Energy-Storing Cryogenic Carbon Capture™ for Utility- and Industrial-scale Processes

- **DE-FE0032020**

Sustainable Energy Solutions

PI: Larry Baxter

Sub-Recipients: Chart Industries, PacifiCorp

Location: Orem, UT, Project at Kemmerer, WY

DOE: $200,000
Non-DOE: $50,000

Total: $250,000

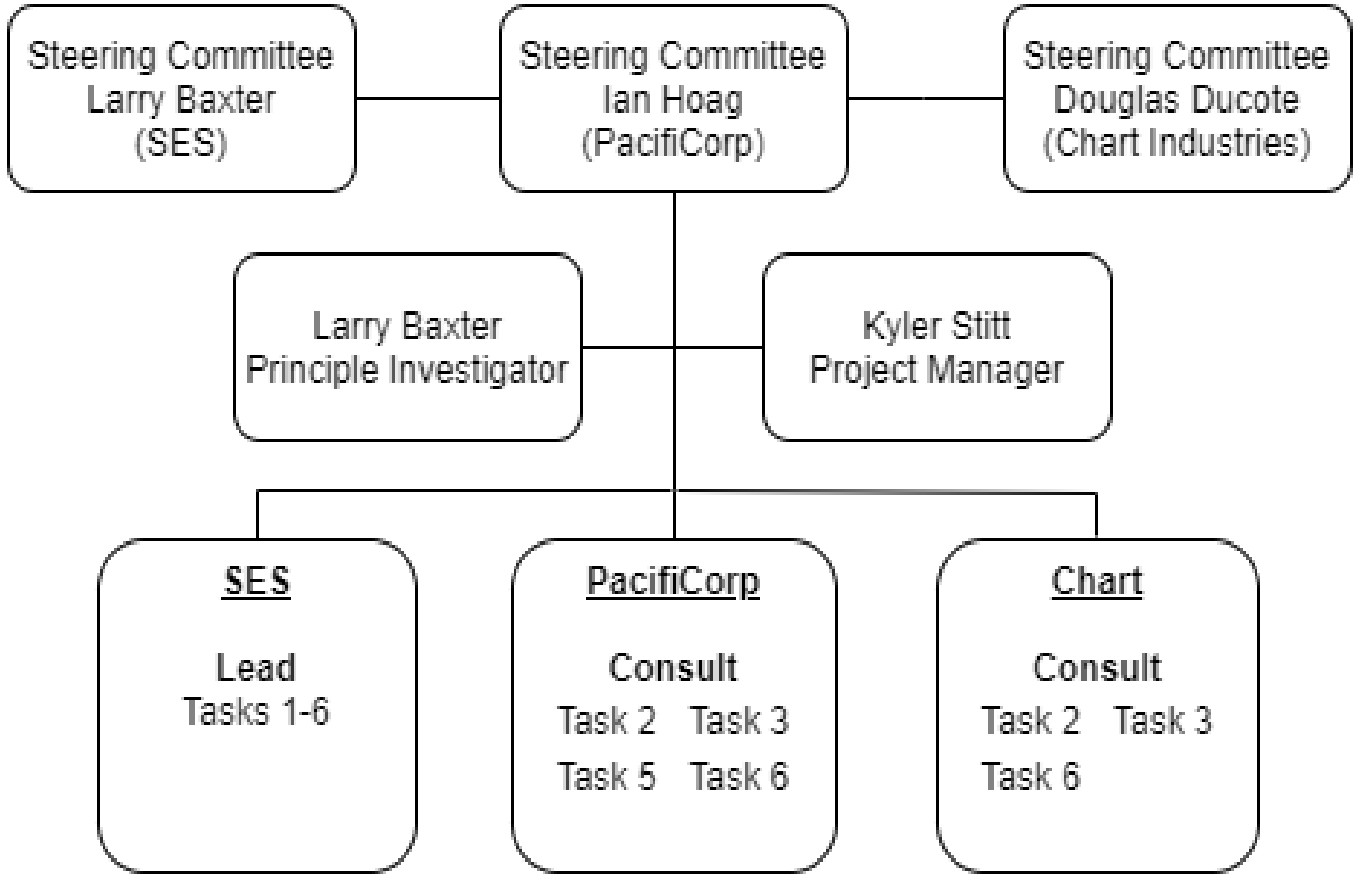
Objectives

- This projects analyses energy-storing potential of cryogenic carbon capture™ (CCC) to provide substantially lower cost and higher efficiency than other grid-level storage
- Quantifiable success criteria include:
  - Energy storage cost < $50/kWh
  - Round-trip efficiency > 95%
- Metrics represent two of the largest issues in energy storage

Relevance and Outcomes/Impact

CCC provides a bolt-on carbon capture solution that competes very well with alternatives and treats flue gases from continuous point sources that range in CO2 content from 4% (NGCC) to 25+% (cement plants). CCC can be configured to provide energy storage with a very small incremental cost increase for systems that have access to natural gas. The energy storage storage rate is 10-15% of the power rate for a power plant or the equivalent to non-power system.

