Blue Bison ATR Advanced CCUS System

primary project goal

Tallgrass MLP Operations LLC is partnering with the University of Wyoming and Technip Energies to perform an initial engineering design of a commercial-scale carbon capture and storage (CCS) system installed at a hydrogen (H_2) production plant proposed to be installed in Douglas, Wyoming. The proposed plant would produce decarbonized H_2 from natural gas (or "blue" H_2), utilizing Haldor Topsøe's auto-thermal reforming (ATR) technology coupled with BASF's OASE® White carbon capture system. The primary project goal is to complete an initial design of a commercial-scale advanced carbon capture, utilization, and storage (CCUS) system that separates, stores, and utilizes more than 100,000 tonnes per year net CO_2 with 90%+ carbon capture efficiency—from an ATR facility producing high-purity H_2 from natural gas—providing a basis for subsequent deployment of CCUS projects of this type.

technical goals

- Design a commercial-scale carbon capture system that could be installed and fully integrated with a 220-million standard cubic feet per day (MMSCFD) blue H_2 facility utilizing ATR technology, producing 99.97% pure H_2 delivery pressure at or above 360 pounds per square inch absolute (psia).
- Establish system capability of meeting CO_2 capture requirements of 95% pure CO_2 with 90+% capture efficiency, CO_2 delivery pressure at or above 2,215 psia, and a goal for CO_2 transport and storage costs at or below $10 per tonne.
- Identify potential utilization pathways for CO_2 and H_2.
- Determine levelized cost of hydrogen and cost of carbon capture to help achieve the U.S. Department of Energy's (DOE) target for carbon-neutral blue H_2 production of less than $1 per kg.

technical content

The proposed site for the H_2 production plant with integrated capture is adjacent to Tallgrass' midstream gas processing plant in Douglas, Wyoming (see Figure 1). This location has multiple favorable characteristics:

- Immediate proximity to existing natural gas lines and existing gas processing plant with its infrastructure and utilities.
- Plausible regional market options for blue H_2 utilization in power generation, renewable diesel production, decarbonized ammonia production in the Midwest, and transportation uses.
- Options for CO_2 utilization with storage opportunities within 1 mile of the host site, enhanced oil recovery (EOR) fields in the regions, and the Wyoming CO_2 corridor initiative.

program area:
Point Source Carbon Capture

ending scale:
pre-FEED

application:
Pre-Combustion Industrial PSC

key technology:
Solvents

project focus:
BASF's OASE® White Carbon Capture System with Natural Gas Reforming

participant:
Tallgrass MLP Operations LLC

project number:
FE0032114

predecessor projects:
N/A

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partners:
University of Wyoming; Technip Energies

