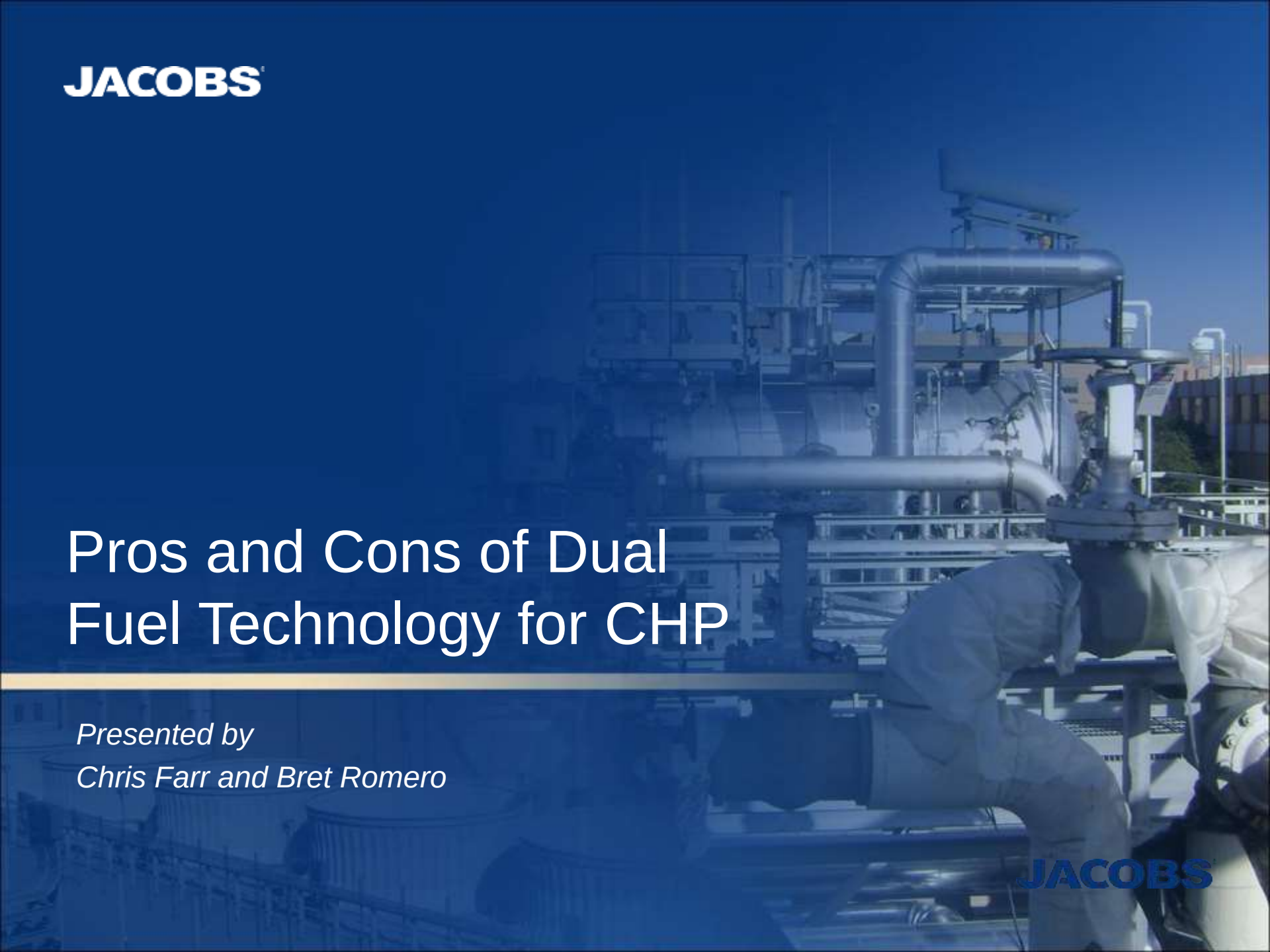

Pros and Cons of Dual Fuel Technology for CHP

Presented by
Chris Farr and Bret Romero

Introduction

- Project Examples
- Why Dual Fuel?
- Considerations
- System Comparison

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University of Oklahoma
15 MW