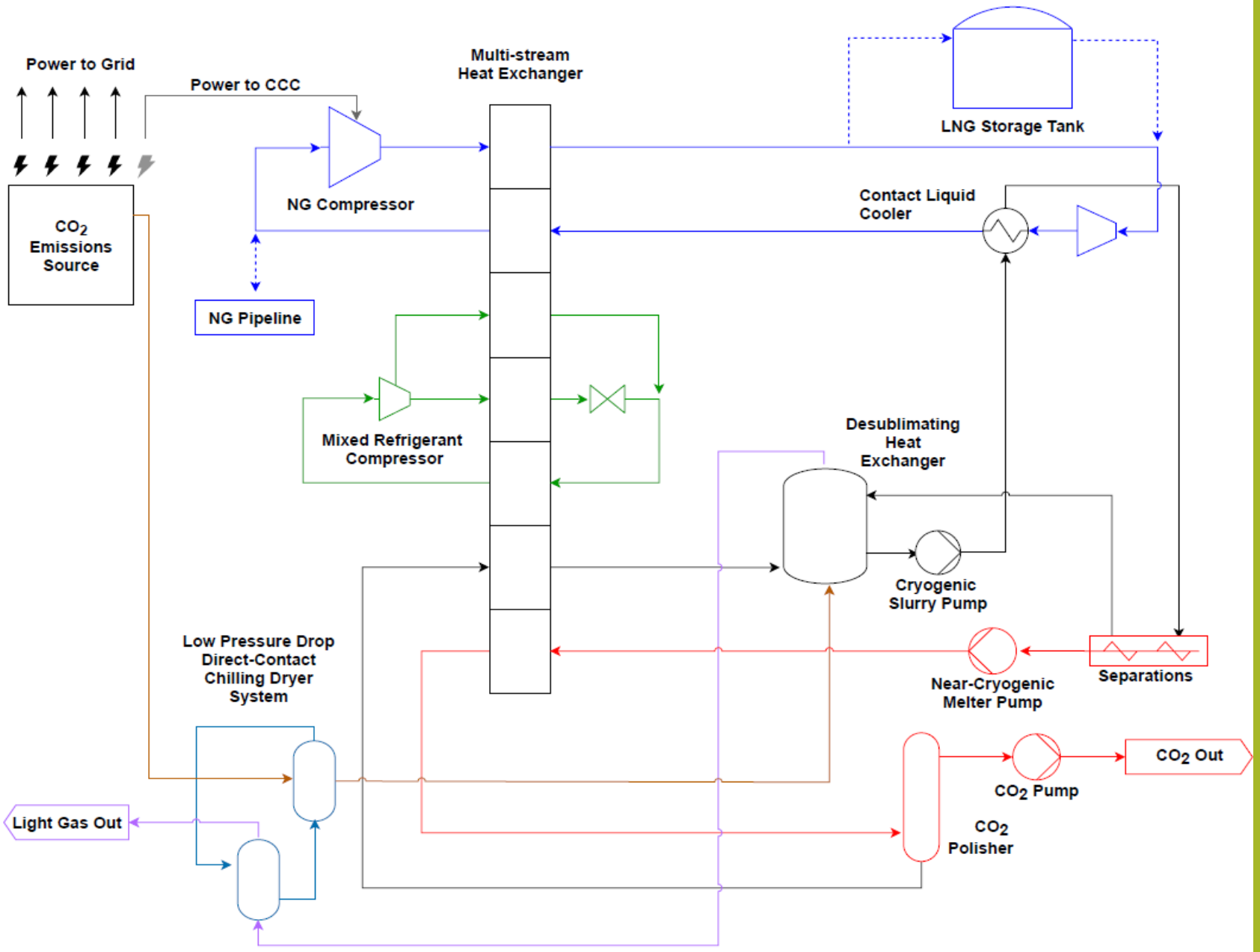
Project Team



SES Engineering Team

Name	Title	Relevant Project Roles
Larry Baxter (PhD)	Principal Investigator	Process design, modelling
Kyler Stitt (MS)	Project Manager/Engineer	Project management, Phase II Pre-FEED prep, process design
Eric Mansfield	Chemical Engineer	Process design, modeling, programming
Christopher Hoeger (MS)	Chemical Engineer	System and unit operation modeling, process design
Stephanie Burt	Chemical Engineer	Modeling, process design, proposals
Dave Frankman (PhD)	Mechanical Engineer	Spray tower design, direct-contact dryer development
Skyler Chamberlain (MS)	Mechanical Engineer	Screw press, overall system design
Aaron Sayre	Manufacturing Engineer	Direct-contact dryer, HX, and Pump
Dallin Parkinson (MS)	Mechanical Engineer	Chilling Heat Exchanger specialist, operations lead
Ethan Bever	Mechanical Engineer	Pumps, heat exchangers, mechanical design

CCC PFD


Power to Grid
Power to CCC
Multi-stream Heat Exchanger
LNG Storage Tank
CO_2 Emissions Source
NG Compressor
Contact Liquid Cooler
NG Pipeline
Mixed Refrigerant Compressor
Desublimating Heat Exchanger
Cryogenic Slurry Pump
Low Pressure Drop Direct-Contact Chilling Dryer System
Near-Cryogenic Melter Pump
Separations
CO_2 Out
CO_2 Pump
CO_2 Polisher
Light Gas Out

