# University of Minnesota

## Combined Heat and Power Plant

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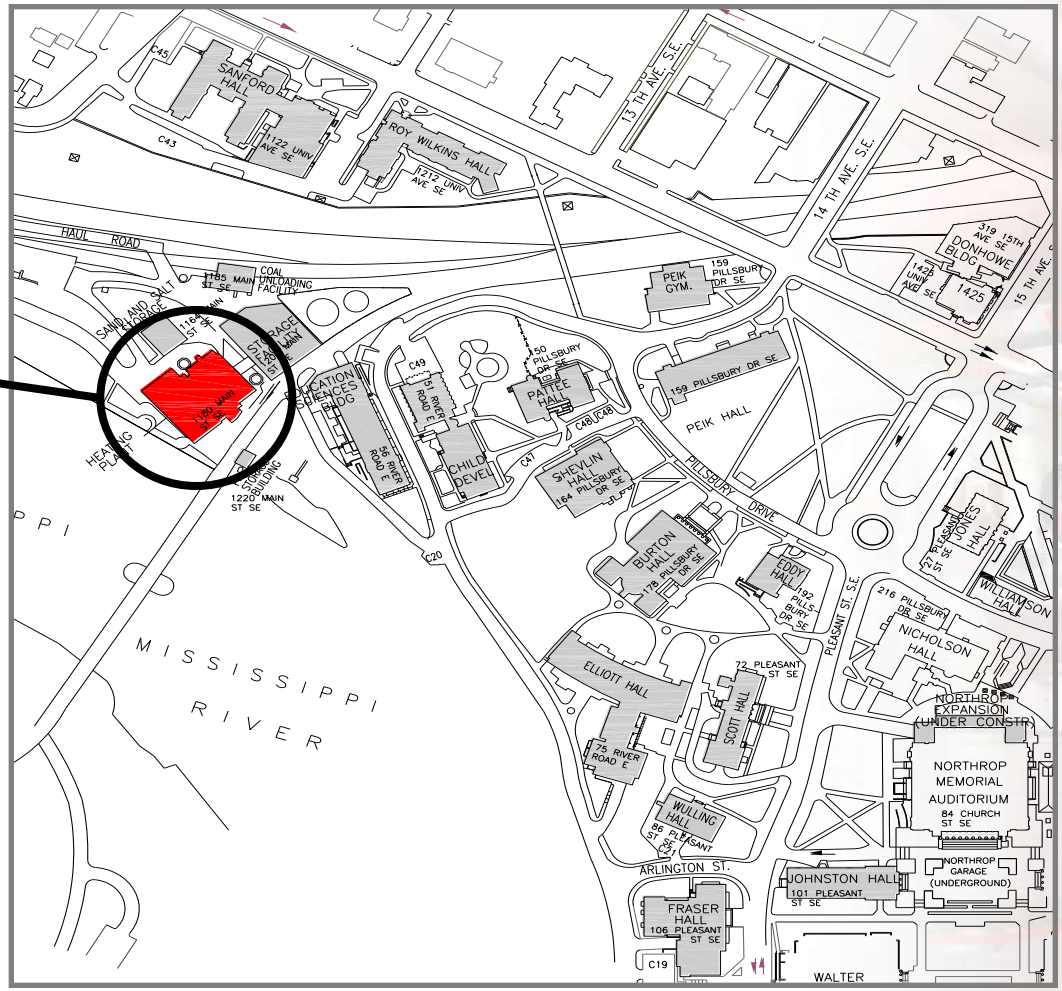
# Location Map

**Combined Heat & Power Plant Project Location**




**University of Minnesota Twin Cities East Bank Campus**

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# Aerial Photo

# Energy Management Principles

**Reliable**

**Sustainable**

**Cost-effective**

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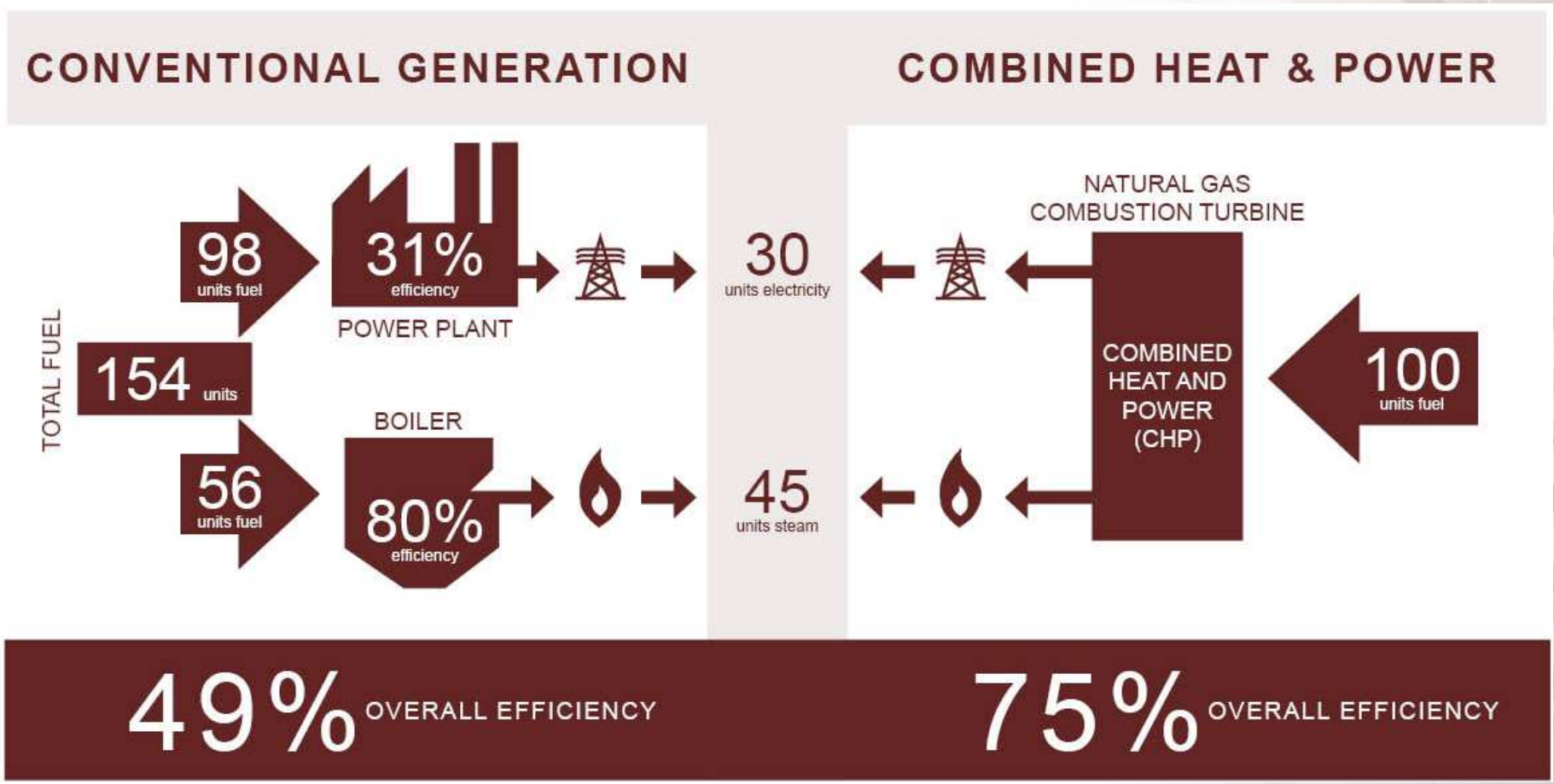
# Pathway to Combined Heat and Power

