2023 Western States Tripartite Conference

A bright way to an energy transition: BrightLoop™

March 2023

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BABCOCK & WILCOX

INTRODUCTION

A GLOBAL ENERGY LEADER CREATING A BRIGHTER FUTURE

Providing high quality and innovative technologies since 1867

- More than 17,000 patents continuing to drive innovation and change
- Globally recognized technology leader and innovator at the forefront of the energy transition

Ensuring energy security for customers and the world

- Helping customers overcome the technical challenges associated to transitioning from current to future energy sources
- Delivering systems, parts, construction and field services to help plants operate more effectively and efficiently

Making net-zero ambitions a reality today

- Our waste- and biomass-to-energy, carbon capture, hydrogen production and environmental technologies support the reduction of greenhouse gases, including CO_2 and methane, in an environmentally friendly way

BUILDING A BRIGHT FUTURE TOGETHER

Boilers and Steam Generation Equipment

1867 — Founded

1880 — Founded

WWI — B&W provides boilers for US navy

1922 — B&W Diamond Power, which provides boiler cleaning systems, was founded

1929 — B&W built and put into service the first recovery boiler in the world

1932 — B&W builds and installs penstocks for hoover dam

1936 — SPIG (custom cooling systems provider) was founded, which was later acquired by B&W in 2016

1939 — B&W installs Coke Handling System in CA

1949 — B&W introduces package boilers

WWII — B&W provides boiler navy war ships

1952 — B&W installs CO Boiler in CA

1953 — B&W creates atomic energy division

1953 — B&W powers navy nuclear submarine

1959 — B&W powers US navy nuclear ships

1972 — B&W built North America's first refuse-to-energy plant

1982 — B&W built world's largest dry scrubbing designed and installed

1995 — B&W bought Joy Environmental, an ESP and scrubber specialist

New Decarbonization Technologies

2000 — B&W purchased Vølund™'s WtE[1], biomass, gasification and other businesses

2008 — B&W built its first carbon capture pilot unit (SolveBright™)

1989 — B&W sold first boiler with SCR to meet CA emissions

2012 — B&W supplied US's first ultra-supercritical boiler

1989 — B&W built world's largest WtE plant

2020 — B&W partnered with Eos to enter short-term energy storage market

1990 — B&W built world's largest chemical recovery boiler

2021 — BrightLoop™ for decarbonization and hydrogen production is now commercially viable

1999 — B&W awarded contract to develop fuel cells and hydrogen reformers for US navy

2021 — B&W invests in solar technology and decarbonization platform

2010 — B&W installs first full scale solar test boiler in Lancaster CA

2023 — Optimally positioned to lead the energy transition

1. *WtE = Waste-to-Energy.*

WE'RE HELPING CUSTOMERS CREATE CLEAN AND RELIABLE ENERGY

CLEAN ENERGY SOLUTIONS

B&W BABCOCK & WILCOX RENEWABLE

SUPPORTING A CIRCULAR ECONOMY

Ecologically sound ways of using and recycling resources like biomass, municipal waste, and solar energy to create clean, renewable baseload power while reducing greenhouse gas emissions.

B&W BABCOCK & WILCOX ENVIRONMENTAL

REDUCING THE IMPACT OF GREENHOUSE GAS EMISSIONS

Hydrogen production, carbon capture, ash handling, cooling systems, energy recovery and storage, and advanced emissions control solutions to help preserve the world's natural resources.