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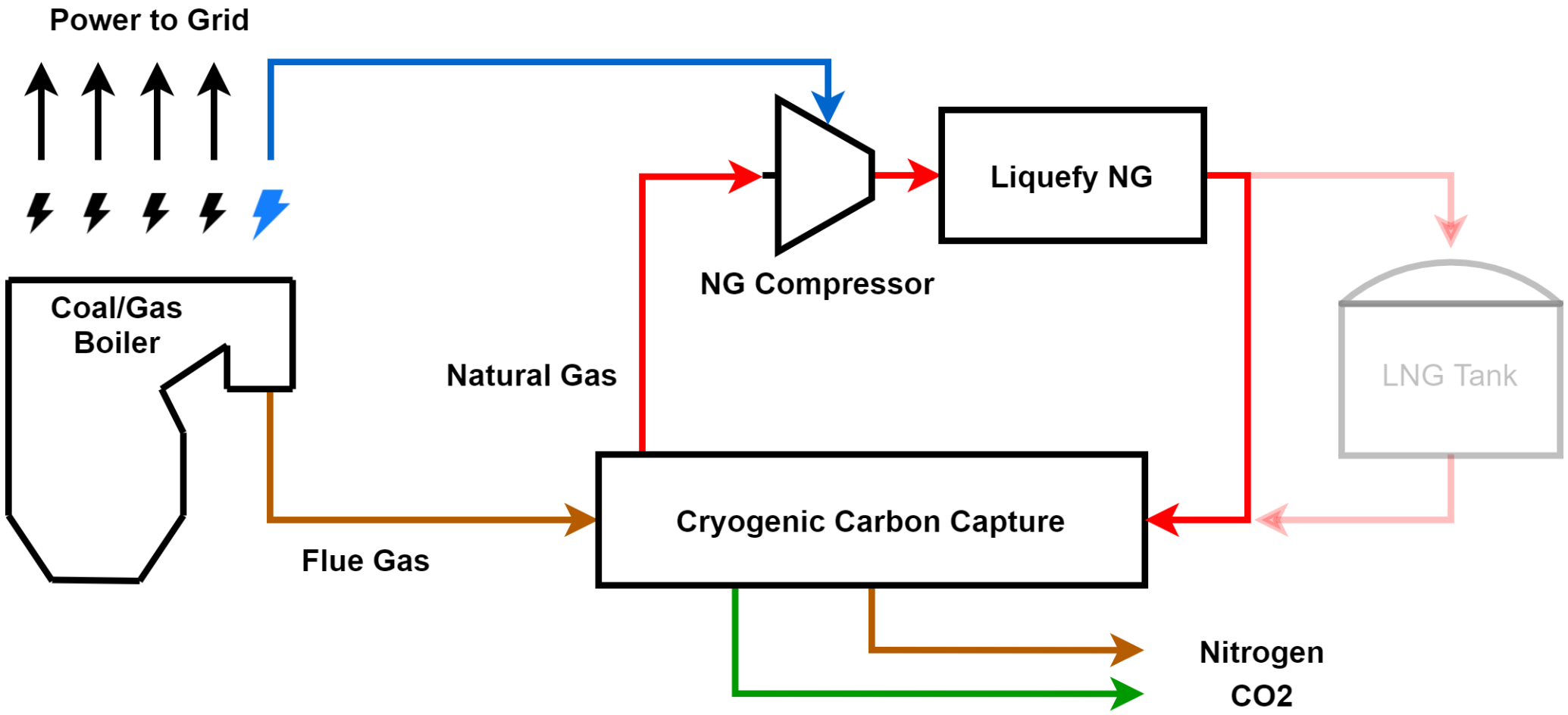
Normal Process Illustration



