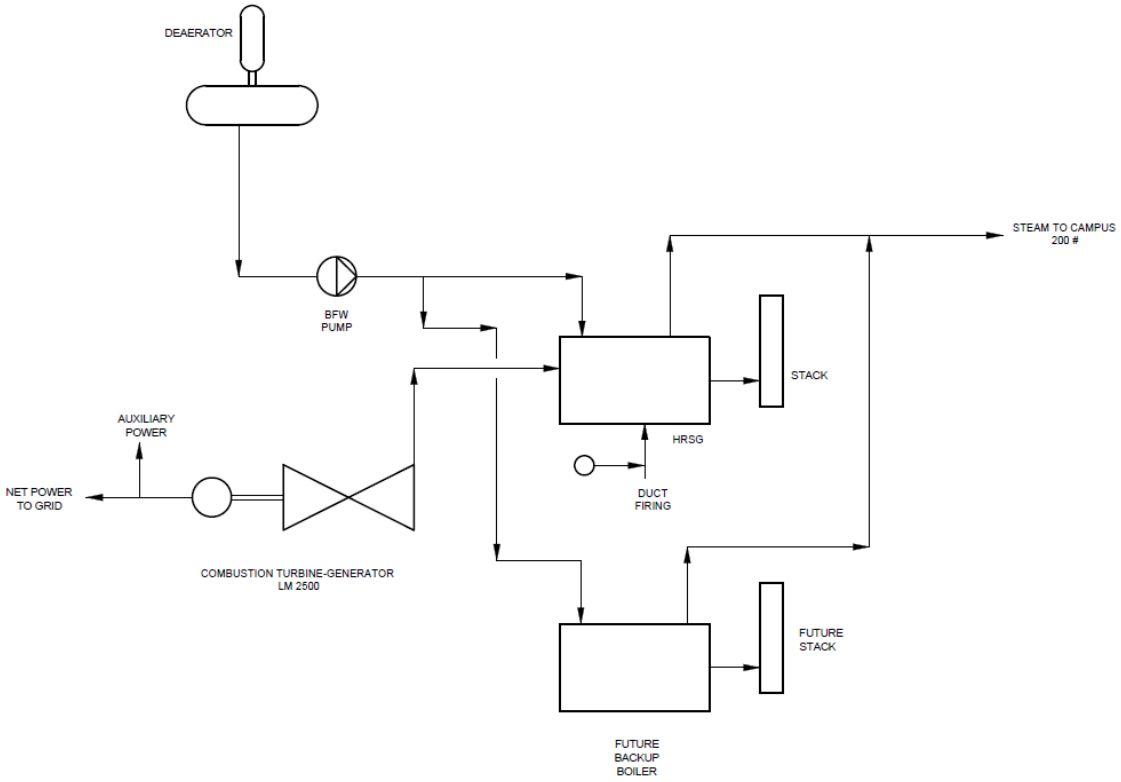
Future Capacity, (with CHP):

Boiler	Steam Capacity
SG-201	200,000 pph
SG-202	250,000 pph
SG-203	200,000 pph
Boiler 4	Retired
HRSG-fired	250,000 pph
	900,000 pph

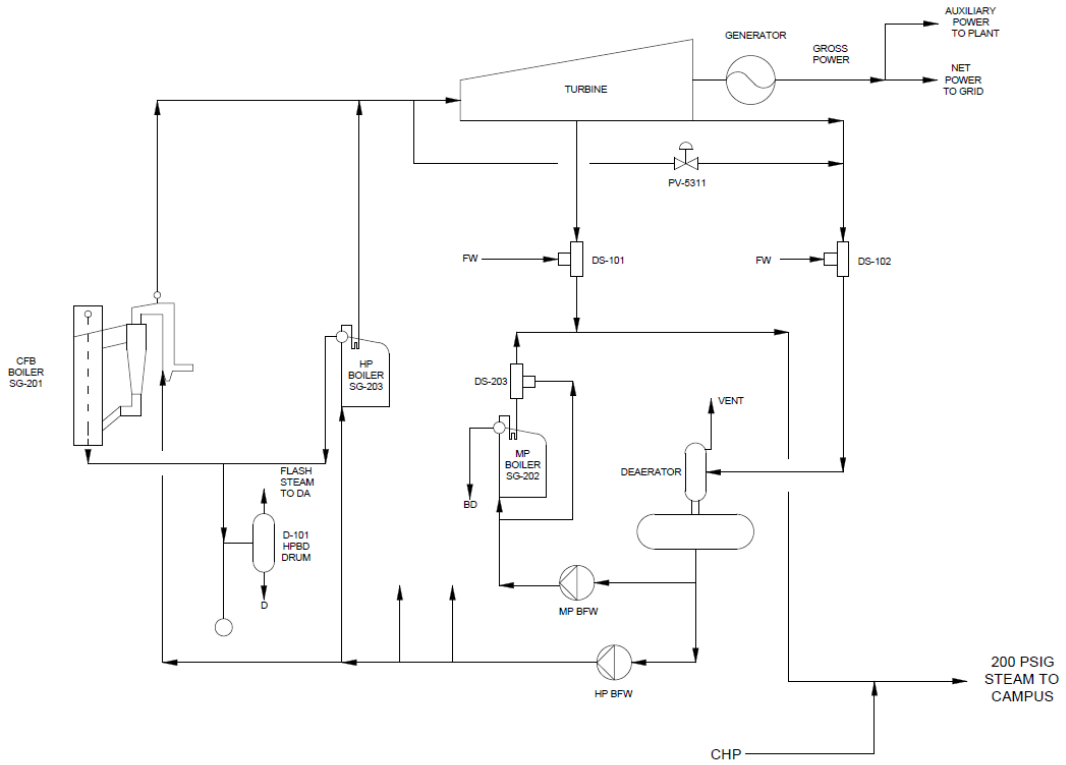
Generators	Electricity
BP ST-Gen, G-101	16 MWe
Total	16 MWe

Generators	Electricity
BP ST-Gen, G-101	16 MWe
GE LM 2500	22 MWe
	38 Mwe

University of Minnesota – Future Infrastructure



University of Minnesota – Future Infrastructure



University of Minnesota Questions

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