Methane Mitigation Using Linear Motor Leak Recovery Compressor

DOE Project No. DE-FE0031875

Jason Stair

GTI Energy

U.S. Department of Energy

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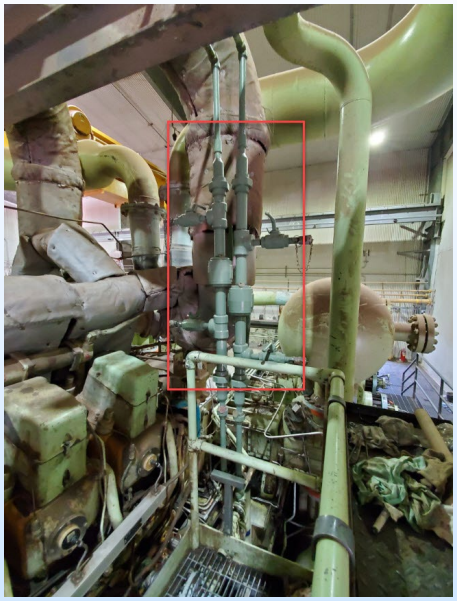
Project Overview

- Funding (DOE and Cost Share)
  - DOE: $1,499,918
  - CS: $375,002 (Operations Technology Development)
- Overall Project Performance Dates
  - 2/4/2021 – 9/30/2024
- Project Participants
  - GTI Energy
  - University of Texas – Center for Electromechanics
- Overall Project Objectives
  - Design, build, and test a methane leak recovery compressor for midstream compressor stations

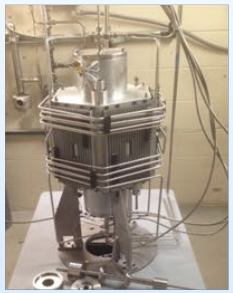
Technology Background

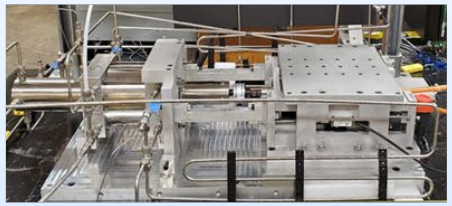
- Compressor stations have concentrated methane leaks
  - Compressor packing
  - Engine starters
  - Valves
  - Blowdowns, etc.
- Existing solutions are often costly and only partially address leaks
- GTI is developing a unique, linear motor driven compressor
  - Recover gas from any/all sources
  - Compress leaks directly back to pipeline
  - Minimize impact on existing equipment

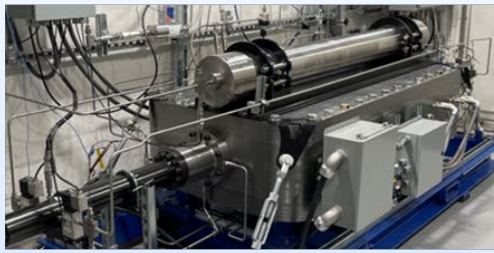


Technology Background

Key programs have advanced technology towards commercialization







Unit 1

- 2018
- ARPA-E CNG
- Hermetically Sealed

Unit 2

- 2019
- Commercial Proof of Concept
- Significantly Reduced Cost

Unit 3

- 2020
- DOE High Purity Air
- 10 to 3000 psia

Unit 4

- 2023
- 60 kw DOE H2 Expander
- 12,000 psi hydrogen

Competing Technology

- **Other recovery compressors** – limited discharge pressure, inefficient flow control, high maintenance, and/or expensive
- **Fuel gas recovery** – requires operating compressor, adds reliability risk
- **Static seals** – single emission fix for when compressor is taken offline, do not stop emissions when running
- **Low/no-bleed pneumatics** – partial solution, massive retrofit requirement, reliability risk
- **Packing maintenance** – labor-intensive and typically done without regard to actual emissions rate