# CHP Efficiency

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# Right Sizing Process

**Develop Load Profiles** → Heat Balance Modeling → Financial Analysis → Sensitivity Analysis

- Hourly steam demand history
- Hourly electrical demand history
- Load growth projections

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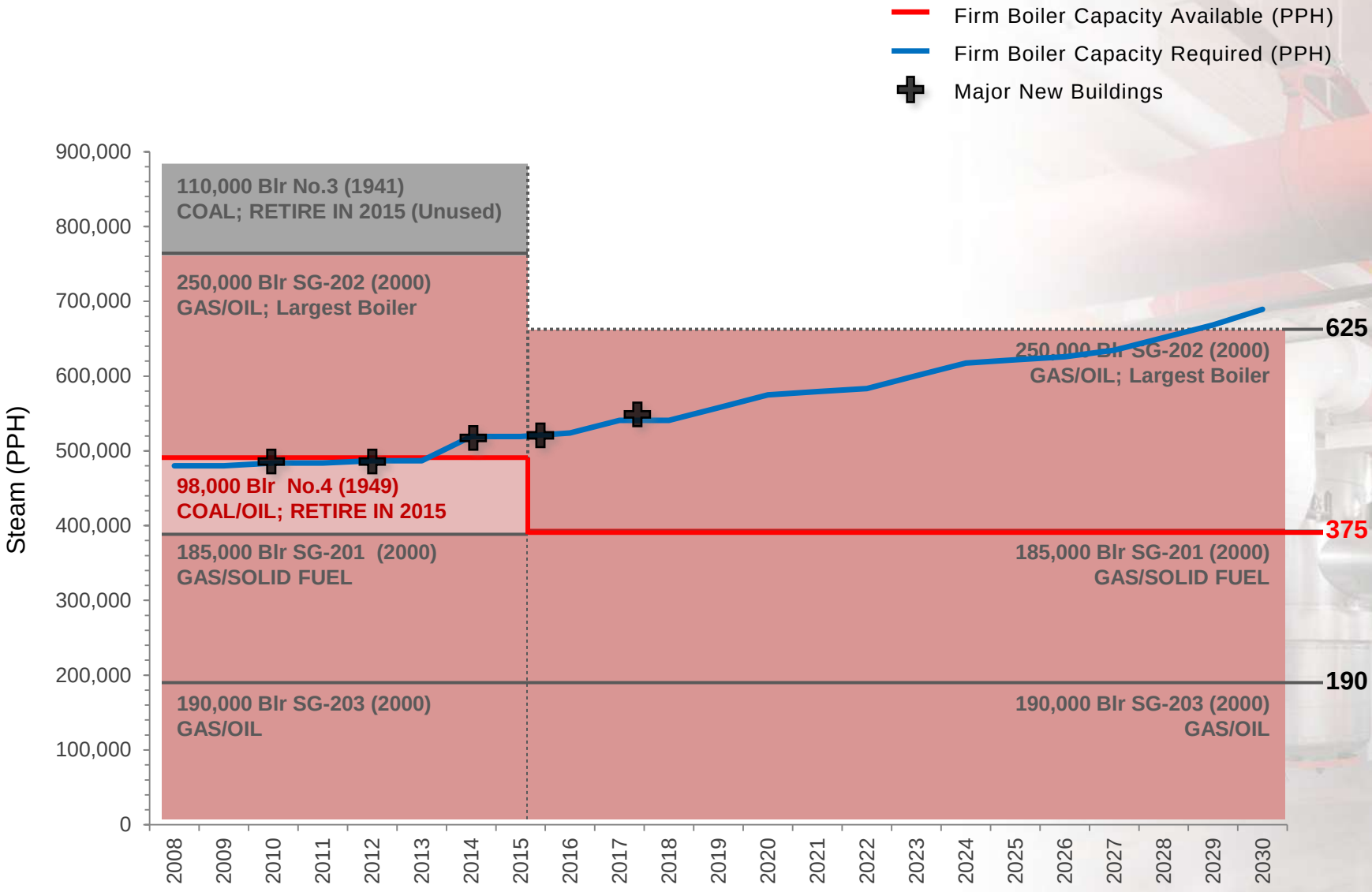
# Right Sizing Process