start date:
10.01.2021

percent complete:
5%

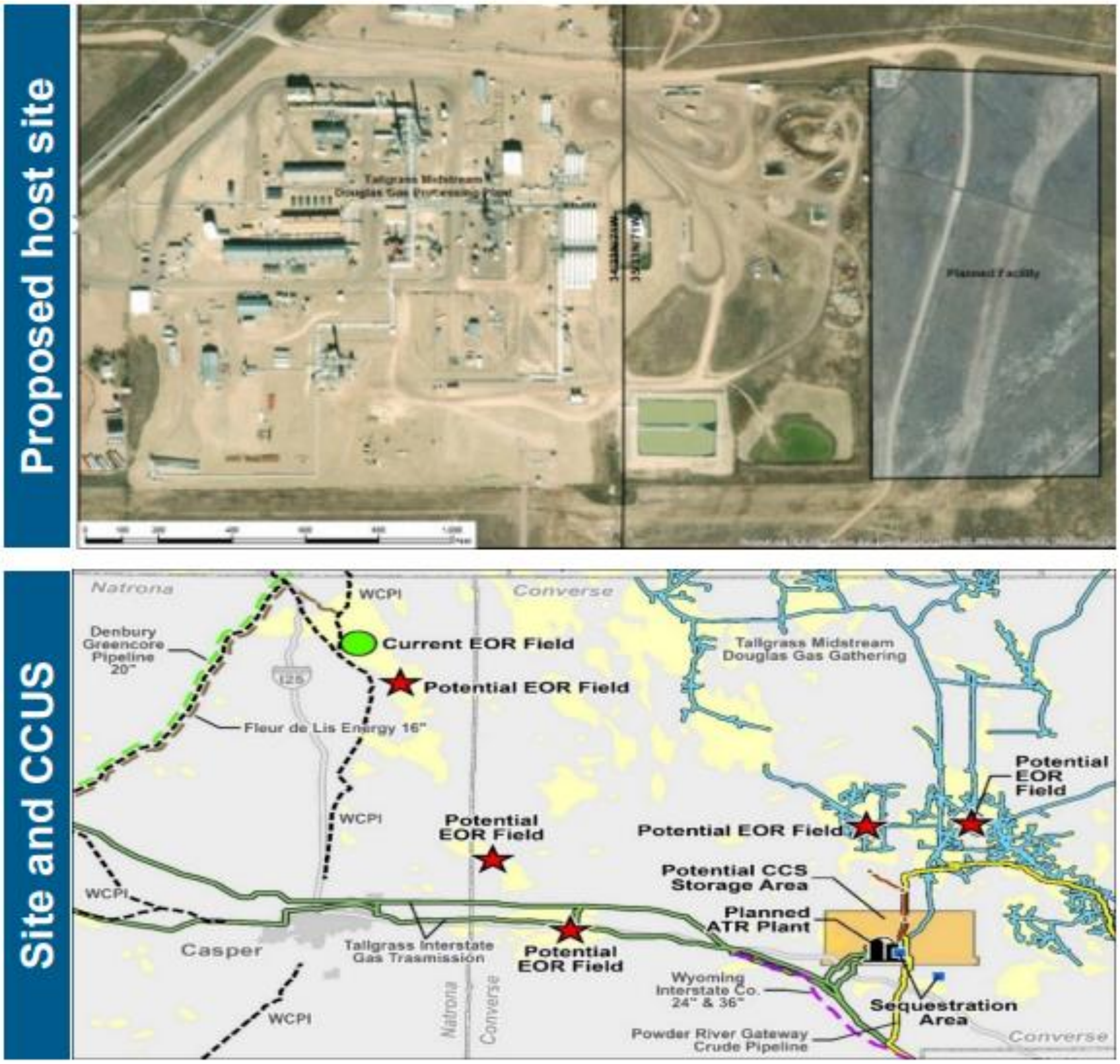

Figure 1: Proposed project site.

The proposed H_2 production plant would leverage Haldor Topsøe's SynCOR™ ATR technology (see Figure 2). SMR is the most common natural gas reforming technology deployed, but SMR produces CO_2-loaded flue gas requiring post-combustion capture. However, in ATR, most of the CO_2 generated can be efficiently captured from the high-pressure raw synthesis gas (syngas) stream via amine scrubbing. Unlike SMR, ATR requires oxygen input, but for high CO_2 capture rates the ATR approach is preferred to SMR. The SynCOR ATR technology is oxygen-blown, featuring an adiabatic reformer upstream to convert heavy feedstocks to methane and a fired heater to preheat the feed natural gas, and a high-pressure steam byproduct is used to generate power in a steam turbine generator, which can offset the power demand of the air separation unit (ASU) needed for oxygen production.

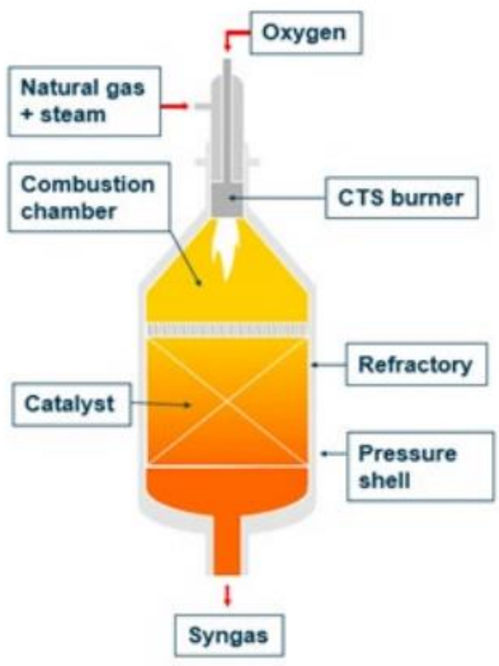

Figure 2: SynCOR™ autothermal reformer.

The integrated H_2 production plant would integrate the autothermal reformer with deep water-gas shift (WGS) and thorough CO_2 capture via BASF's OASE white carbon capture system. The overall process concept for the integrated plant is depicted in Figure 3.