Tescorp Vent Master
www.tescorp.com

Cook Static-Pac®
www.cookcompression.com

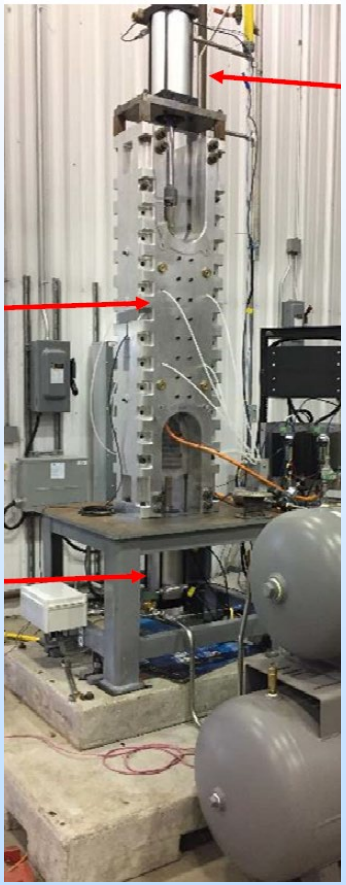
Haug Sirius
www.sauerusa.com

Linear Compressor Advantage

- **Semi-hermetically sealed –** No additional gas leaks during operation
- **High discharge pressure** – Return gas to midstream pipelines
- **Accurate flow control** – Maintain existing vent system at 0 to 0.25 psig
- **No impact on existing equipment** – Existing equipment left unmodified to maintain reliability
- **Single moving part** – Lower cost and maintenance
- **Oil free design** – Reduced maintenance and gas contamination
- **Wet gas** – Compress wet or heavy gas

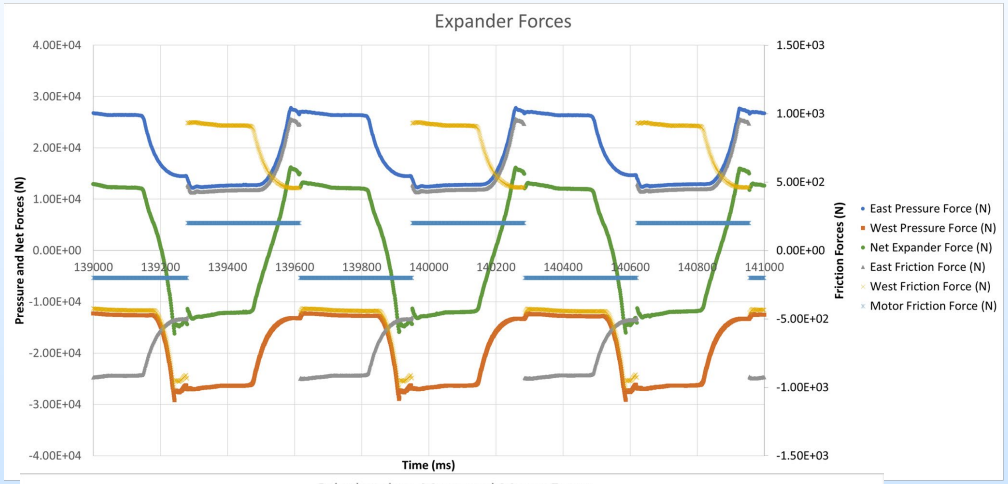
Project Scope

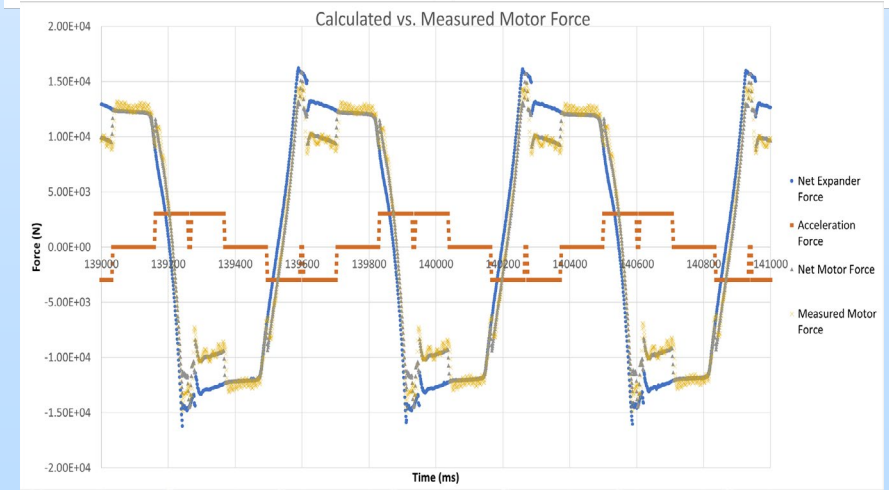
- Design a linear motor leak recovery compressor
  - Inlet: Near atmospheric (0 to 0.25 psig)
  - Discharge: 1500 psig
  - Target flow: 60 SCFM
- Integrate compressor into leak recovery skid
- Install compressor and recovery skid in GTI's environmentally controlled test chamber
- Extensively test complete linear motor leak recovery skid to verify performance and durability
- Success: Show durability and accurate flow control for a reasonable price

