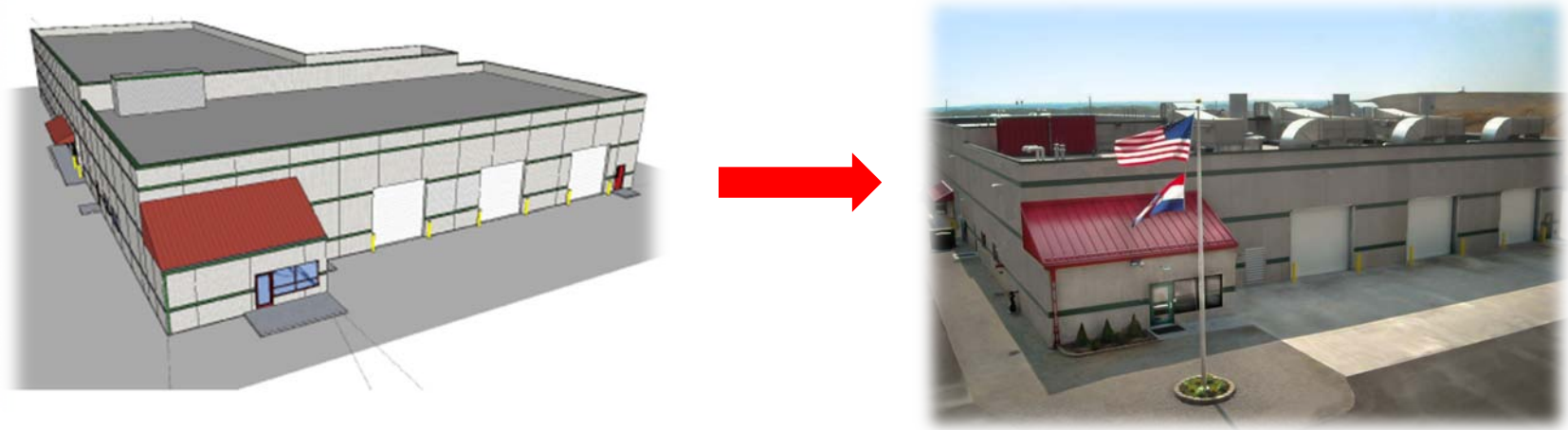
Concept to Completion

Maryland Heights Renewable Energy Center



EPA - Landfill Methane Outreach Program
January 30, 2013

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General Executive, Renewable Development & Project Management

Ameren MISSOURI

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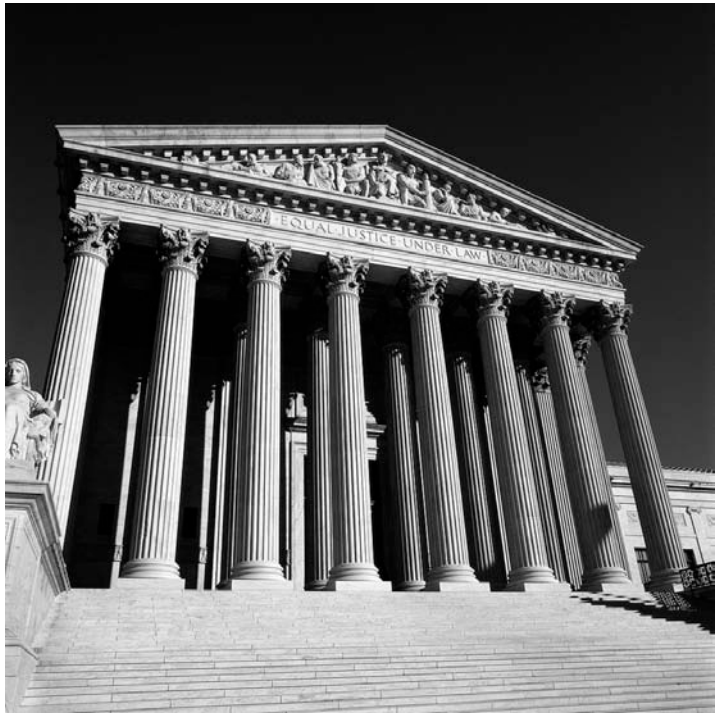

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Presentation

1. Project Background
2. Project Overview
3. Project Challenges
    1. Land
    2. Noise
    3. Emissions
    4. Fuel Treatment
4. Operations
5. Lessons Learned