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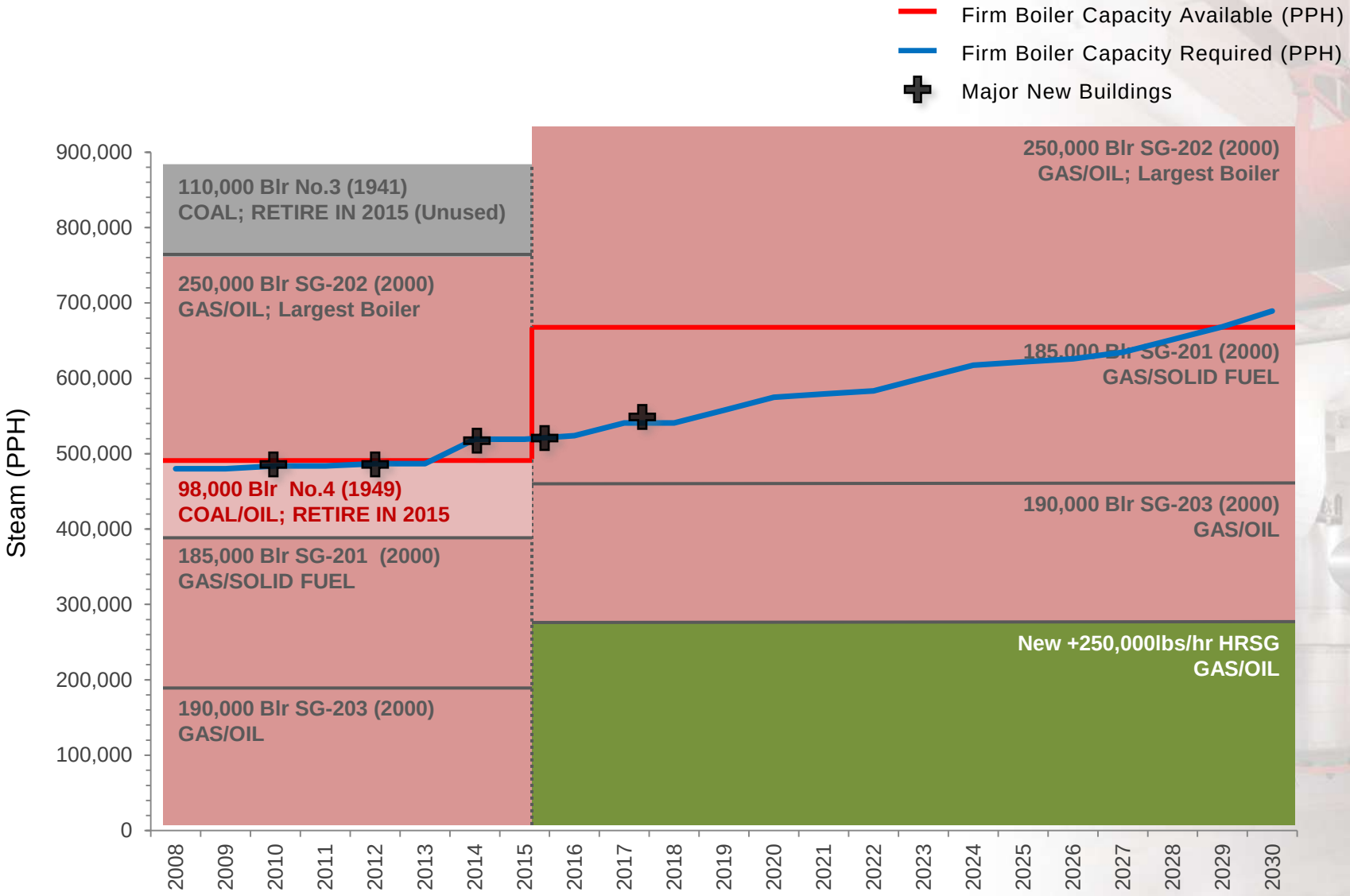


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# Right Sizing Process

Develop Load Profiles → **Heat Balance Modeling** → Financial Analysis → Sensitivity Analysis

- Thermoflex graphical heat balance software coupled with high-resolution spreadsheet models
- Entire coordinated system (multiple plants) must be modeled
- Evaluate campus performance under varying **load** and **ambient conditions**