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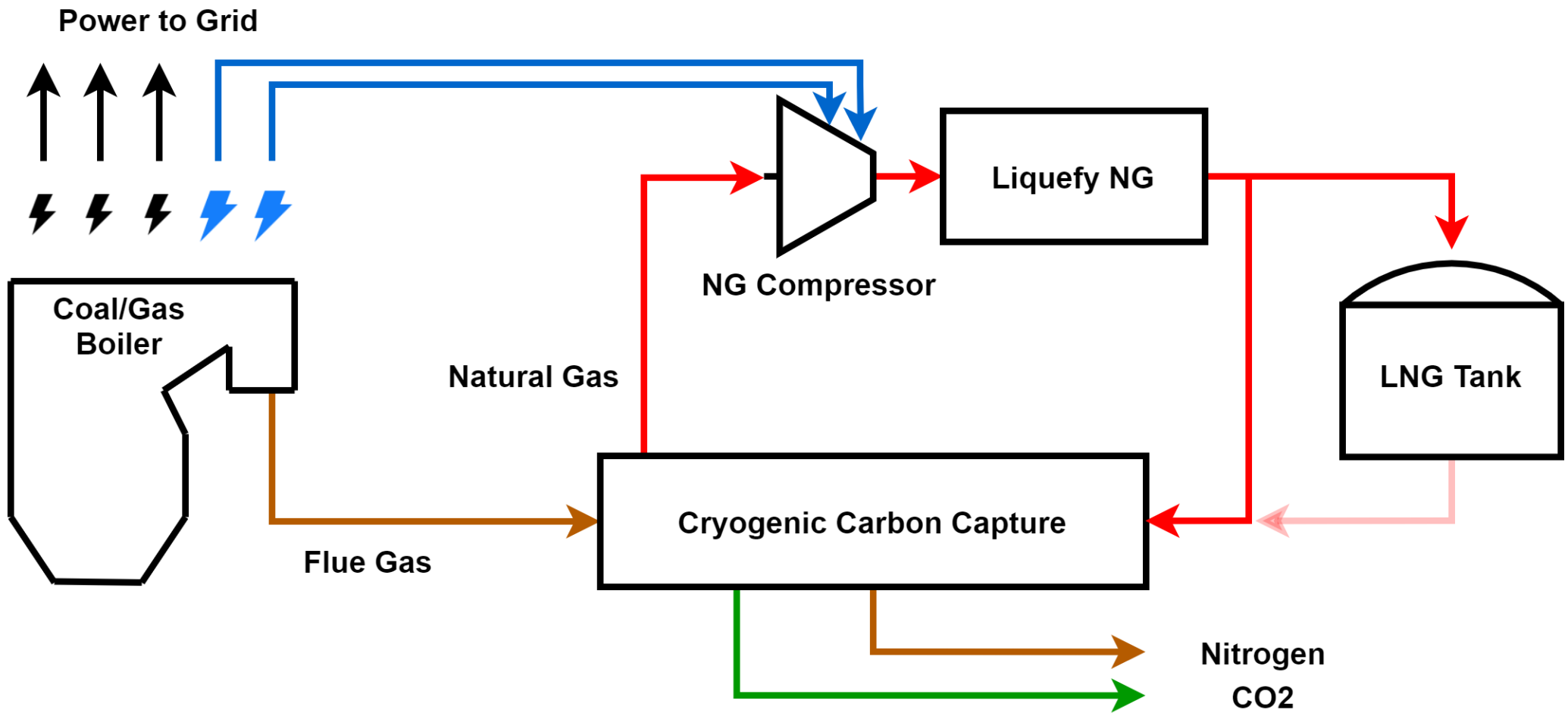
Energy Storing Illustration