METHANE TO MEGAWATTS

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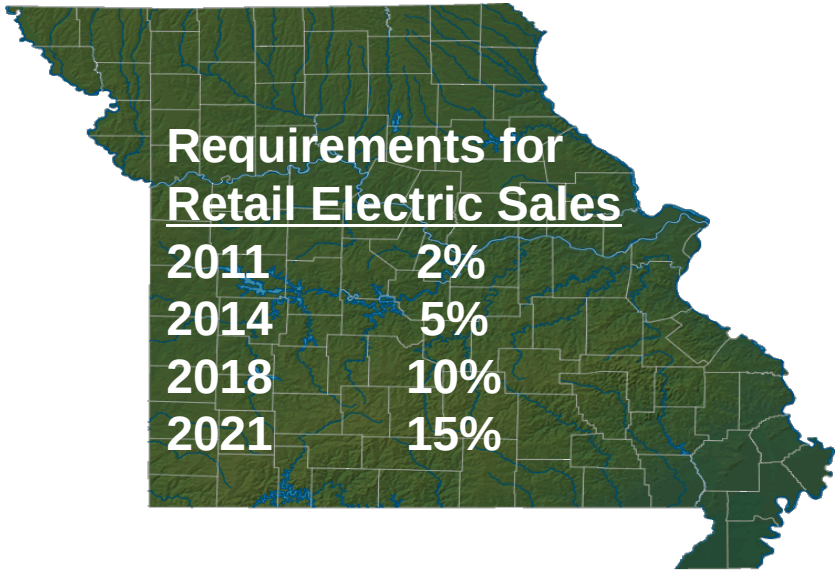
Missouri – Renewable Energy Standard (RES)

- Green Power Initiative (Prop C)
- Effective date: January 1, 2011
- Solar must be 2%
- Limitations: Cost of compliance is not to exceed a 1% increase in rates
- Generation needed to meet requirements:

  2011 ~840,000 MWhs

  2025 > 7.3 million MWhs



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Project Overview

- Approximately 15 MW of generation – 3 ea. Mercury 50 Turbines
- Approximately 12 MW of generation (Net @ 40 F)
- Net production 70,000 to 110,000 MWh
- Began operation on June 15, 2012
- Design and Build by Green Companies Inc.
  - 20 months to construct
  - Zero lost time accidents
  - 450 employees trained for construction
  - 100,000+ man-hours
  - Over 10,000 feet of pipe installed
  - 1/4 million feet of wire installed