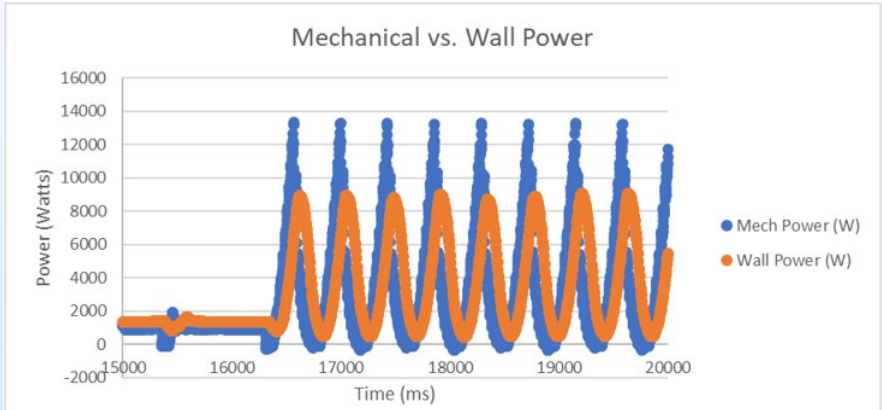


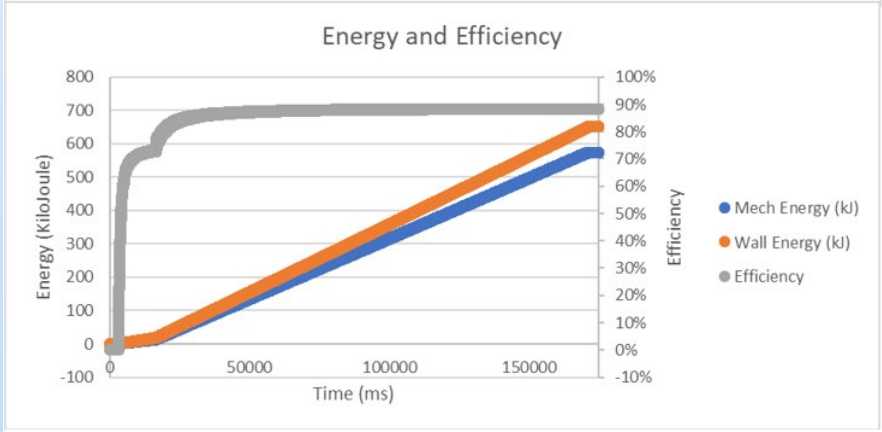
Project Status

- Motor control and performance has been thoroughly tested and validated



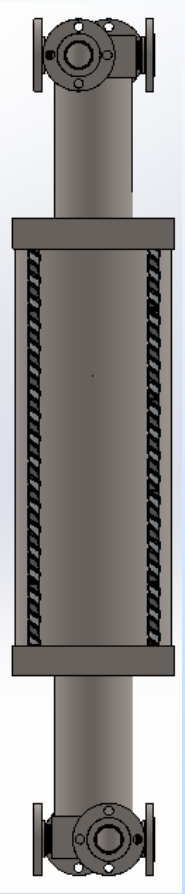






Project Status

- Motor assembly has undergone design iterations to improve durability, cost, modularity, and ease of assembly/maintenance
  - Single motor design ➔ One motor per stage
  - Modular frame design to easily scale compressor power
  - Modular design to reduce manufacturing costs and interchangeability
  - Modified hermetically sealed design to reduce cost and improve pressure rating
  - Identified and tested alternative drives and power supplies to reduce cost and improve efficiency