TRADITIONAL

B&W BABCOCK & WILCOX THERMAL

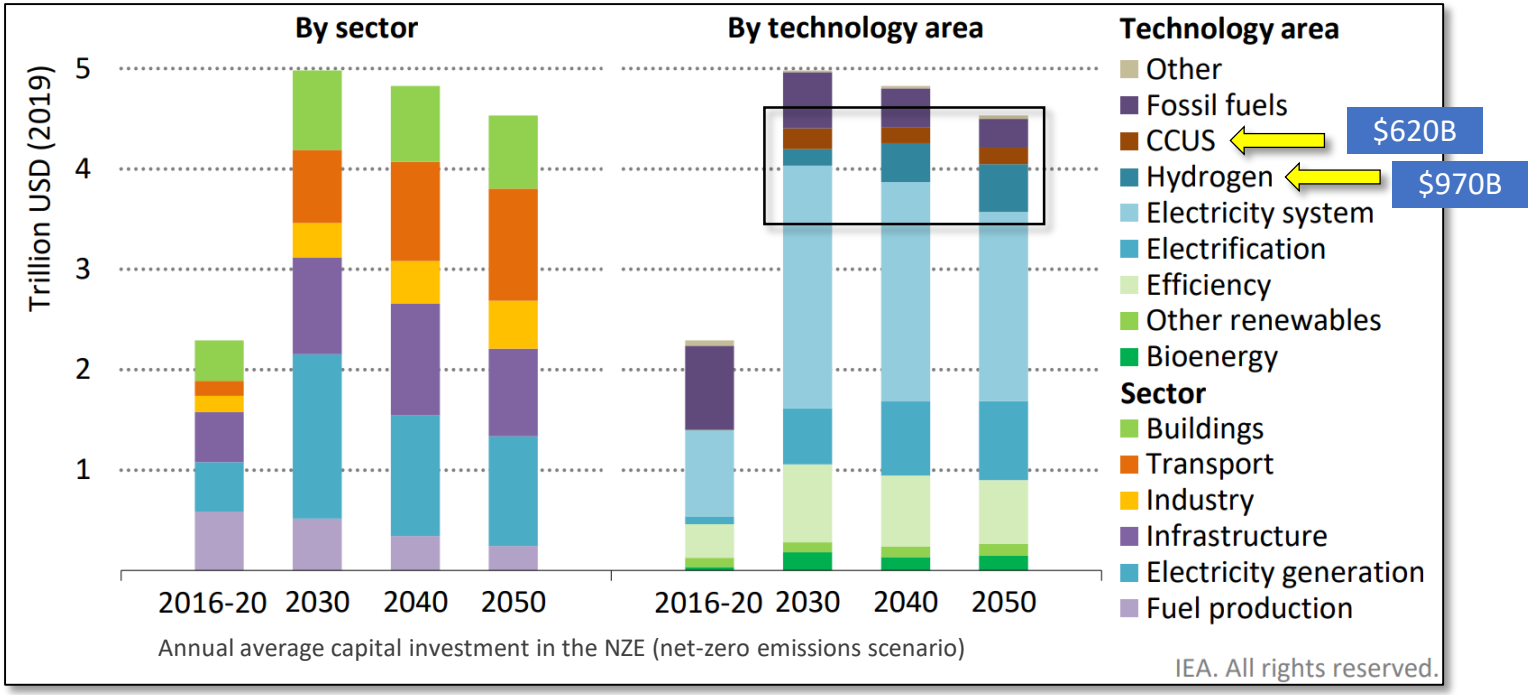
CREATING RELIABLE AND EFFICIENT STEAM GENERATION

Providing boilers and related equipment, aftermarket parts, service and upgrades to help utilities and industries generate reliable thermal energy from a wide range of fuels and bridge the gap during the global transition to new energy sources.