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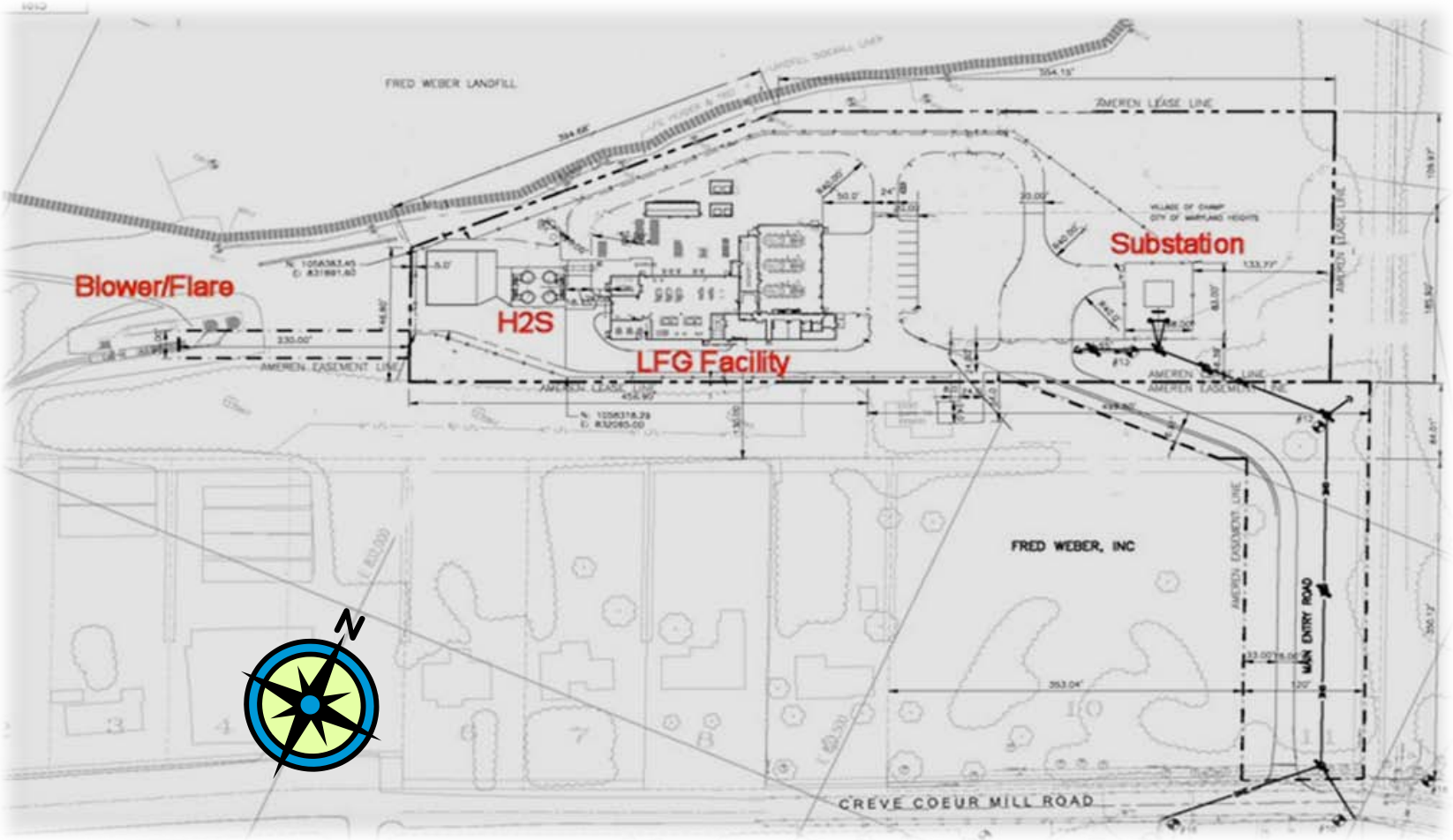
Project Overview - Plant Site



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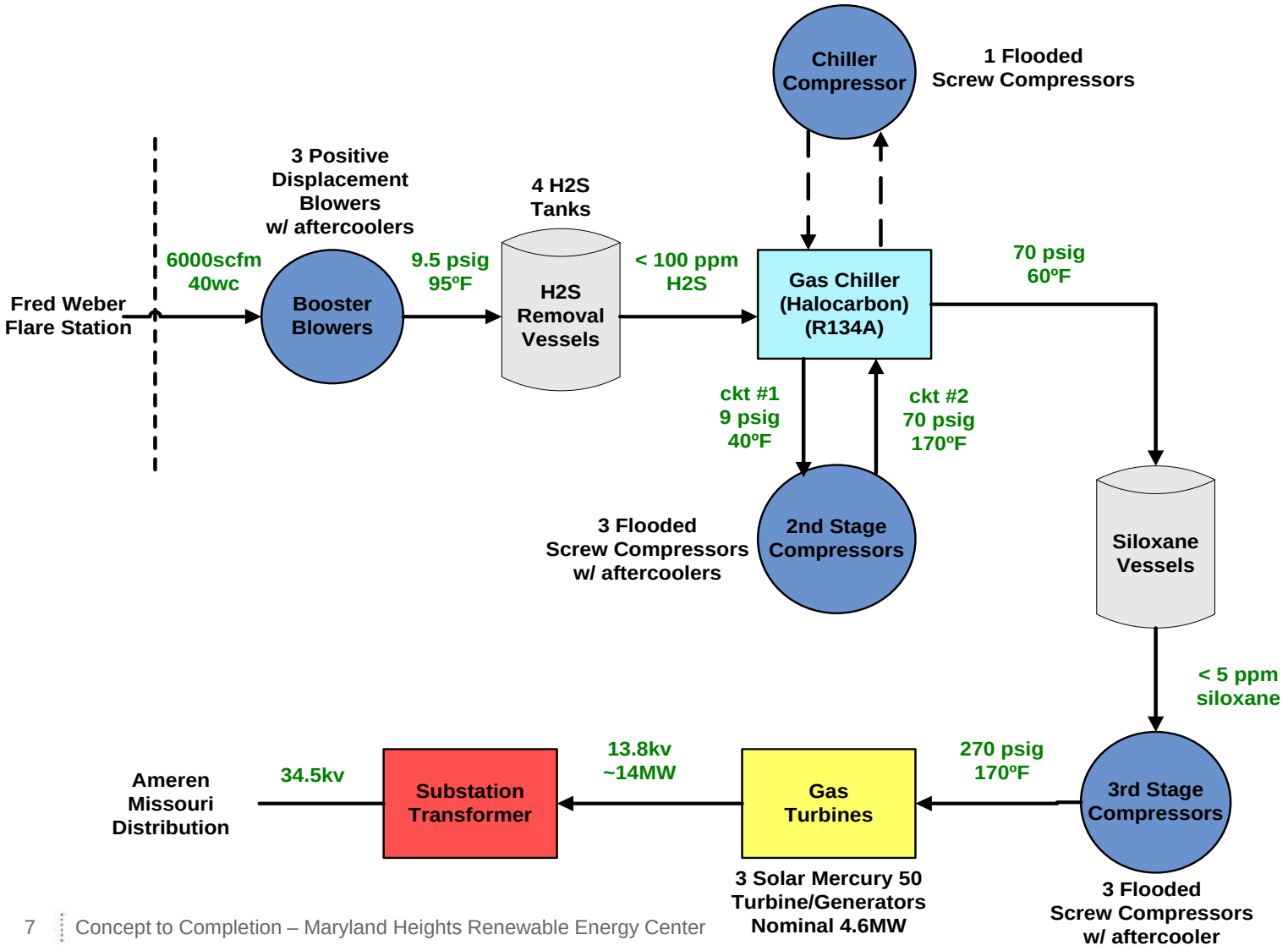
Project Overview – Gas Flow Process