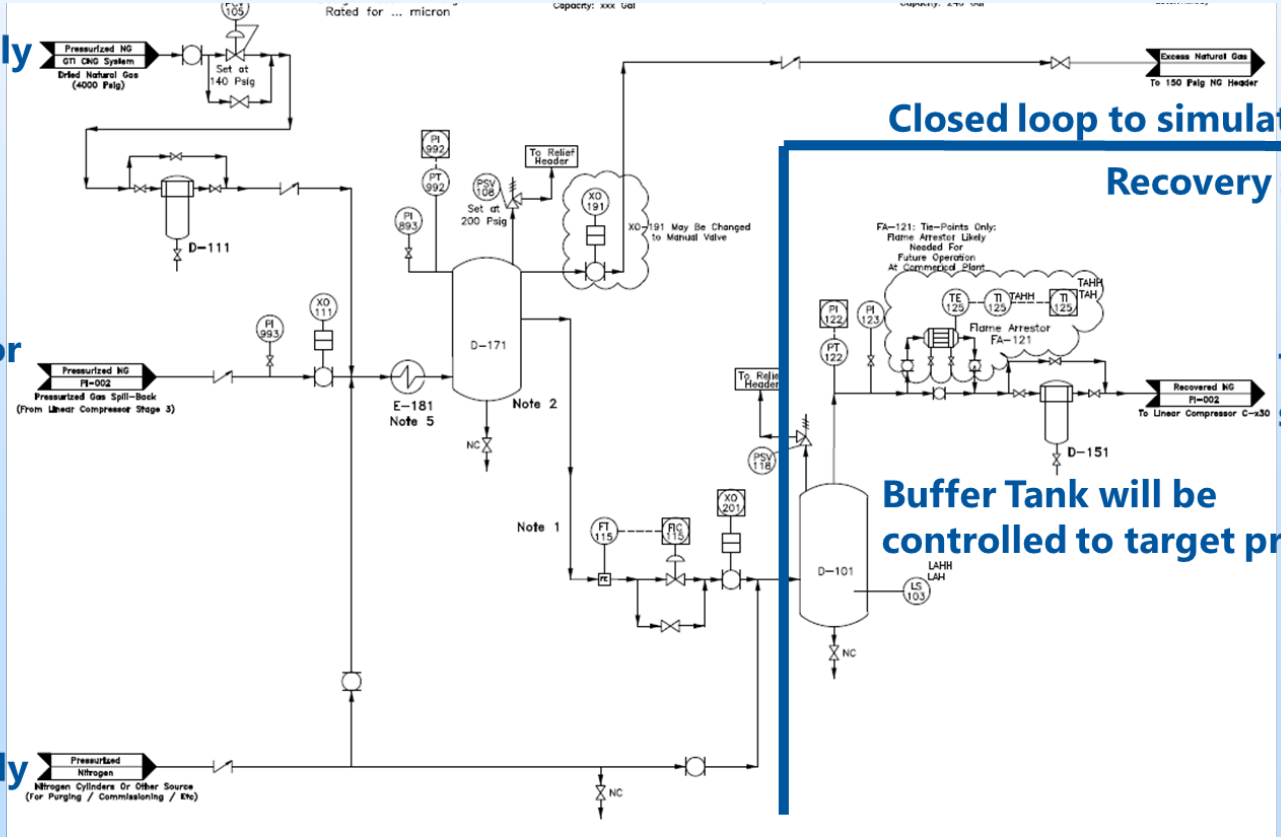


Project Status

- Compressor has undergone multiple design iterations to improve performance, durability, and ease of assembly/maintenance
  - Single acting design ➔ Double acting design
    - Improved flow control and reduced inlet pulsations
  - Lip seals ➔ Low leak split ring seals
    - Improved durability and efficiency (less friction)
  - Optimized compressor valves
    - Lower pressure drop and suitable for variable flow
  - Modified compressor layout
    - Easier assembly/maintenance, improved flow

