



GTI ENERGY

solutions that transform

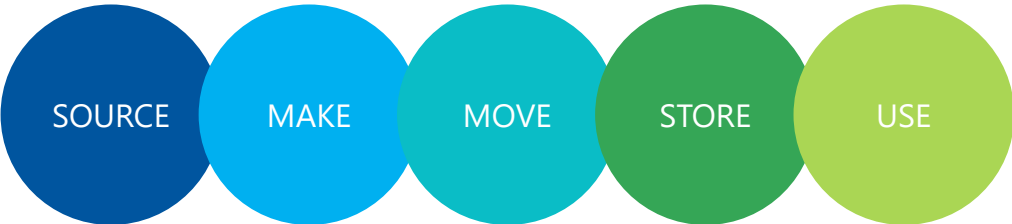
Supercritical Transformational Electric Power (STEP) 10 Mwe sCO₂ Pilot Plant Demo

ASME TurboExpo23 – sCO₂ Pilot/Commercial Systems Panel

John Marion – Sr. Program Director

June 28, 2023

We develop, scale and deploy solutions in the transition to low-carbon, low-cost energy systems



We work collaboratively to address critical energy challenges impacting gases, liquids, efficiency and infrastructure

Supercritical Transformational Electric Power (STEP) Project



Scope: Design, construct, commission, and operate a **10 MWe sCO₂ Pilot Plant Test Facility** - reconfigurable to accommodate other testing

Team: GTI Energy (**GTI ENERGY**)
Southwest Research Institute (**SwRI**[®])
General Electric Global Research (**GE-GR**)
U.S. Department of Energy (**DOE NETL**)

Joint Industrial Partners:



Schedule: Three budget phases (2016-2024)

Cost: \$165.6MM Total / \$124.5MM Federal Funding (includes building)



STEP Project

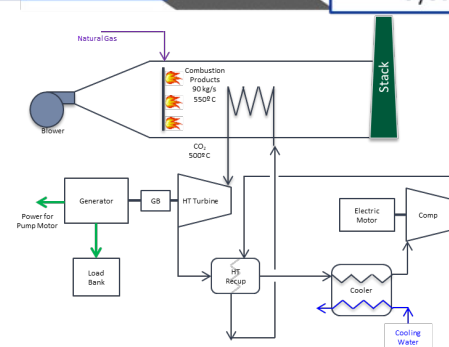
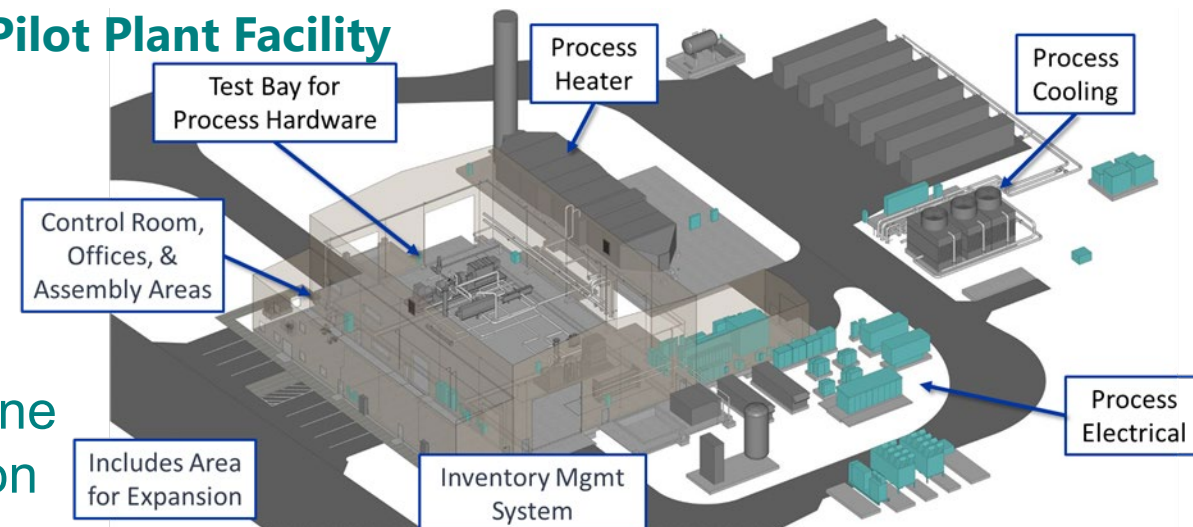


Design, construct, commission, operate 10 MWe sCO₂ Pilot Plant Facility

- reconfigurable to accommodate other testing

Objectives:

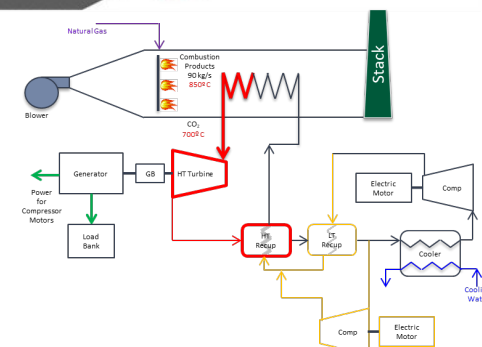
- **Demonstrate pathway to efficiency > 50%**
- **Demonstrate operability at 500°C & ≥700°C turbine inlet temperature with 10 MWe net power generation**
- **Verify System Performance & Operability:**
 - Quantify component and system performance
 - Demonstrate operation across control parameters
 - Measure transient response through start-up, load change, and shutdown



Simple Cycle

- Shortest time to initial data
- Controls & safety
- Component performance
- Steady & transient cycle data

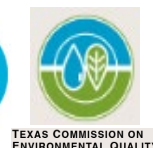
T_{IT} 500°C, 250 bar



Recompression Cycle

- Inventory management
- Starting transients
- Parallel compressor control
- SOA component efficiencies
- Cycle efficiency > 50%

T_{IT} 715°C, 250 bar



STEP Test Facility Installation Progressing 2023



STEP Test Facility Installation Progress



February 2023 – SwRI, DOE, GTI leaders

Recent progress

- All components in place except for turbine gearbox
- Compressor loop operational in December
- Piping completed in May
- Remaining electrical installation in work, to be completed in July