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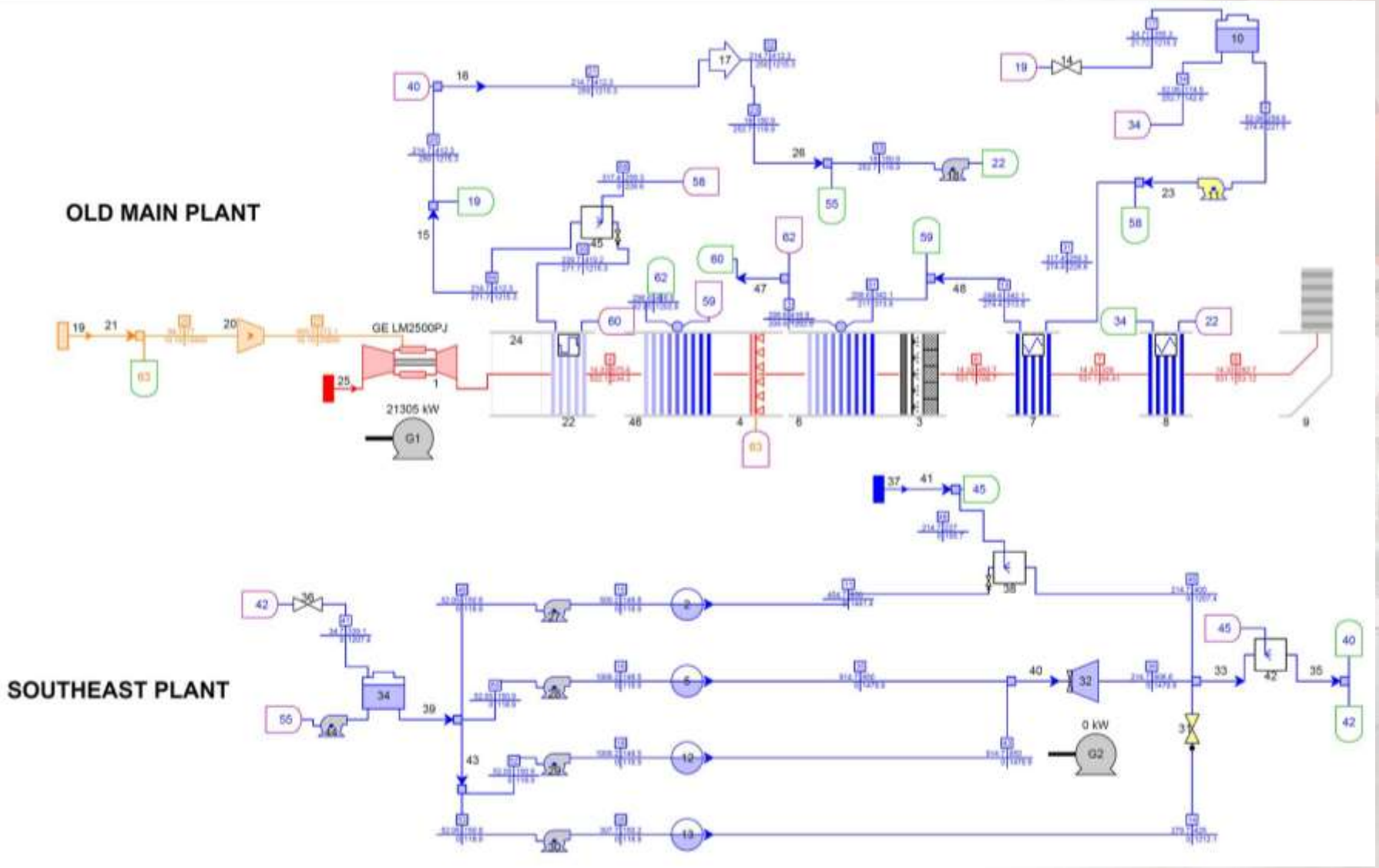
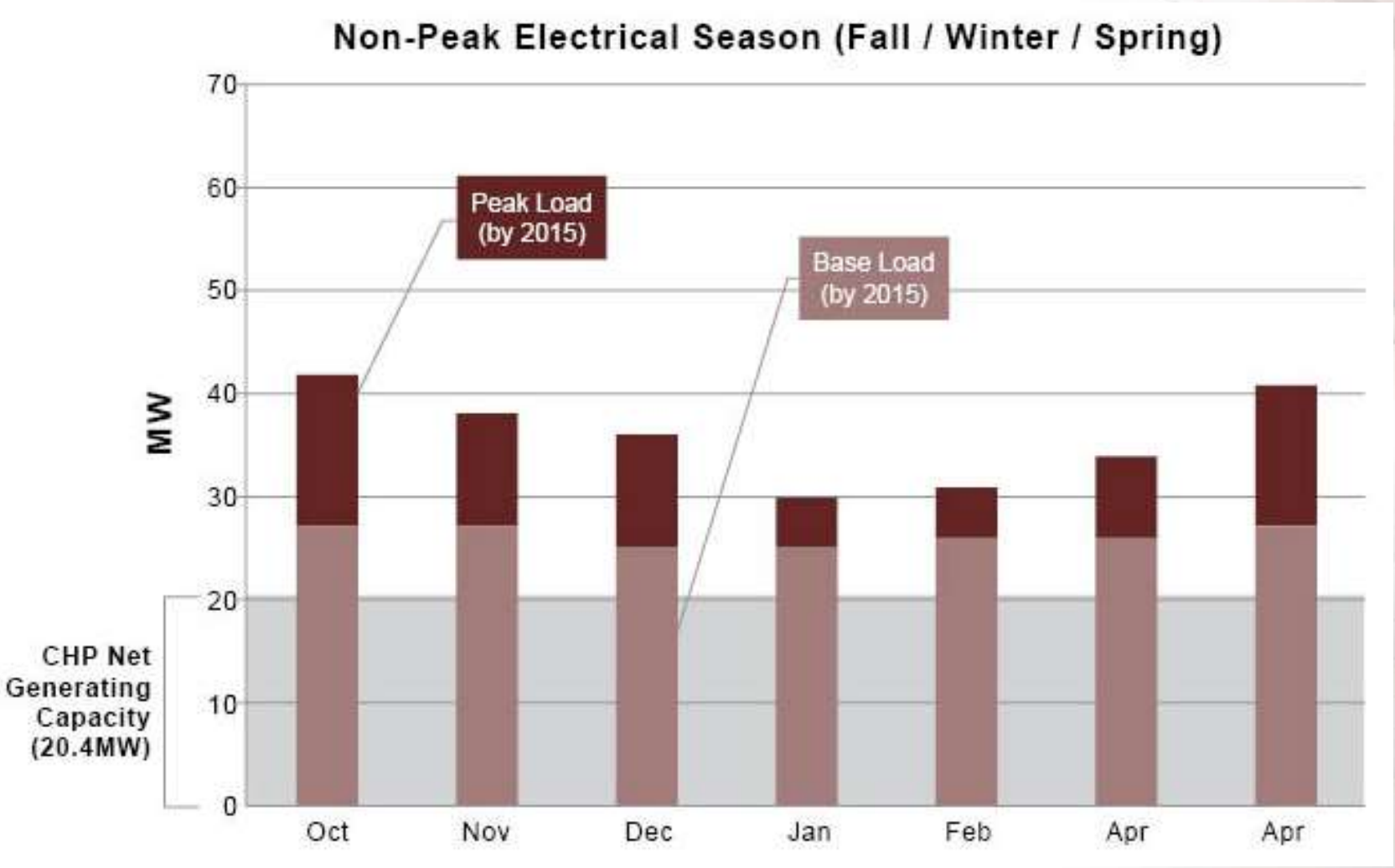
# Sample Thermoflex Diagram