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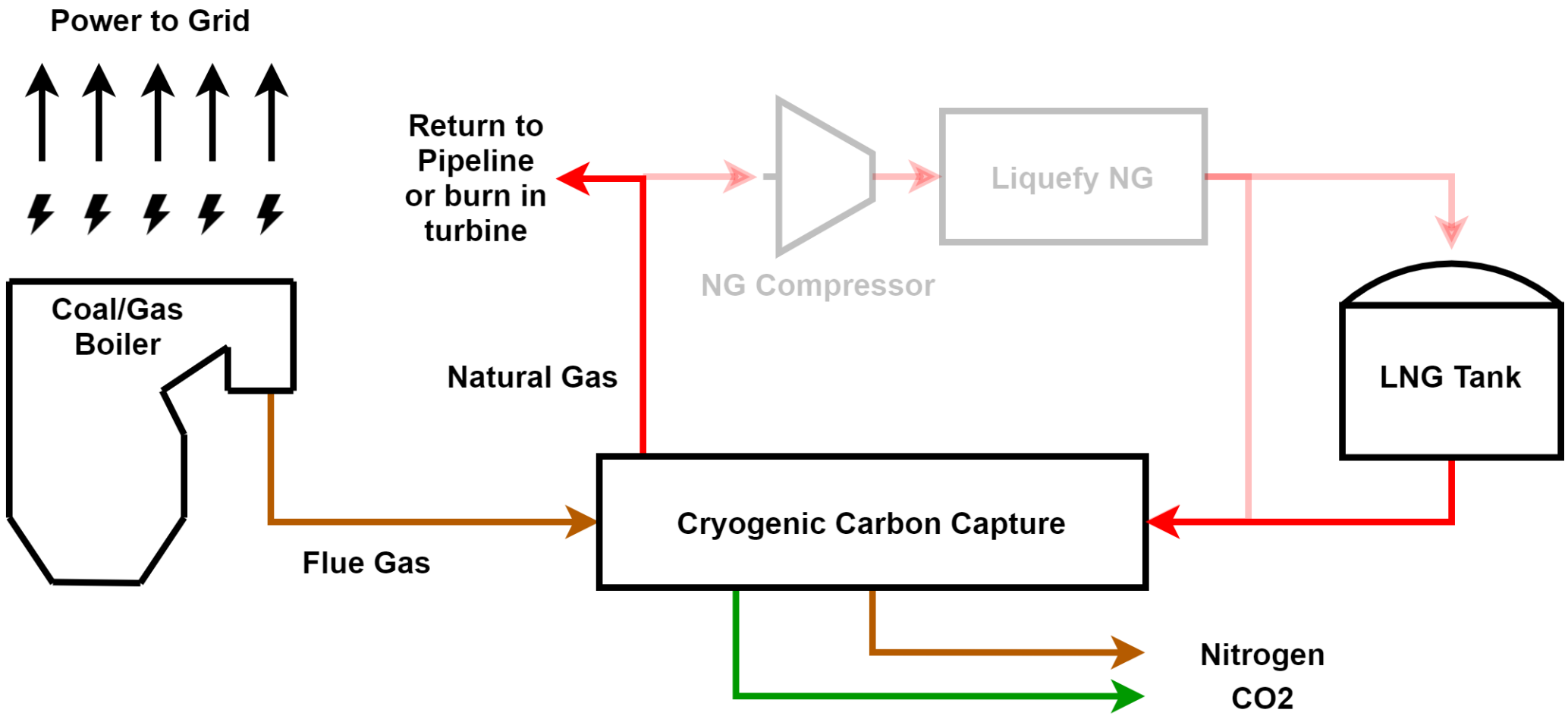