Project Challenges – Land

- Limited real estate
- Poor soil
- Across two municipalities
- No access road, no utilities

- Solution
  - Build your own site
  - Remove 70,000 CY
  - Install over 100,000 CCY

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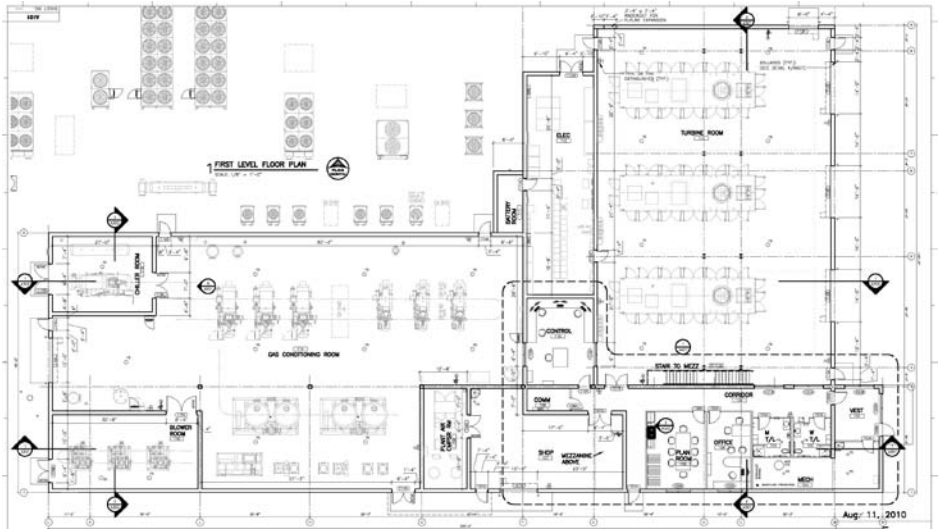
Project Challenges - Noise

- Located near school and homes
- 50 decibel sound limit

- Solution
  - Enclose equipment inside a plant
  - Move cooling equipment and associated fans to north side
  - Utilize low noise on outside equipment
  - Silencers on gas turbines exhausts
  - Utilize doors on north and west sides for routine work