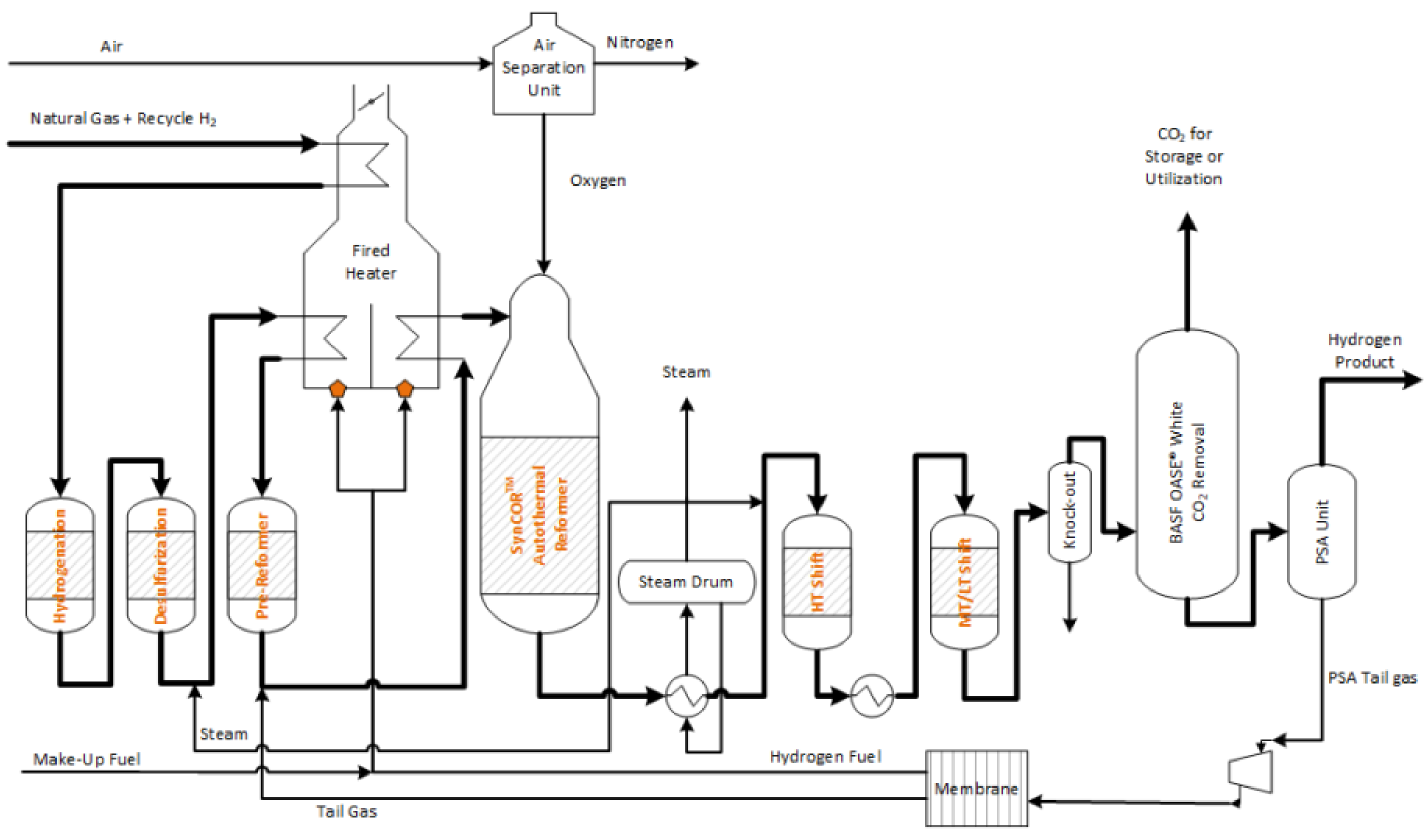

Figure 3: Process concept for integrated ATR with CO_2 capture.

BASF's OASE white is a state-of-the-art amine solvent-based technology for pre-combustion capture of CO_2 from syngas. It is a high-efficiency process, requiring low energy consumption per ton CO_2 captured.