# Electric Demand vs. CHP Capacity



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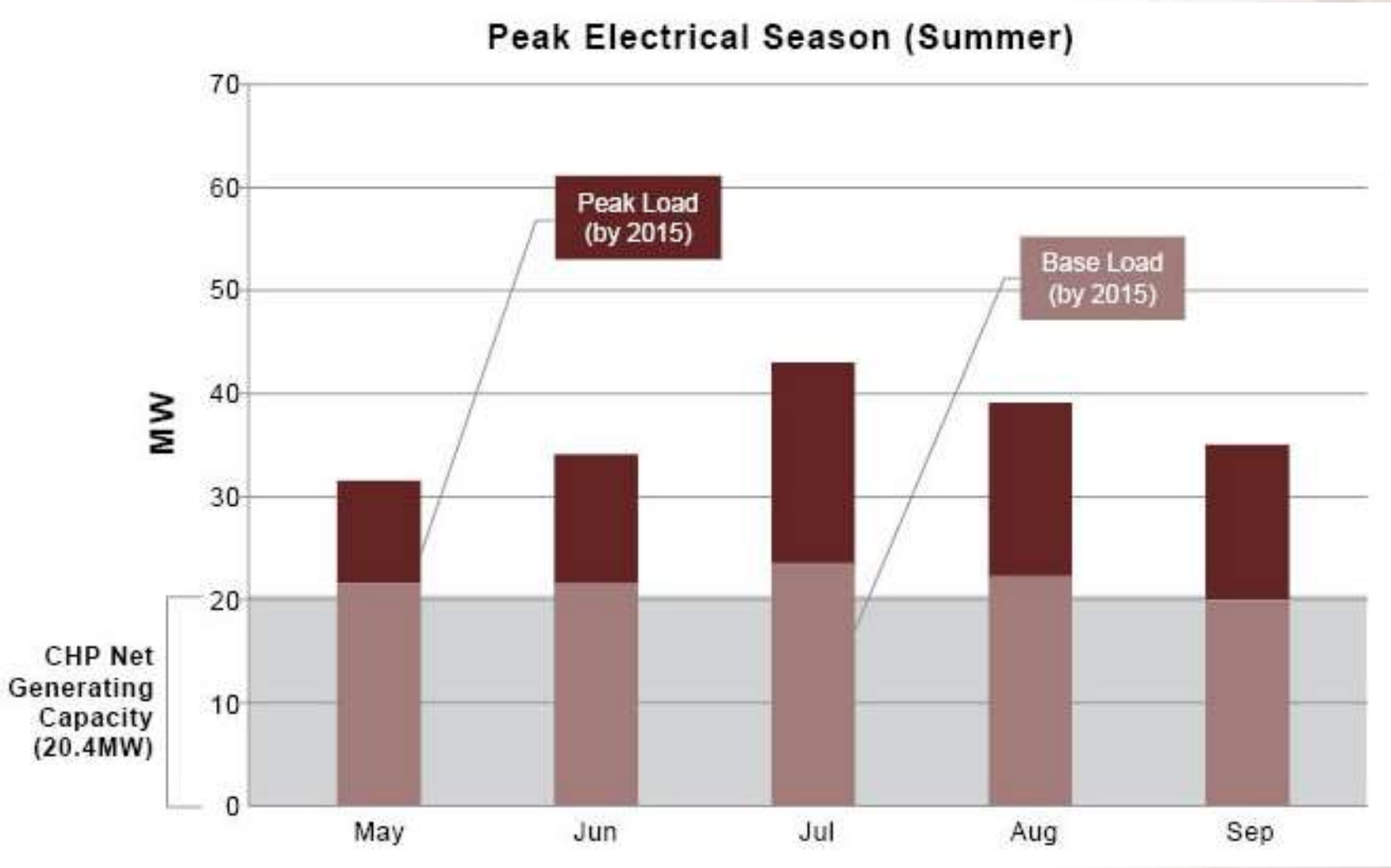

# Right Sizing Process

Develop Load Profiles → Heat Balance Modeling → **Financial Analysis** → Sensitivity Analysis

- Spreadsheets used to calculate **total annual fuel consumption** and **utility costs** for each option
- O&M costs calculated for each option
- Total Cost of Ownership for each option

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# Cost-Effective: Projected Savings

| | Traditional Boiler | Two – 7.5 MW Turbines (15 MW total) | One - 22 MW Turbine |
|---|---|---|---|
| First Cost | $ 41M | $ 80M | $ 81M |
| Annual Purchased Utility Costs | $ 25.7M / yr | $ 20.5M / yr | $ 18.9M / yr |
| Incremental Annual O&M Costs | $ 656K / yr | $ 2.26M / yr | $ 2.12M / yr |
| **20-Year Avoided Cost** | **N/A** | **$69M** | **$167M** |

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# Right Sizing Process

Develop Load Profiles → Heat Balance Modeling → Financial Analysis → **Sensitivity Analysis**

- Financial analysis based on DOE projections for utility cost escalation
- Analyzes financial performance of a proposed solution against unforeseen fluctuations in **fuel gas** and **purchased electricity** costs