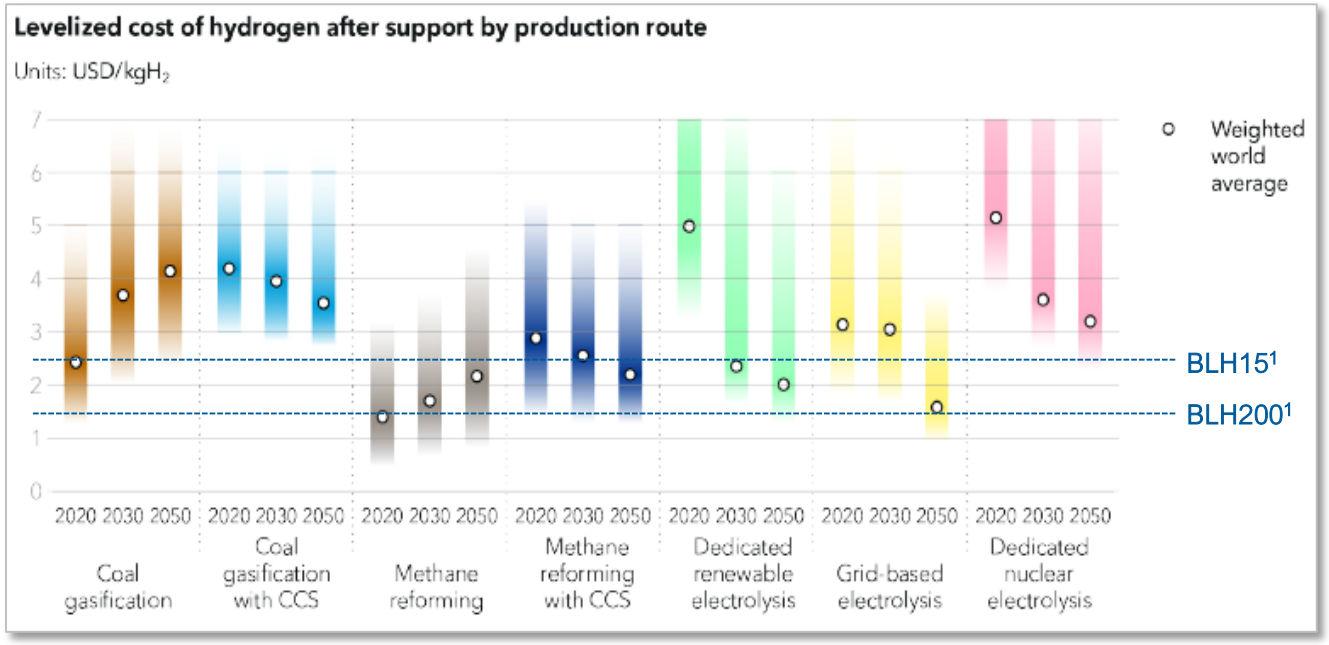
HYDROGEN MARKET

OVERVIEW

GLOBAL ANNUAL CAPITAL INVESTMENT IN CARBON CAPTURE AND HYDROGEN IS GROWING



MATURING TECHNOLOGY AND INCREASING POLICY SUPPORT DRIVING DOWN COST OF HYDROGEN



The levelized cost of hydrogen (LCOH) from BrightLoop's 15 TPD facilities (BLH15) is projected to be cost competitive with other forms of hydrogen production today, while the LCOH from at-scale 200 TPD facilities (BLH200) is projected to meet or beat the long-term cost forecasts for all large-scale hydrogen generation technologies

Source: DNV.

1. Company estimate. Based on feedstock cost of $1/mmbtu.

INFLATION REDUCTION ACT FOR CLIMATEBRIGHT™

Clean Hydrogen Production Tax Credit (PTC): 45V

- New 10-year incentive for clean hydrogen production with four tiers and a maximum of 4 kilograms of CO_2 equivalent per kilogram of hydrogen
- Green hydrogen awards: **$3/kg**

Carbon Capture & Sequestration Tax Credit: 45Q

- Increases the tax credits, lowers the threshold to be applicable, and adds direct air capture making carbon capture affordable
- CO_2 increases to **$85/ton** and DAC increases to **$180/ton; 12-year term**

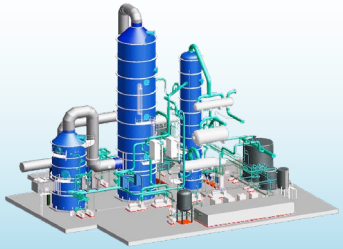
Clean Electricity Investment Tax Credit (ITC): 48C

- New, tech-neutral ITC replaces Energy ITC after 2024, emissions-based and flexible between clean technologies
- Renewable energy offsets CapEx at **30%,** with potential for multiple 10-20% bonuses

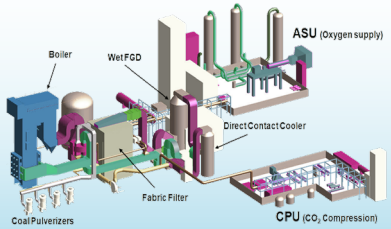
B&W KEY TECHNOLOGIES

GLOBAL LEADER IN CLEAN POWER PRODUCTION TECHNOLOGIES — OUR CLIMATEBRIGHT™ SUITE

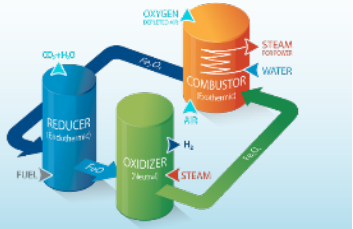
SolveBright™
POST-COMBUSTION CARBON CAPTURE