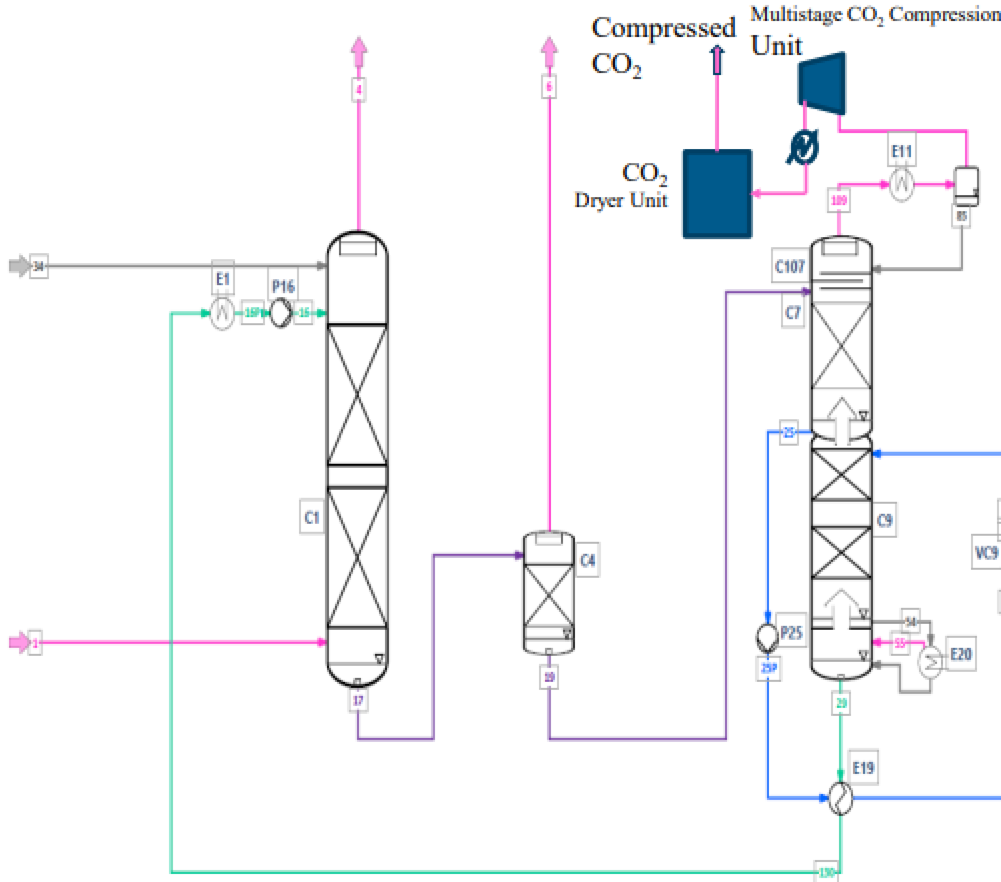

Figure 4: BASF OASE® White carbon capture technology.

*TABLE 1: SOLVENT PROCESS PARAMETERS

Proposed Module Design		(for equipment developers)		
Syngas Flowrate	kg/hr		219,160	
CO_2 Recovery, Purity, and Pressure	% / % / bar	99.9	99.57	152
Absorber Pressure Drop	bar		0.2	
Estimated Absorber/Stripper Cost of Manufacturing and Installation	$ / kg/hr		—	

*Numbers presented in this document represent best current information

Other Parameter Descriptions:

Chemical/Physical Solvent Mechanism – Combination of physical and chemical.

Solvent Contaminant Resistance – Currently unknown.

Solvent Foaming Tendency – Currently unknown.

Flue Gas Pretreatment Requirements – Currently unknown.

Solvent Makeup Requirements – Currently unknown.

Waste Streams Generated – Currently unknown.

Process Design Concept – See Figure 3.

Proposed Module Design – See Figure 4. The pressure, temperature and composition of the gas entering the module are as follows:

Pressure	Temperature	Composition entering BASF module						
		vol%						ppmv
psia	°F	CO_2	CO	CH_4	$Ar+N_2$	H_2	H_2O	H_2S
378	60	24.7	0.58	0.82	0.49	72.65	0.77	0

Technology advantages

- State-of-the-art, commercially proven technologies for syngas generation and treatment.

R&D challenges

- Developing a mechanical design for the largest advanced heat exchanger reformer (TPR®), which can be integrated with the ATR to reduce O_2 consumption and minimize methane (CH_4) slip from the TPR.
- Verifying test data for use of pure blue H_2 as fuel in LSV® burners in the ATR preheater to minimize or eliminate CO_2 production in the fired heater.

status

The project team has developed utility flow digrams, piping and instrumentation diagrams, and heat and material balances. A 3D model of the system is being generated.

available reports/technical papers/presentations

"Blue Bison DE-FE0032114 Kickoff Meeting," Kickoff Meeting Presentation, October 19, 2021.
https://netl.doe.gov/projects/plp-download.aspx?id=11230&filename=Blue+Bison+DE-FE0032114+Kickoff+Meeting.pdf