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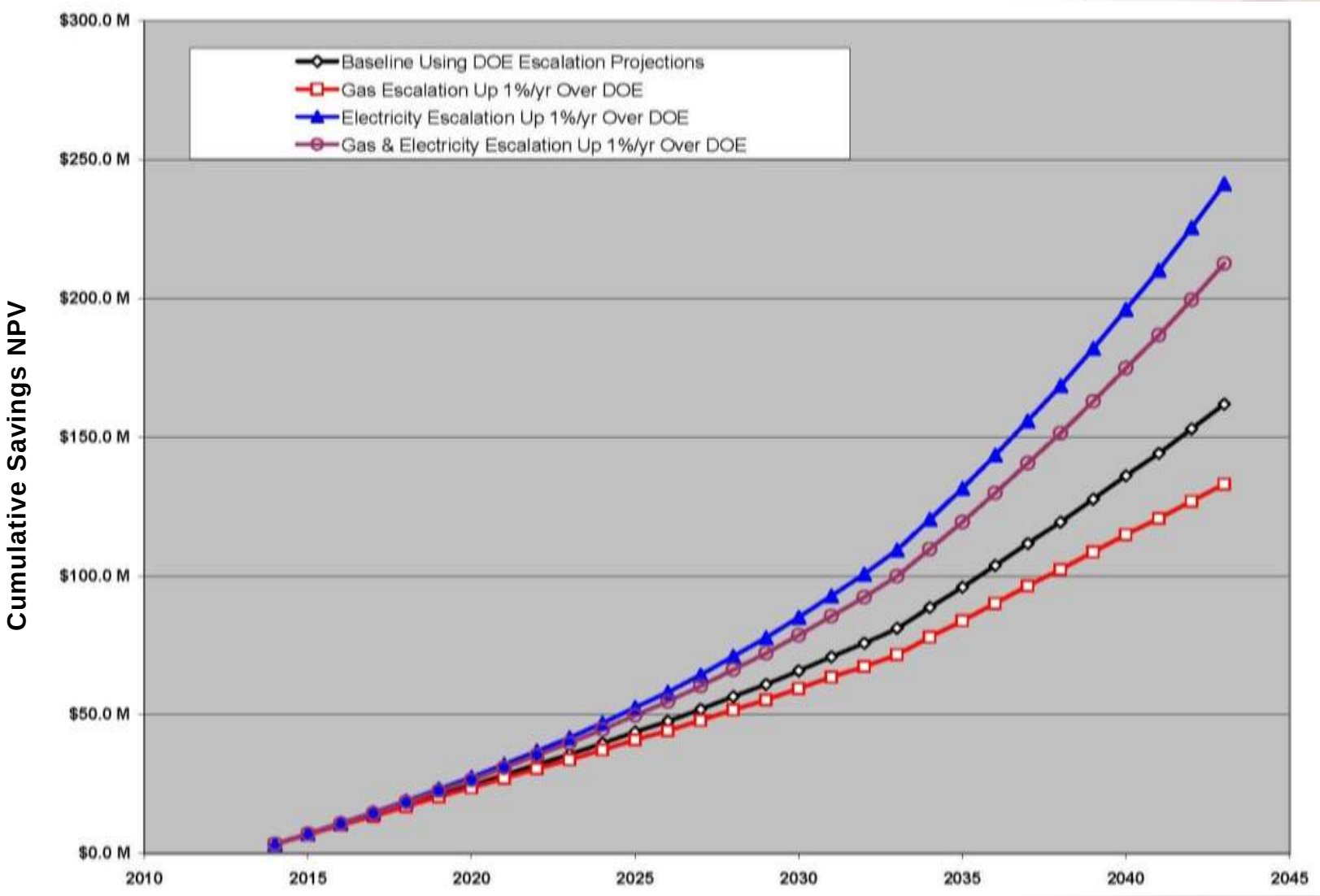
# Utility Rate Sensitivity Analysis

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# Sustainable: GHG Reduction

| | Traditional Boiler | Two – 7.5 MW Turbines (15 MW total) | One - 22 MW Turbine |
|---|---|---|---|
| Total GHG Emissions Due to Campus Steam and Electric Demand | 205,000 metric tons / year | 183,000 metric tons / year | 173,000 metric tons / year |
| Total GHG Savings | N/A | 22,000 metric tons / yr | 32,000 metric tons / yr |
| **Percent Reduction** | **N/A** | **10.7%** | **15.8%** |