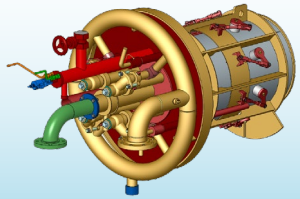
OxyBright™
OXYGEN-FUEL COMBUSTION



BrightLoop™
HYDROGEN PRODUCTION



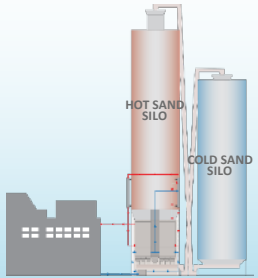
BrightGen™
HYDROGEN COMBUSTION



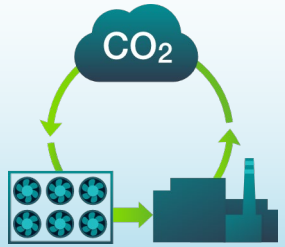
EMERGING TECHNOLOGIES

Long Duration Energy Storage

Green Steam



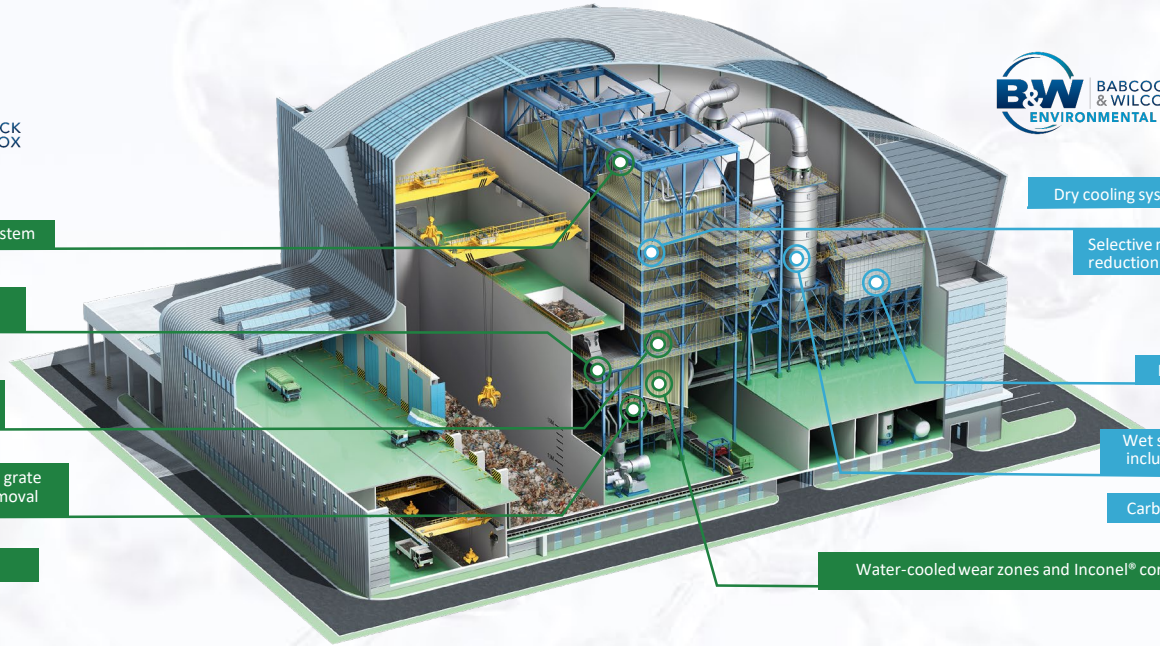
Direct Air Capture



- B&W is at the forefront of developing CO_2 capturing technologies
- Multiple technologies ready for commercial demonstration
- 93 active patents related to carbon capture technology
- Positioned to provide critical solutions to meet global climate goals

B&W'S PORTFOLIO OF CLEAN POWER PRODUCTION SOLUTIONS CONTINUES TO EVOLVE TO REACH CUSTOMERS AT ALL STAGES OF THEIR ENERGY TRANSITION.