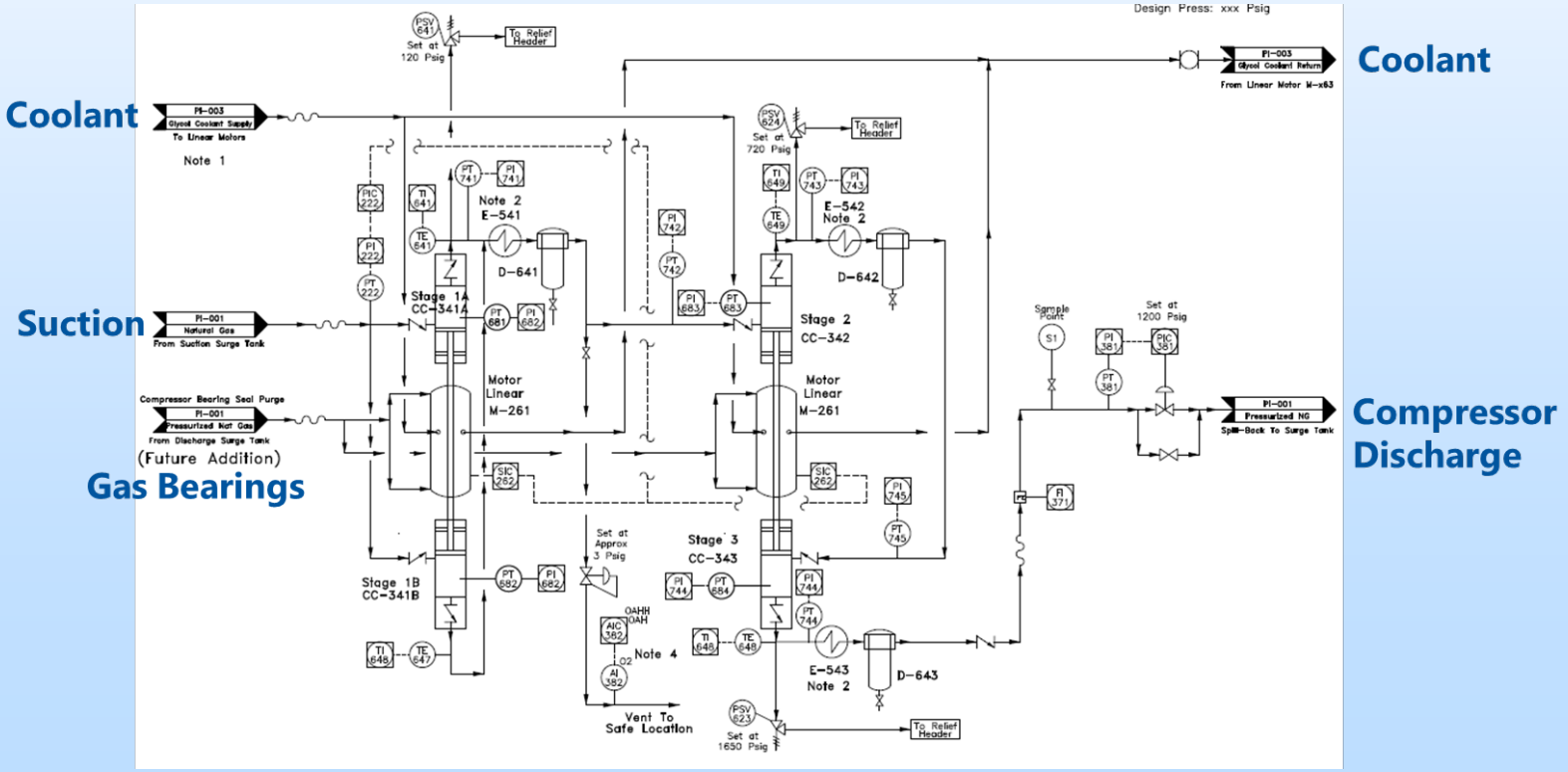
Technology Status

- Compressor tested in closed loop
- Leaks will be simulated by independent control system and will flow into recovery skid buffer tank