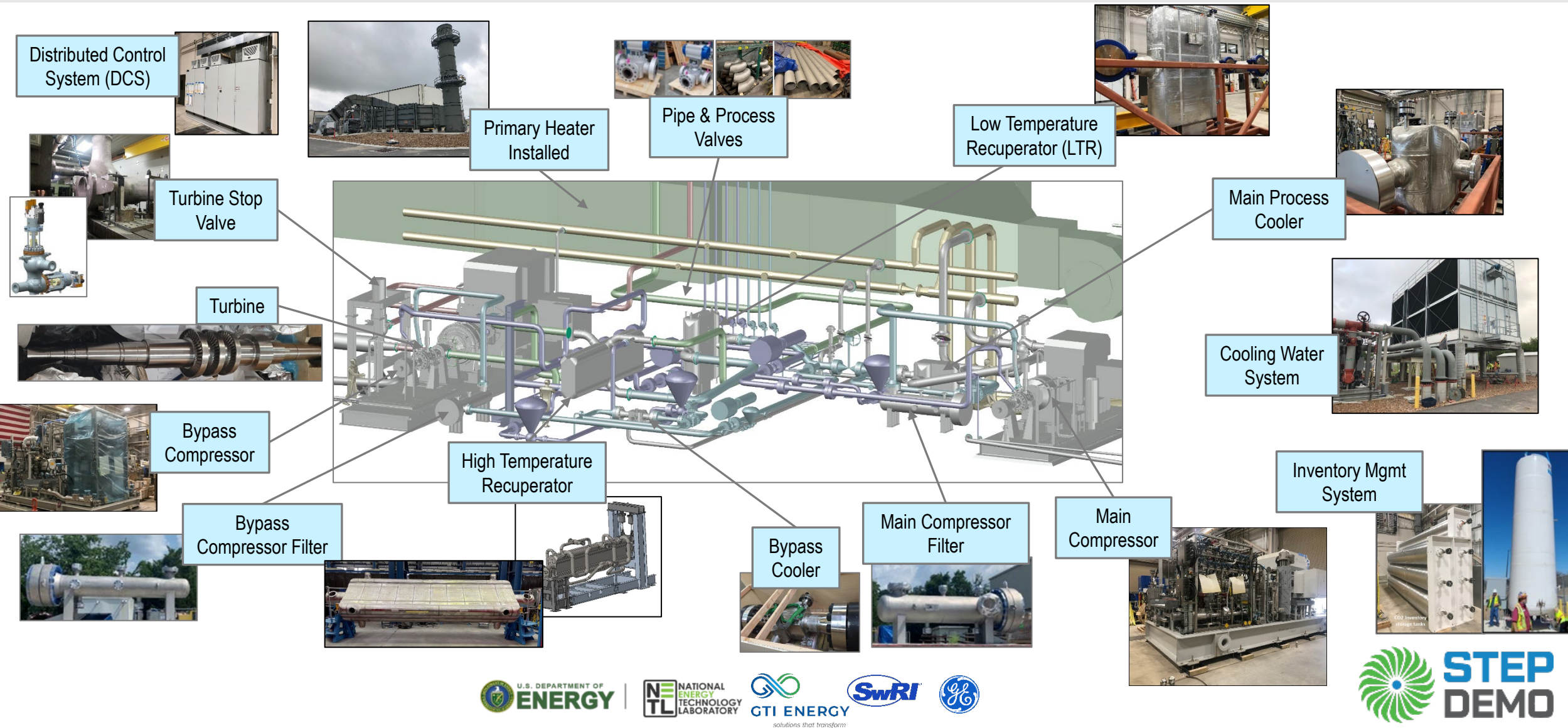


Noteworthy 2023 achievements

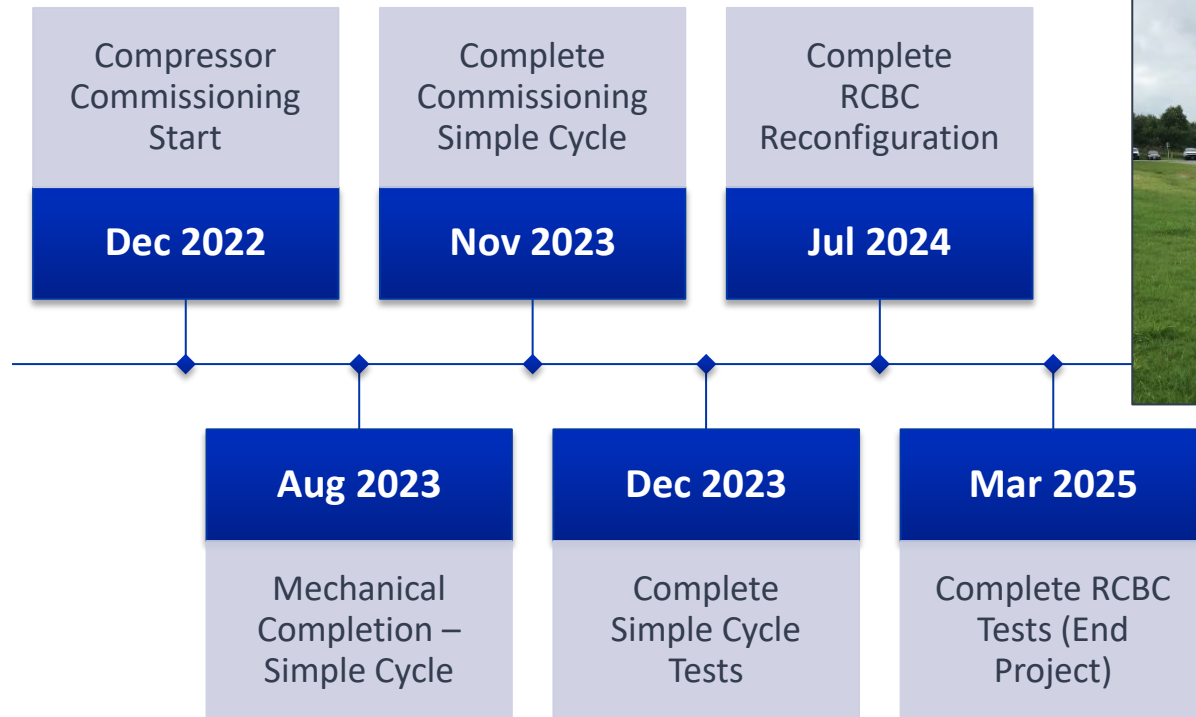


- STEP achieved sCO₂ conditions for the first time January 2023
- Compressor achieved full speed, full pressure operation for extended periods of time

STEP Facility and Equipment Layout



Timeline to Test Operations



STEP pilot contribution to sCO₂ Technology Maturation

[High Temperature Indirect sCO₂ power]



Technology	STEP pilot	Future	
Perf. Verification		with commercial products	key objective for STEP
Plant Operability		with commercial applications	key objective for STEP
Static & Dyn. Modeling		refine with data	Developed and validated on STEP
Supply Chain		gain experience & confidence	Immature now and should come with market
Materials (design & use) 740H welding 282 casting 625 welding	 	gain experience	STEP applying ASME available and guidance
Plant Arrangement		with commercial application	STEP arrangement flexible not compact
Turbine		commercial products	STEP turbine is technology development not product development
Compressor		gain experience & confidence	STEP compressor specification evolved with learnings
Heat Exchangers		gain experience & confidence	STEP heat exchangers push scale
Valves		gain experience & confidence	STEP valves adapted from steam plants



Summary and Outlook



- **sCO₂ power cycles are versatile to heat source and application and provide potential performance AND cost benefits over steam cycles**
- **Technology maturation by the STEP project will provide path to future commercial systems with potentially higher efficiency and lower emissions**
- **STEP test operations are planned for late 2023 (Simple) and early 2025 (RCBC)**
- **Valuable learnings on design and fabrication with advanced alloys:**
Turbomachinery rotor (N105) & Casing (IN625), Primary Heater (740H), Turbine Stop Valve (H282), thick-walled (740H) piping, High Temperature Recuperator (316S)
- **Opportunity for deep technology and operations insights available through Joint Industry Partnership**

Keep up to date on STEP Project progress at www.STEPdemo.us

Gratefully Acknowledging the Support from U.S. DOE-NETL and Project Partners



www.STEPdemo.us

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