GLOBAL LEADER IN COMPREHENSIVE WASTE-TO-ENERGY SOLUTIONS



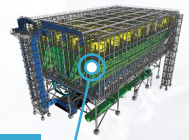
On-line boiler washing system

DynaFeeder® waste fuel feeder system

VoluMix® system for improved combustion

DynaGrate® combustion grate
DynaDischarger® ash removal

Energy storage systems



Dry cooling systems

Selective non-catalytic reduction (SNCR) NO_x control

Fabric filter baghouse

Wet scrubber with ADIOX® including energy recovery

Carbon capture solutions

Water-cooled wear zones and Inconel® corrosion protection

FIELD SERVICES

COMPONENT & SYSTEM UPGRADES

CONTROL SYSTEMS

REPLACEMENT & SPARE PARTS

OPERATION & MAINTENANCE

NET-NEGATIVE CARBON INTENSITY FOR BIOMASS AND MUNICIPAL SOLID WASTE

OxyBright with B&W's biomass-fired BFB boiler produces carbon negative electricity with a -**2,500**gCO_2e/kWh **carbon intensity**

OxyBright with B&W's WtE solution could produce carbon negative electricity with a -**1,000** gCO_2e/kWh **carbon intensity**

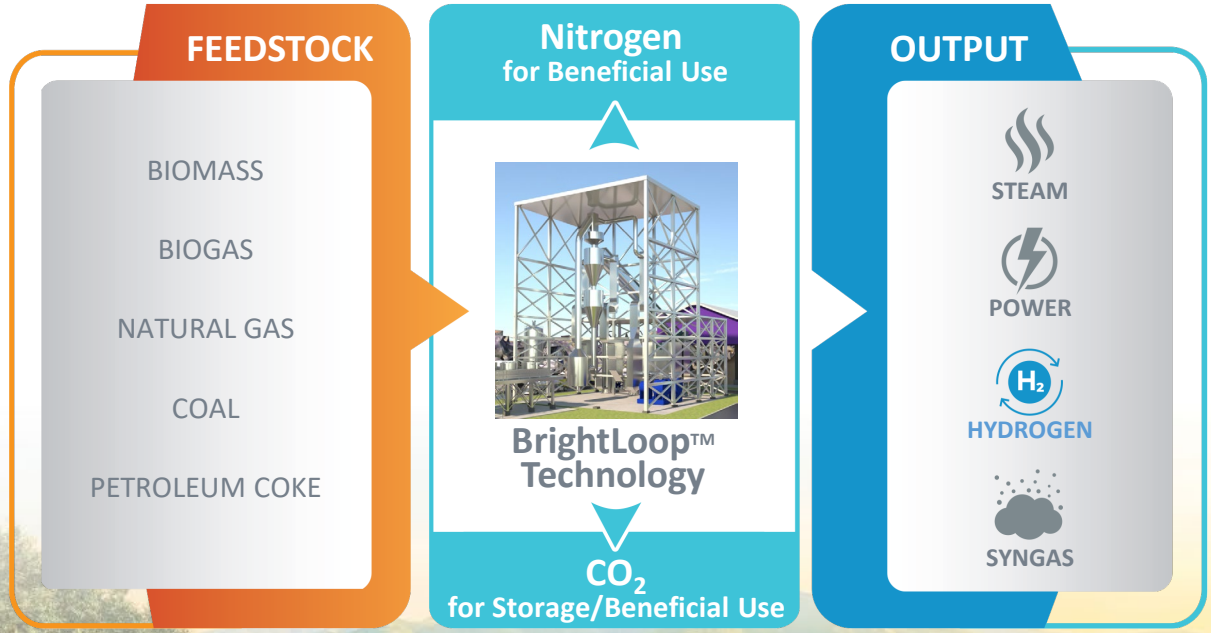
Our negative carbon intensity (-2500 gCO_2e/kWh) is **nearly seven times more negative than the US grid is positive** (+373 gCO_2e/kWh)

FLUE GAS TREATMENT FOR CARBON CAPTURE

- To optimize carbon capture on solvent-based scrubbing technologies, reductions in various pollutants found in the incoming flue gas are required
- Our solutions include technologies for acid gases, particulate and acid mist, NO_x, mercury, and flue gas moisture