University of Texas at Austin
34 MW

Texas A&M University

34 MW


North Carolina State University
11 MW Dual Fuel


University of California Santa Cruz
4.5 MW

University of Minnesota

20 MW Dual Fuel

University of Minnesota

Need for CHPP

- Replace aging equipment with reliable, sustainable, and cost-effective technology
- Increasing steam demand (campus growth)

Reliable

Sustainable

Cost-effective

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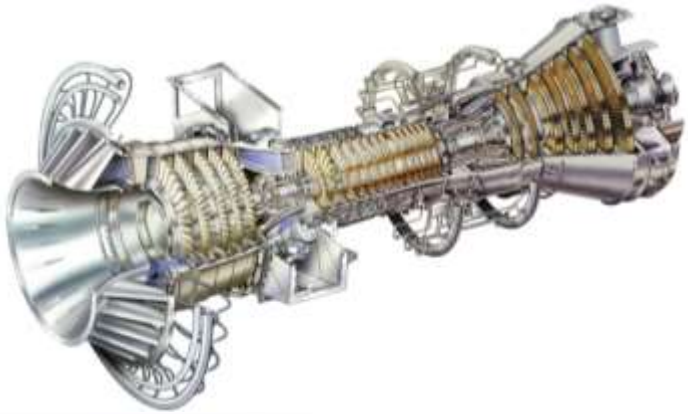
University of Minnesota



Why choose dual fuel?

- Campus currently operates on multiple fuels
- Existing no. 2 fuel oil storage infrastructure
- Taking advantage of interruptible gas rates
- High pressure utility gas not available

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Solicitation Requirements
Dual Fuel CTG 15 – 23 MW, sized to maximize life cycle cost savings
Dual Duct Fired HRSG 250K pounds per hour
Fuel Type Natural gas or No. 2 fuel oil

Bids Received
CTG Manufacturers: 4
HRSG Manufacturers: 3

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Dual Fuel Combustion Turbines

- ✓ **Improved technology**
- ✓ **Multiple vendors** and therefore better competition
- ✓ **Emission control** to meet EPA and state requirements, such as dry low emission technology
- ✓ **Improved reliability**

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Things to Consider

- Reliability and availability
- Financial impacts
- Space impacts
- Operations and maintenance
- Environmental and air permitting

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Consideration: Reliability and Availability

Reliability and Availability | Financial Impacts | Space Impacts | Operations and Maintenance | Environmental

- ✓ **Additional equipment**
- ✓ **Fuel change**
- ✓ **Gas or gas compressor outage**

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Consideration: Financial Impacts

Reliability and Availability | **Financial Impacts** | Space Impacts | Operations and Maintenance | Environmental

- ✓ **Interruptible gas rate**
- ✓ **First cost – 10-15% additional CTG cost**
- ✓ **Impacts to balance of plant / design**
- ✓ **Infrastructure**

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Consideration: Space Impacts

Reliability and Availability | Financial Impacts | **Space Impacts** | Operations and Maintenance | Environmental

- ✓ **Do you have enough space?**
- ✓ **Auxiliary equipment**
- ✓ **Existing Storage?**

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Consideration: Operational Impacts

Reliability and Availability | Financial Impacts | Space Impacts | **Operations and Maintenance** | Environmental

- ✓ **Steam production**
- ✓ **Power production**
- ✓ **Fuel changeover**

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Consideration: Maintenance

Reliability and Availability | Financial Impacts | Space Impacts | **Operations and Maintenance** | Environmental