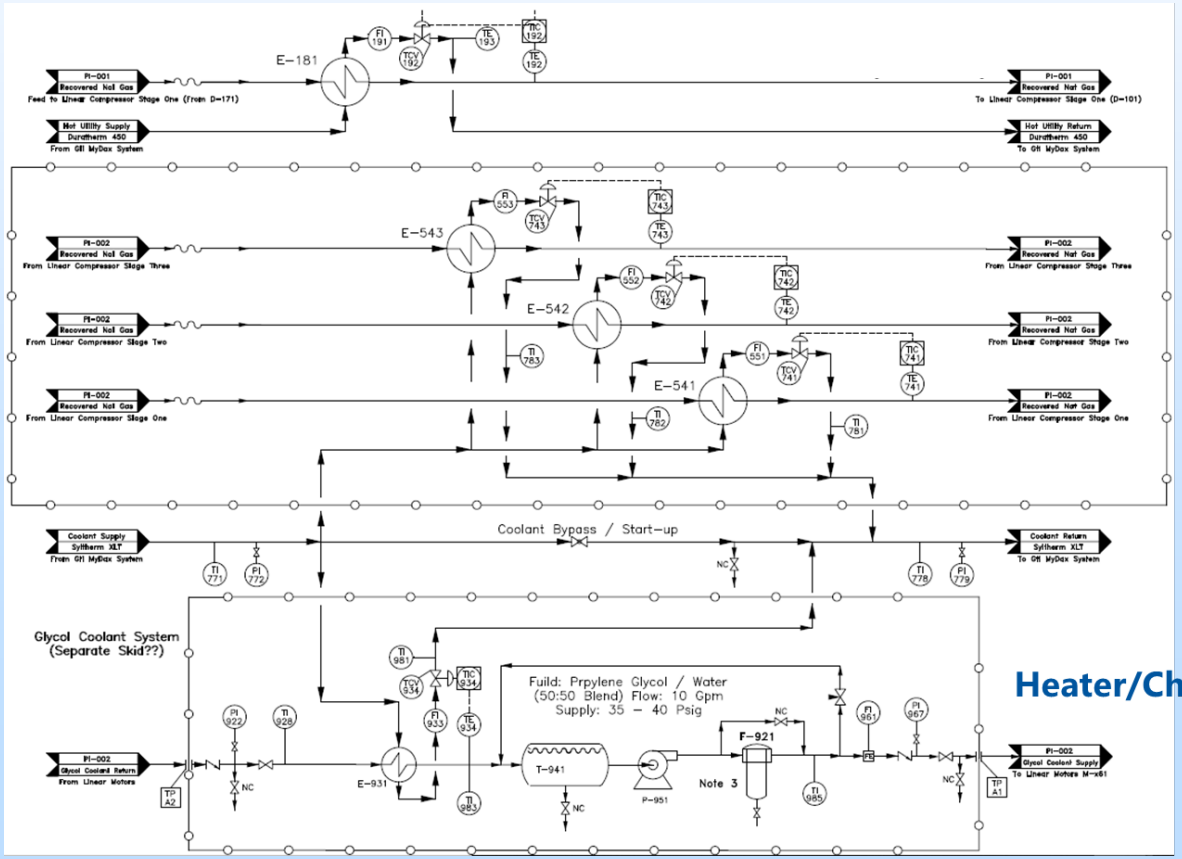
Technology Status

- Filtered gas will flow into 3-stage compressor and compressed to discharge pressure
- Pressures, temperatures, flow and power will be measured to quantify performance



Technology Status

- Simulated leaks, interstage gas, and test chamber will be controlled using heater/chiller to simulate variety of operating conditions



Temp control for leak simulation

Temp control for compressor intercoolers

Heater/Chiller for conditioning gas

Future testing/development/ commercialization

- Preliminary testing and validation will be completed at GTI
- Working with upstream operators to test lower pressure designs in the field
- Working with gas utilities to deploy in midstream
- Working with equipment manufacturers to develop design for 7,200 psi
- Applications beyond methane leak recovery have also been identified and are being pursued