THE WORLDWIDE LEADER IN FLUE GAS PRE-TREATMENT TECHNOLOGIES FOR POST-COMBUSTION CARBON CAPTURE

BRIGHTLOOP™ HYDROGEN PRODUCTION

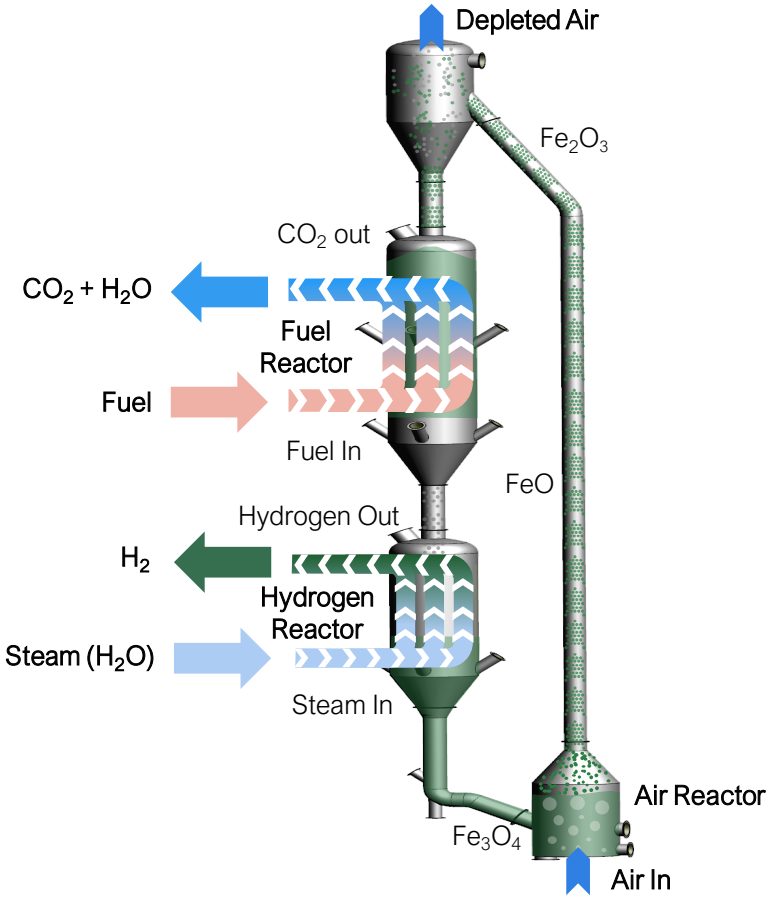


SOLID ADVANTAGES:

- Hydrogen from solid fuels – can utilize a variety of solid or gaseous fuels as feedstock
- High rate of carbon captured – inherent CO_2 isolation without the need for expensive carbon capture equipment
- Competitive hydrogen cost – lower levelized cost of hydrogen when compared to other hydrogen production methods
- Scalable for a range of applications – accommodates both large and small applications

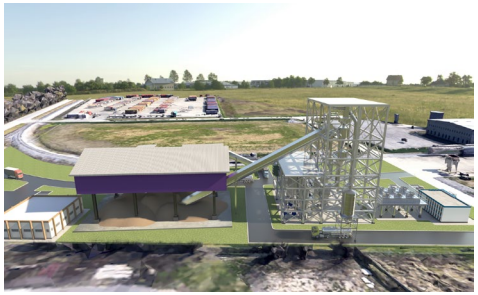
BRIGHTLOOP™ CHEMICAL LOOPING PROCESS

Graphical Demonstration of the Process



Process Key Benefits

CO_2 Capture	• CO_2 capture by design: no need for post-combustion CO_2 capture
Emission Containment	• Concentrated contaminant streams result in more efficient and less expensive control equipment
Selectivity	• Moving bed design allows high purity of product from reaction equilibrium • Compatible with CO_2 capture regulation
Flexibility	• Base technology has wide range of input products and end applications
Scalability	• Process maintains performance at small and large scales
Low Capital Costs	• All the above advantages collectively result in a low cost profile



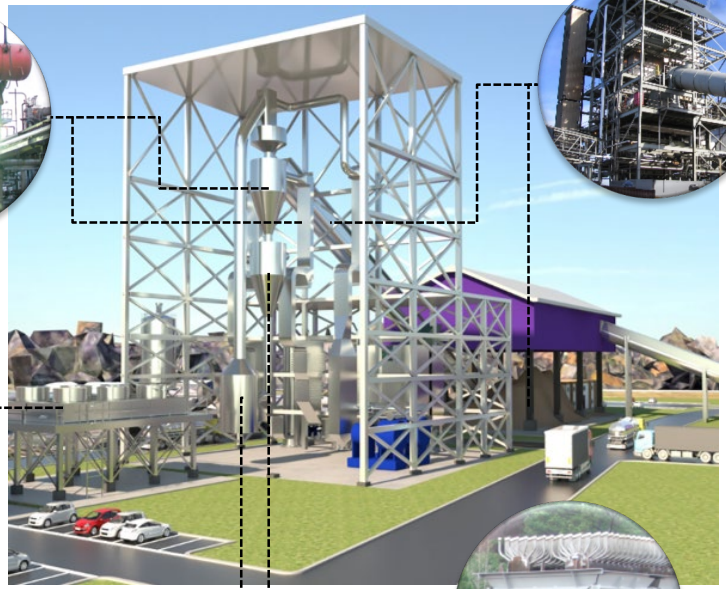
BrightLoop Plant Renderings

BRIGHTLOOP™-BASED ON PROVEN TECHNOLOGY

B&W has extensive experience with design and integration of all major BrightLoop™ component technologies