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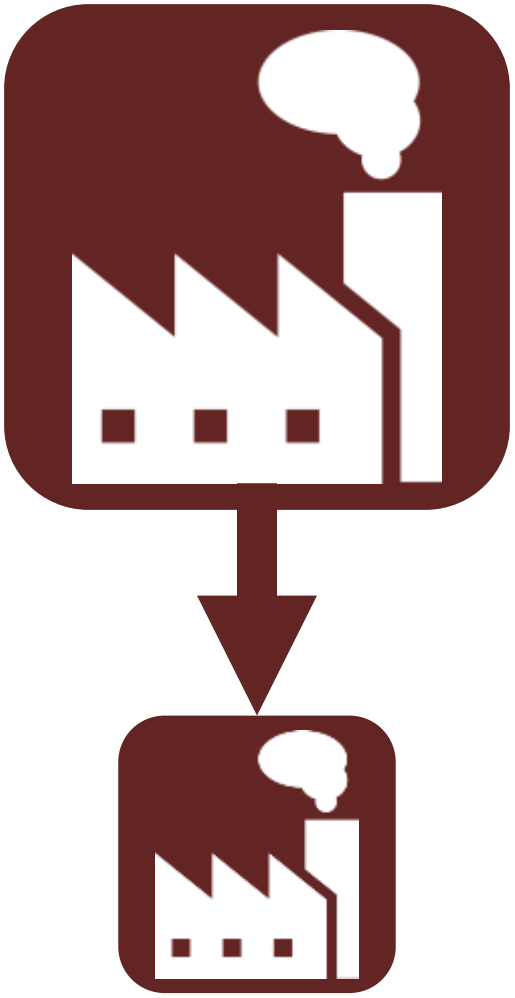
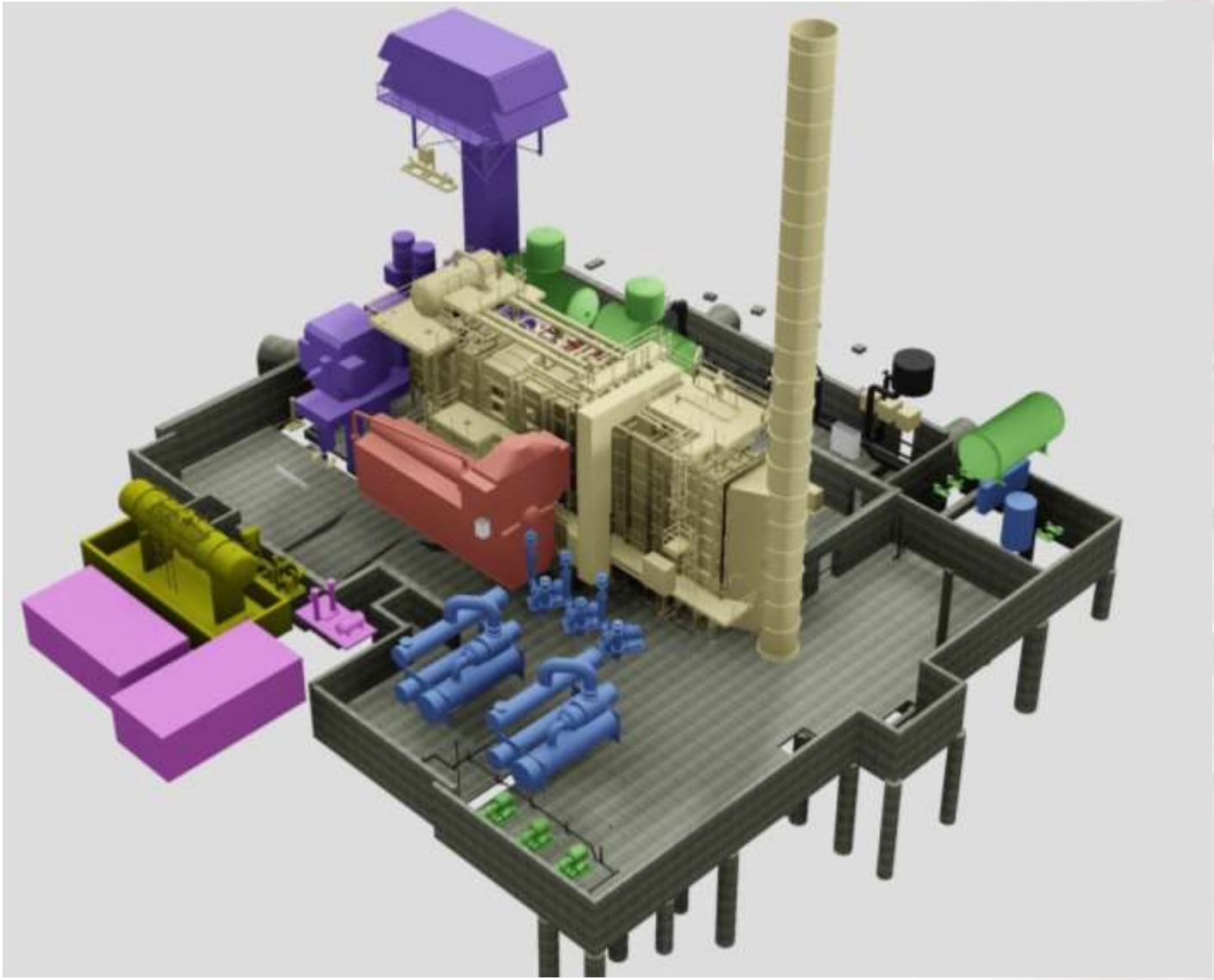
# Sustainable: GHG Reduction