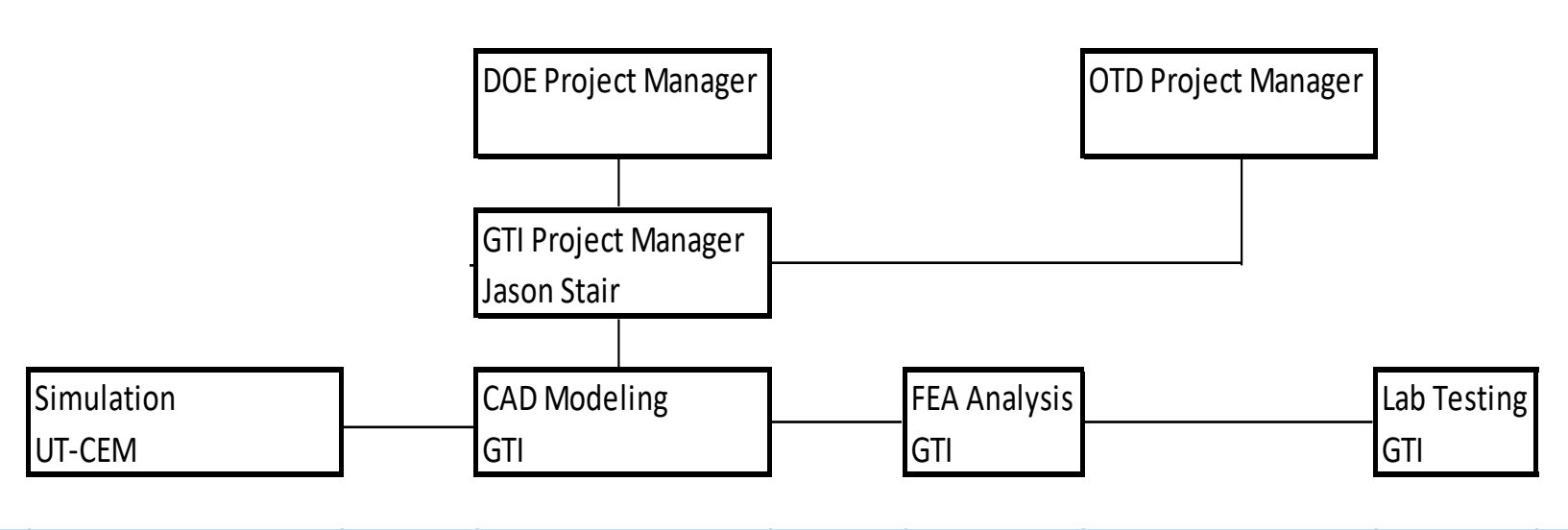
Summary Slide

- Methane capture is necessary to maximize the efficiency of our natural gas resources and infrastructure
- The successful development of a high efficiency, modular compressor capable of operating up to several thousand psi will enable leak mitigation and gas capture across the natural gas value chain

Appendix

Organization Chart

- GTI – Project lead, design lead, compressor testing
- UT-CEM – Simulation, Motor testing
- OTD – Industry insight and feedback
- Burckhardt – Compressor design insight



Gantt Chart

Task	Methane Mitigation	G/NG	2020			2021				2022				2023				2024			
			Quarter																		
			2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	**Project Management and Planning**																				
1.1	Project management plan																				
1.2	Technology mauration plan																				
2	**Preliminary Design**																				
2.1	Simulate performance and control of compressor																				
2.2	Preliminary compressor design	G/NG																			
2.3	Key component design, analysis, and testing																				
2.4	Design and build testing apparatus																				
2.5	Economic analysis																				
3	**Component Testing and Detailed Design**																				
3.1	Preliminary fabrication, testing, and validation																				
3.2	Detailed design and simulation	G/NG																			
4	**Prototype Fabrication, Assembly, and Pilot-Scale Testing**																				
4.1	Prototype fabrication and assembly																				
4.2	Continue from 2.4: Design and build testing apparatus																				
4.3	Continue from 3.1: Preliminary fabrication, testing, and validation																				
4.4	Pilot-scale testing																				
4.5	Final economic analysis																				