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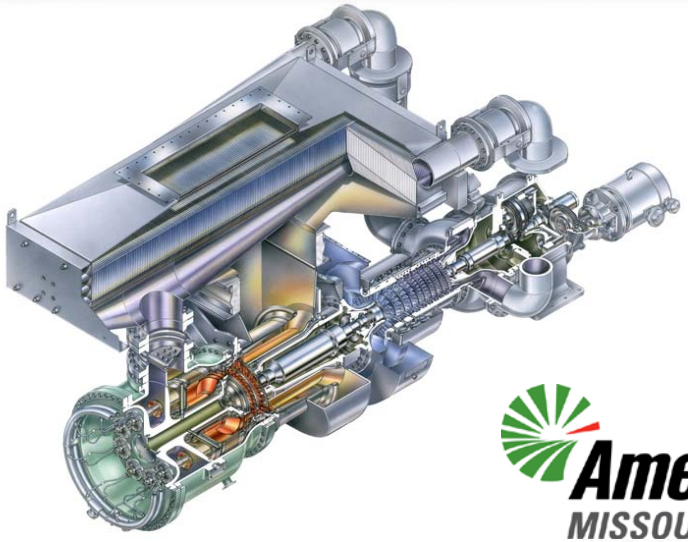
Project Challenges - Emissions

- Located in the St. Louis County non-attainment

- Solution
  - Solar Mercury 50 Turbines
  - 38.5% Efficiency
  - Heat rate of 9,060 btu/kwh
  - 5 ppm NO_X, 10 ppm CO
  - Requires removal of siloxane to avoid plugging of recuperator and unit de-rates
- Disadvantages
  - Requires high fuel pressure
  - Overall worse heat rate vs. reciprocating engines



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Project Challenges – Fuel Treatment (Pressure)

- High Pressure Gas Required
  - Turbines require high compression gas (300 psi)
  - Landfill supplies gas at ~0 psi
- Solution
  - Install multiple stages of compressors
  - Vilter's single flooded screw gas compressors

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Project Challenges – Fuel Treatment (Siloxane)

- Removal of Siloxane
  - Protect the Turbines
  - Siloxane can be found in products such as cosmetics, deodorant, water repelling coatings, food additives, soaps, lotions & plastics

- Solution
  - Install Parker GES system
  - Removes virtually all siloxane, solids, liquids and aerosol contaminants

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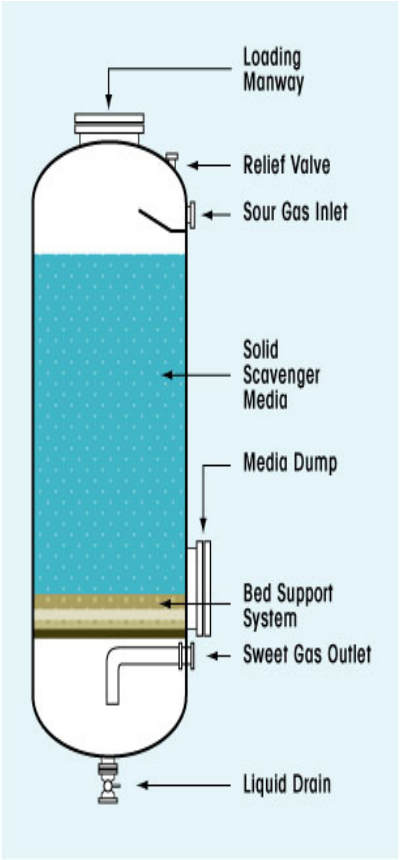
Project Challenges – Fuel Treatment

- Gas Treatment
  - Removal of H_2S
  - Protects Siloxane media
  - Corrosion of gas recovery hardware
  - SOx emissions
- Solution
  - Install H_2S scavenging system with SulfurTreat
  - Removed H_2S to less than 100 ppm
  - Utilized fast reactive metal oxide absorbent



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Operations

- 24/7 operation
  - 3 full time on-site operators
  - Combination - Operator, Maintenance, and I&C Technician
  - Remote Operators from central location
    - Ability to acknowledge alarms remotely
    - Instantly informed of plant status changes
  - Highly Automated System (HAS)
  - Remote All Plant Emergency Trip (APET)

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Lessons for the Future

- Fixed contract with contingency funds was very beneficial
- Perform design prior to start of construction
- Have all vendors on site during entire commissioning and startup
  - Eliminate any finger pointing and scheduling conflicts
- Future considerations:
  - Moisture requirements for H2S removal
  - Online moisture monitoring
  - Oil carryover limits of turbines
  - Heat added from siloxane removal system
  - Online siloxane sampling

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Questions ?

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