- ✓ **Auxiliary system maintenance**
- ✓ **Expensive fuel nozzles**
- ✓ **HRSG fouling – higher particulates**

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Consideration: Environmental Impacts

Reliability and Availability | Financial Impacts | Space Impacts | Operations and Maintenance | **Environmental**

- ✓ **Higher Nox**
- ✓ **Ammonia use and storage**
- ✓ **Public perception**
- ✓ **Fuel storage**
- ✓ **Additional hazard areas**

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System Comparisons

A&M

UT

Natural gas only
GE LM2500

UMinn

Dual fuel GE
LM2500 natural gas
and No. 2 fuel oil

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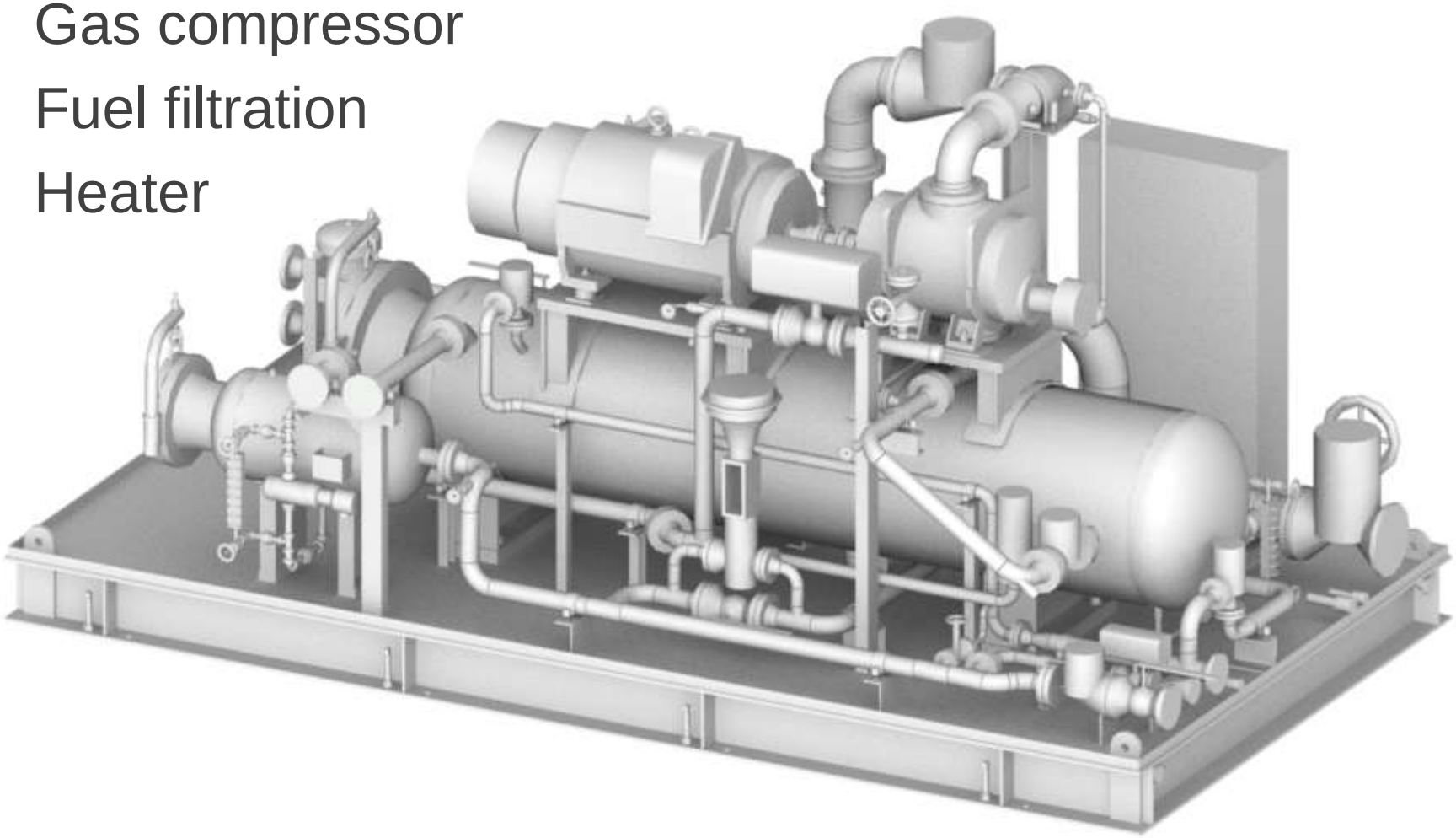
Natural Gas System