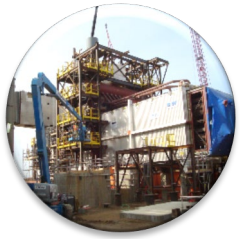
Pressure Vessel and Heat Exchangers
B&W has designed and manufactured tens of thousands of components for utility and industry applications

Air Cooled Condensers
B&W has over a century of heat integration experience



Environmental Control Equipment
B&W has completed thousands of environmental projects for particulate control, emissions control and clean-up
+
Solid Fuel Processing Equipment
B&W has completed thousands of projects with solid fuel handling equipment

Pressure Vessel and Heat Exchangers
B&W has designed and manufactured tens of thousands of components for utilities and industry



Construction
B&W has deep know-how for environmental and boiler projects, having completed thousands of projects

BRIGHTLOOP™ HYDROGEN PRODUCTION PROGRESS

BRIGHTLOOP™ EVOLUTION

COMPLETED

Laboratory Scale

RESEARCH STAGE

Sub-Pilot with
The Ohio State University
and B&W
25 Kilowatts Thermal

SUB-PILOT SCALE

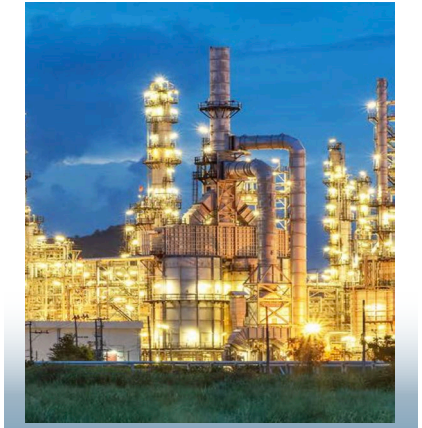
Steam & Hydrogen
25 Kilowatts Thermal

(National Carbon Capture
Center in Alabama)

PILOT SCALE

IN PROGRESS

INDUSTRIAL COMMERCIAL
2.5 to 25 Megawatts Thermal
1.5 to 15 tonnes per day
Hydrogen Output