One 22MW turbine will reduce emissions by more than

**15%**

# General Equipment Arrangement



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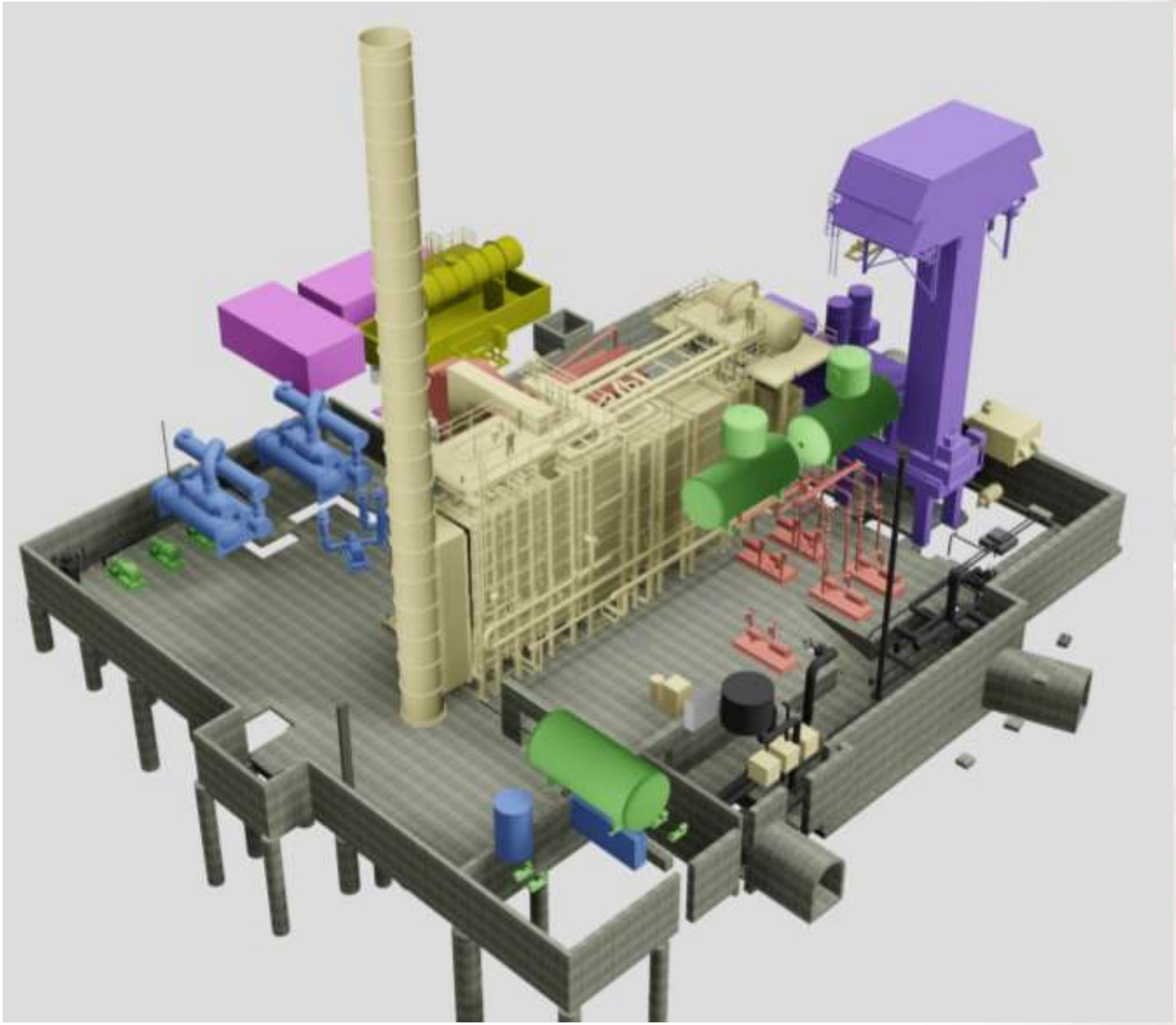

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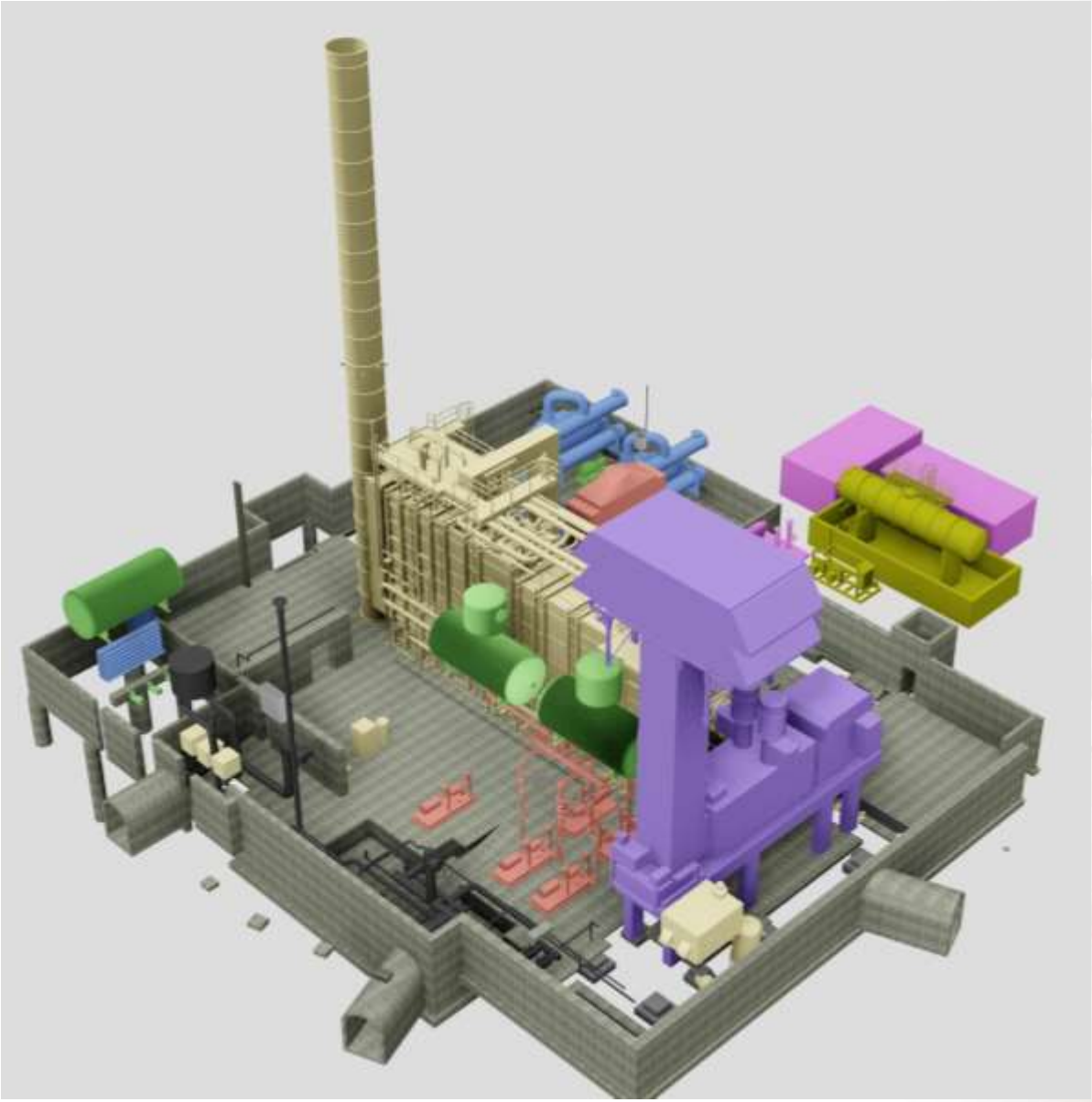

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