- Gas compressor
- Fuel filtration
- Heater



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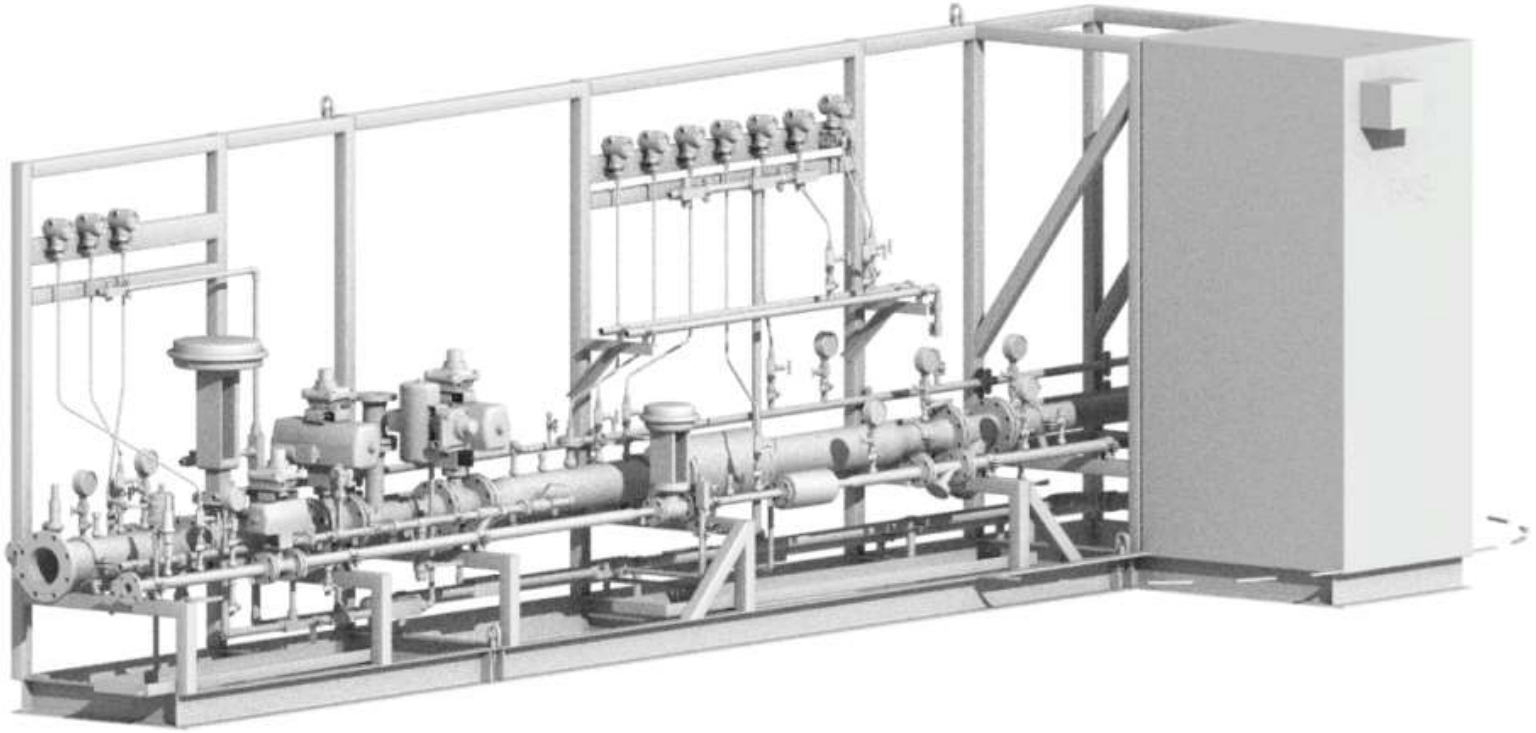
Fuel Oil System