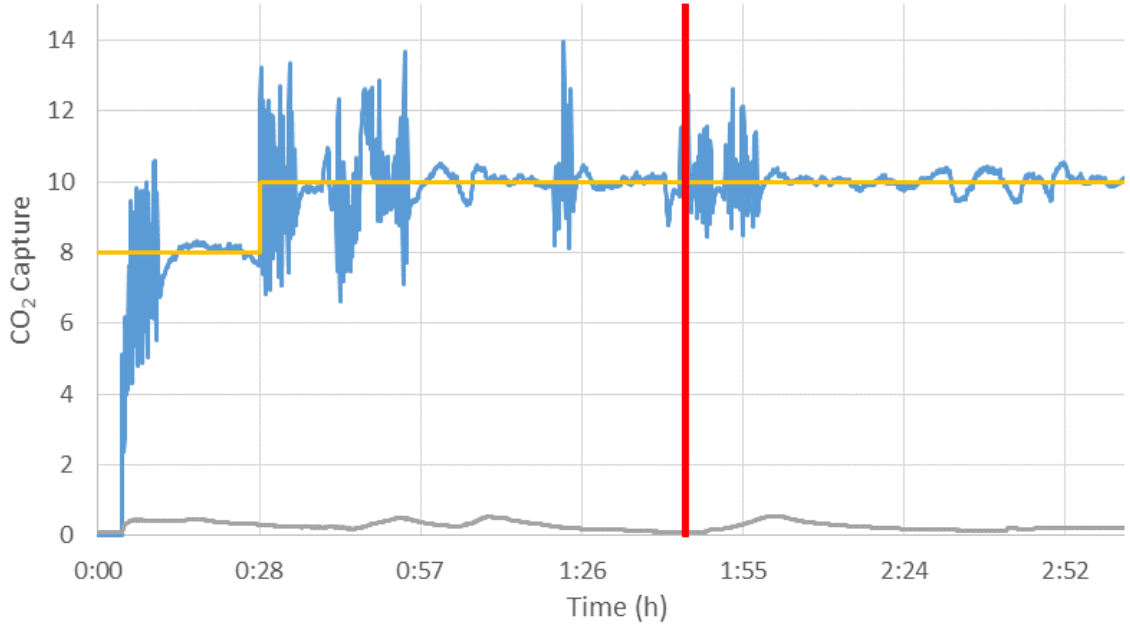
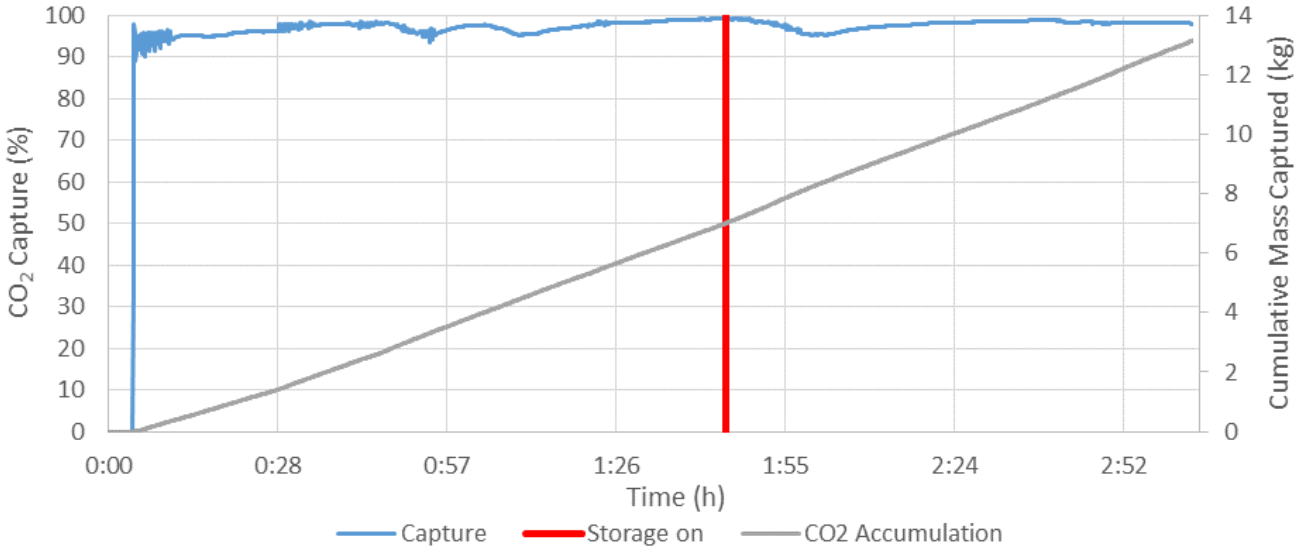
Energy Recovery Illustration