- Unloading
- Storage tanks
- Pumps
- Filtration
- Atomizing
- Purge system
- Waste oil storage



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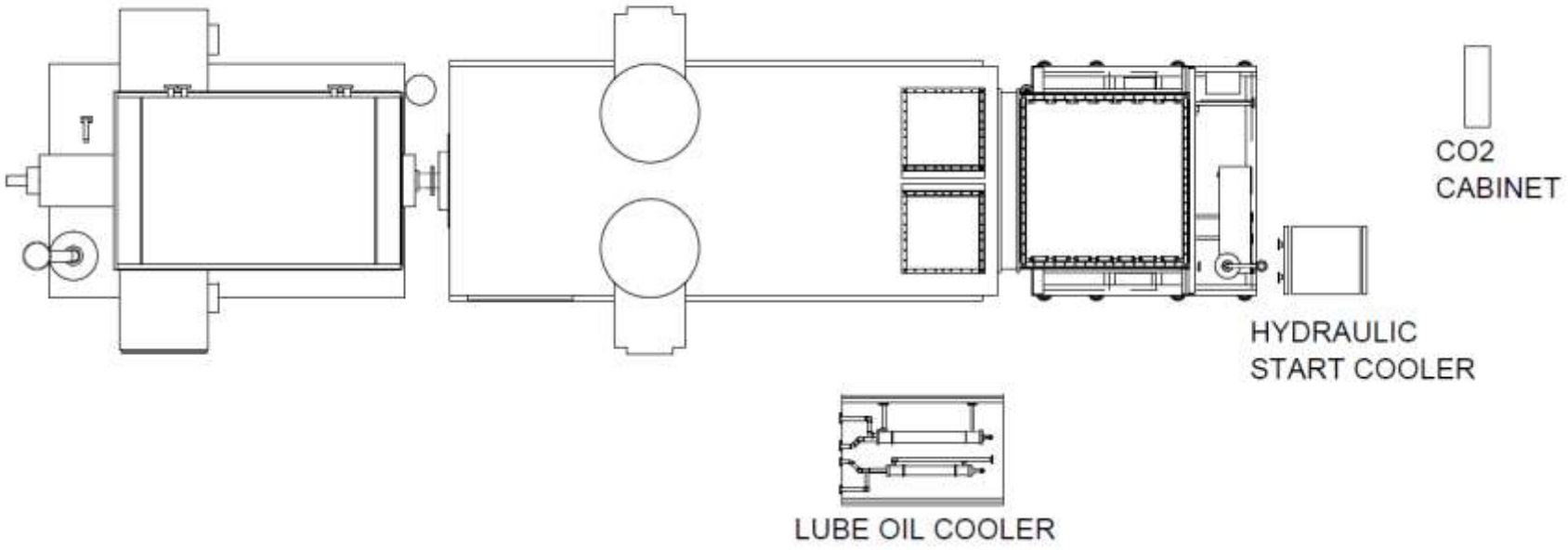