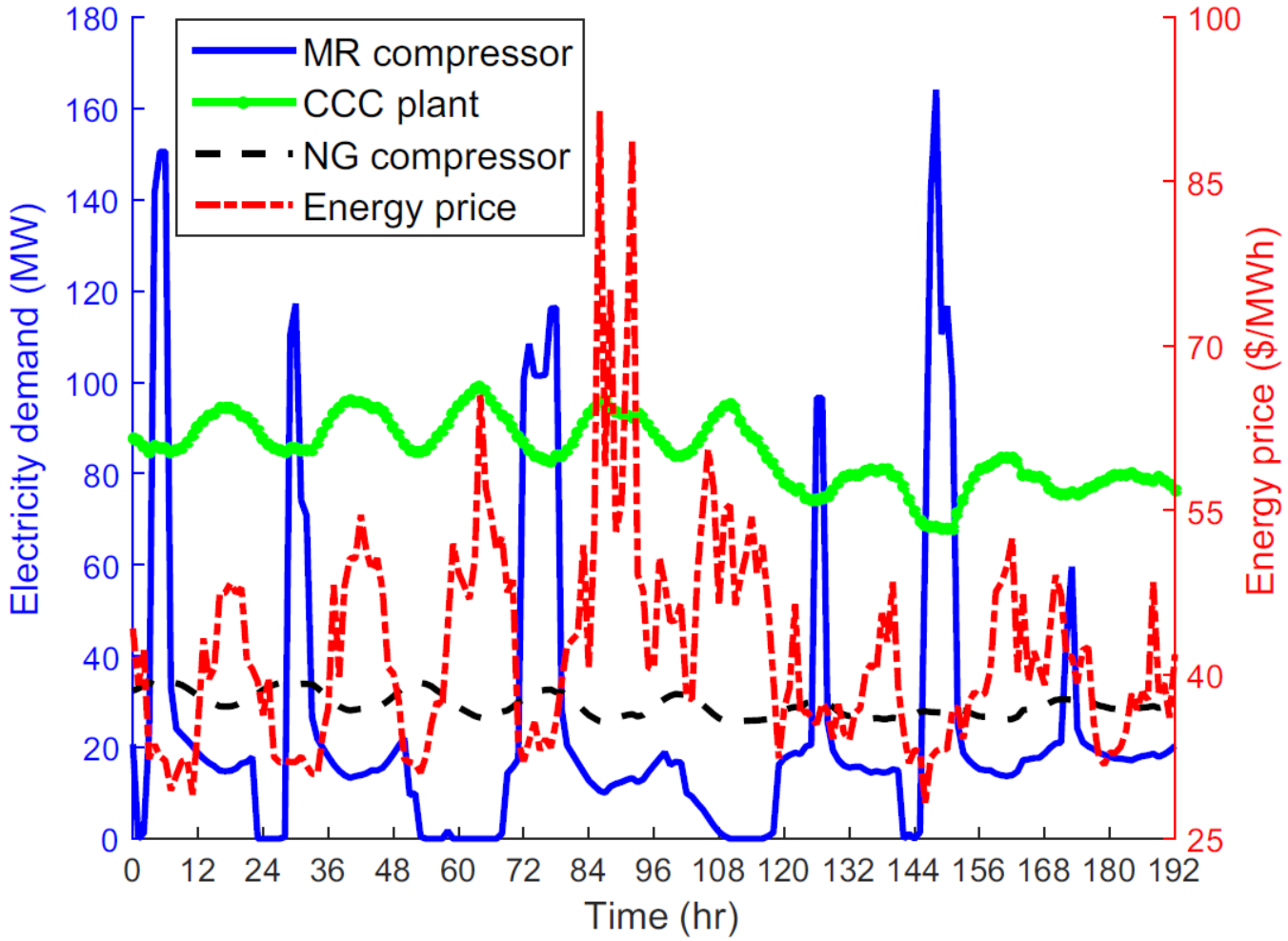


Energy Storage





Preliminary electricity demand analysis



Source: Safdarnejad, Hedengren, Baxter, *Applied Energy* 172 (2016) 66–79

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NETL Contributions

1. Current target location is a coal-fired power plant in Wyoming. It has since been scheduled for early retirement, possibly earlier that would allow us to complete a demonstration, especially a full-scale demonstration. Some idea of future timing for future of this funding would be helpful.
2. The economics look promising for baseload plants and even more so for load-following plants. Many fossil plants must follow dynamic dispatch schedules as intermittent sources become more prominent. NETL help in characterizing this dynamic future would be great.
3. This technology provides great value in the US but potentially even more value in other countries. NETL cooperation in talking with such countries would be great.

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Acknowledgements and Contact Information

PacifiCorp has agreed to host and provide information for this project.
Chart Industries is providing technical assistance (and now owns SES).
SES employees and BYU graduate students provided the experimental data and analyses completed thus far.
Wyoming and Utah, NETL, Alberta, Canada, and several private companies have provided financial support and access to data.

PI: Larry Baxter, larry.baxter@chartindustries.com
Manager: Kyler Stitt, kyler.stitt@chartindustries.com