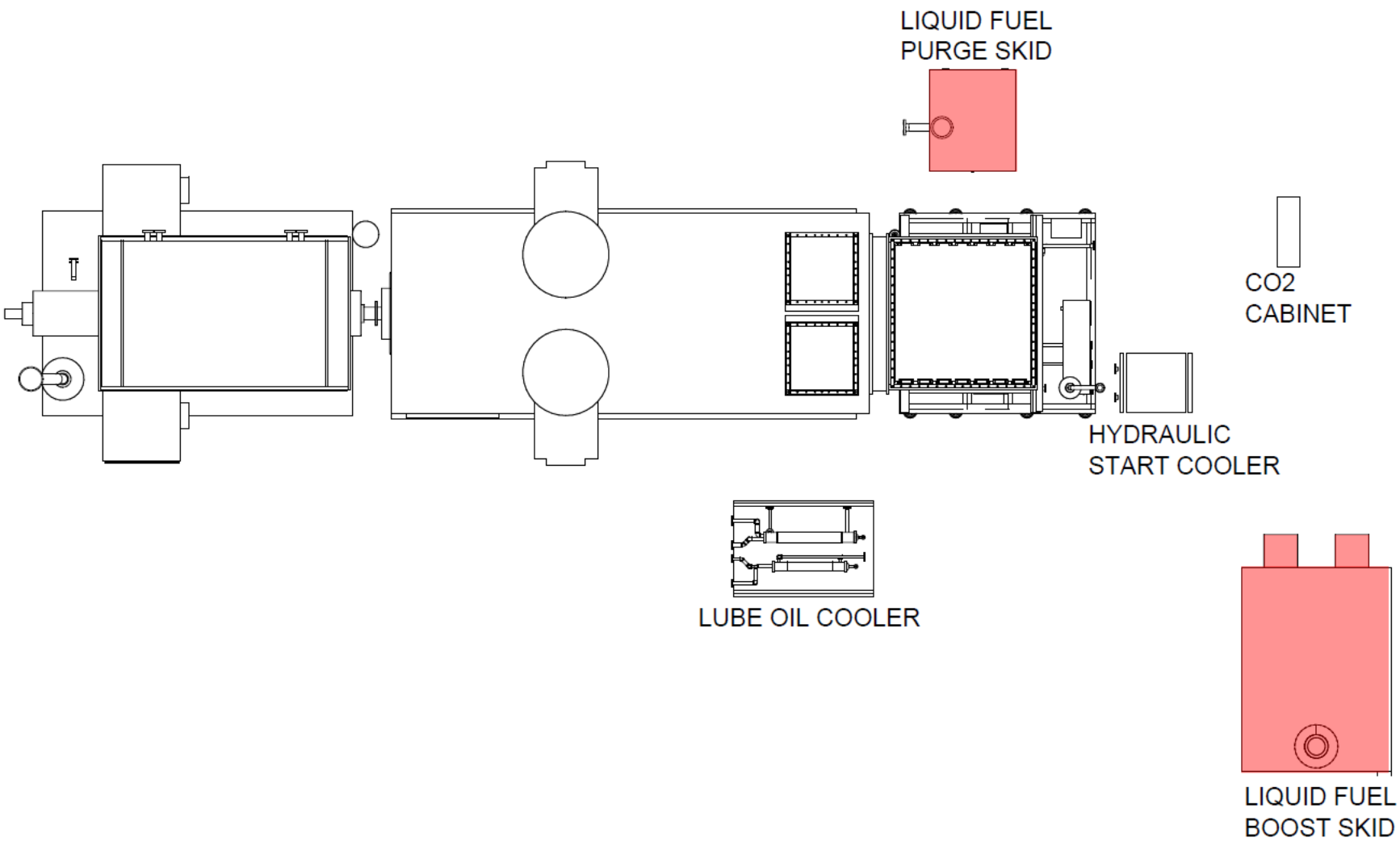
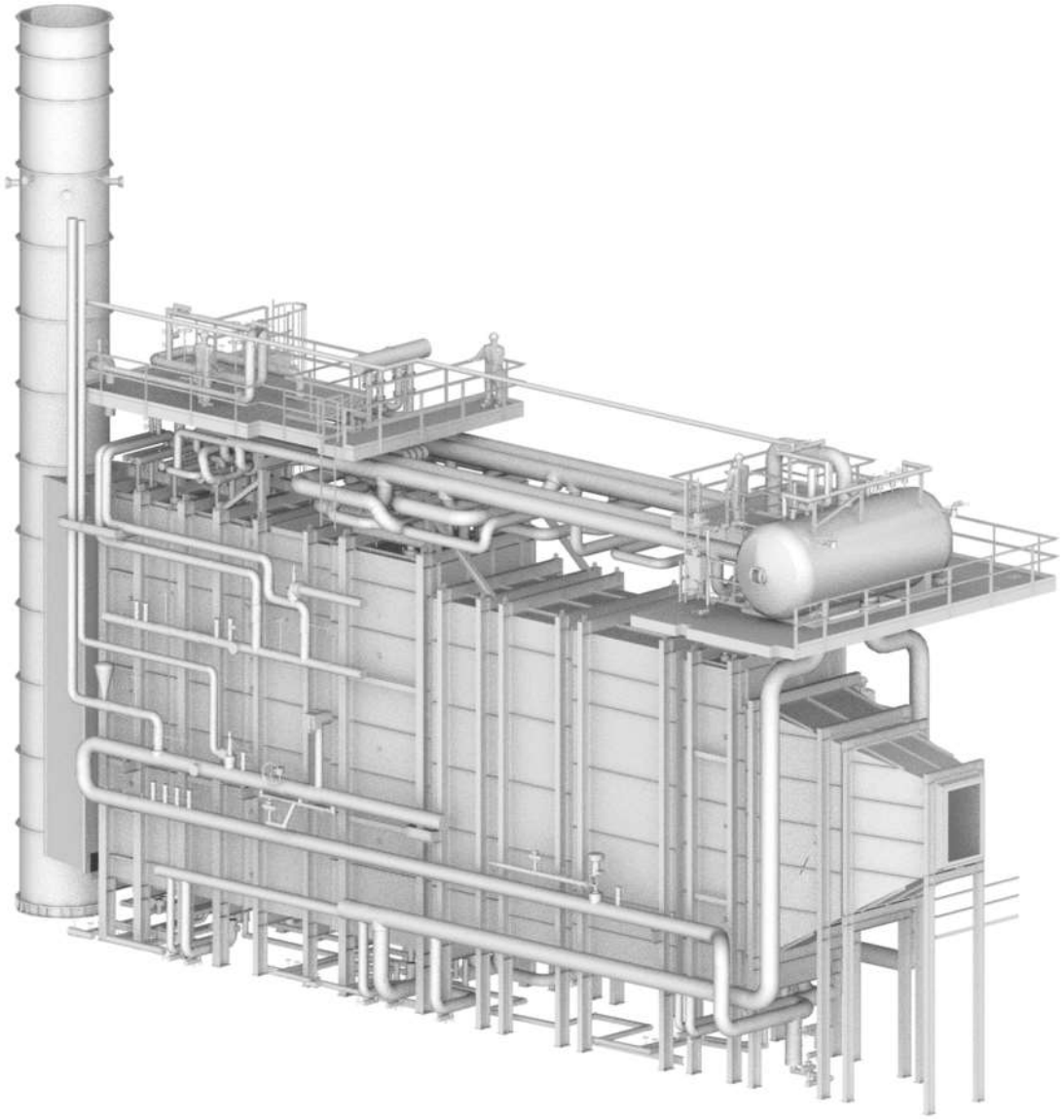
Single Fuel LM2500



Dual Fuel LM2500



Heat Recovery Steam Generator



- Separate fuel trains
- Atomizing system
- Overall minimal size impact

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Summary

- ✓ **Financial impacts**
- ✓ **Operational impacts**
- ✓ **Need for onsite power production**

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