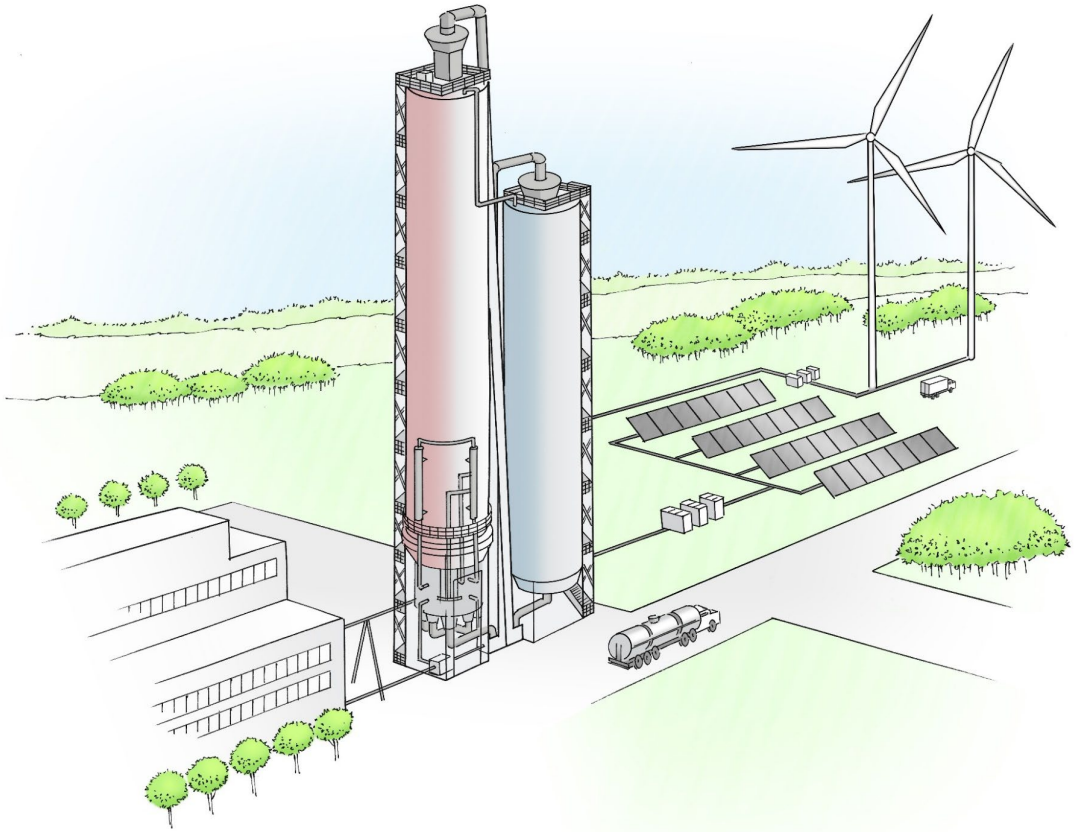


UTILITY COMMERCIAL
100 to 550 Megawatts Thermal
60 to 320 tonnes per day
Hydrogen Output

1994 - 2004 | 2008 | 2014 | 2024 | 2026

GREEN STEAM

- Produce steam for process use from renewable energy
- Combines particle-based (sand) thermal energy storage with a moving bed steam generator
- Electric flow-through heater heats sand when renewable electricity available
- Sand silos sized to hold enough sand for 24/7 steam production



GREEN STEAM
CHARGE CYCLE (CONSUME ELECTRICITY)

Electrically Heated Sand

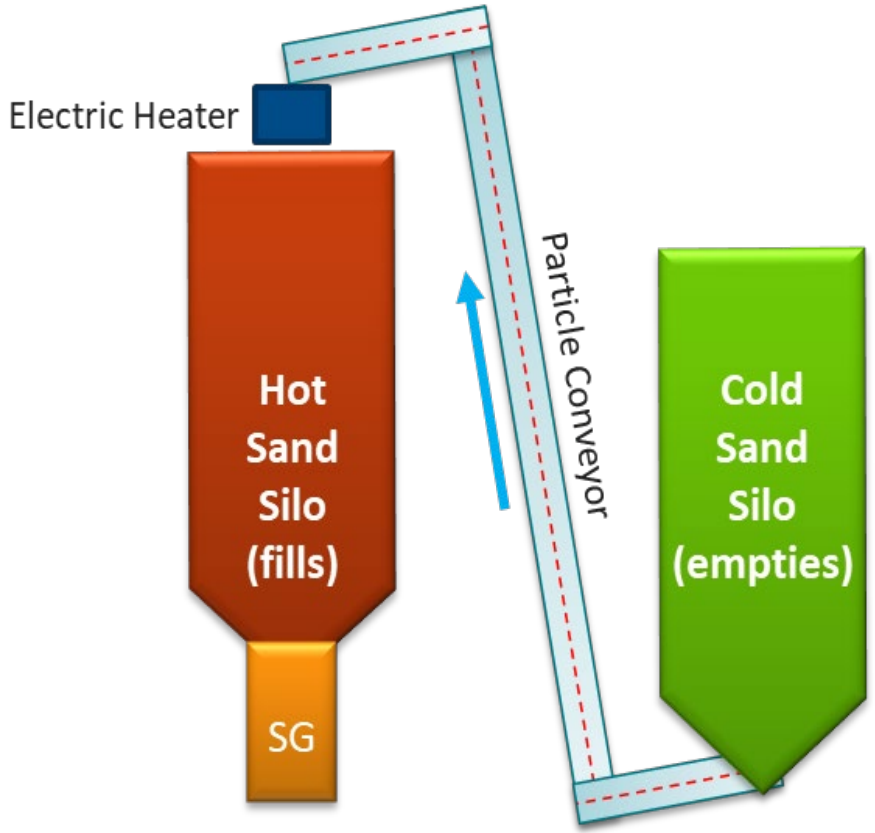
- When renewable power is cheap
- Intermittent

Sand moves from Cold to Hot Silos

- Only moves when Solar PV is available

Temperatures

- Cold Sand ~ 200°C
- Hot Sand ~ 600°C



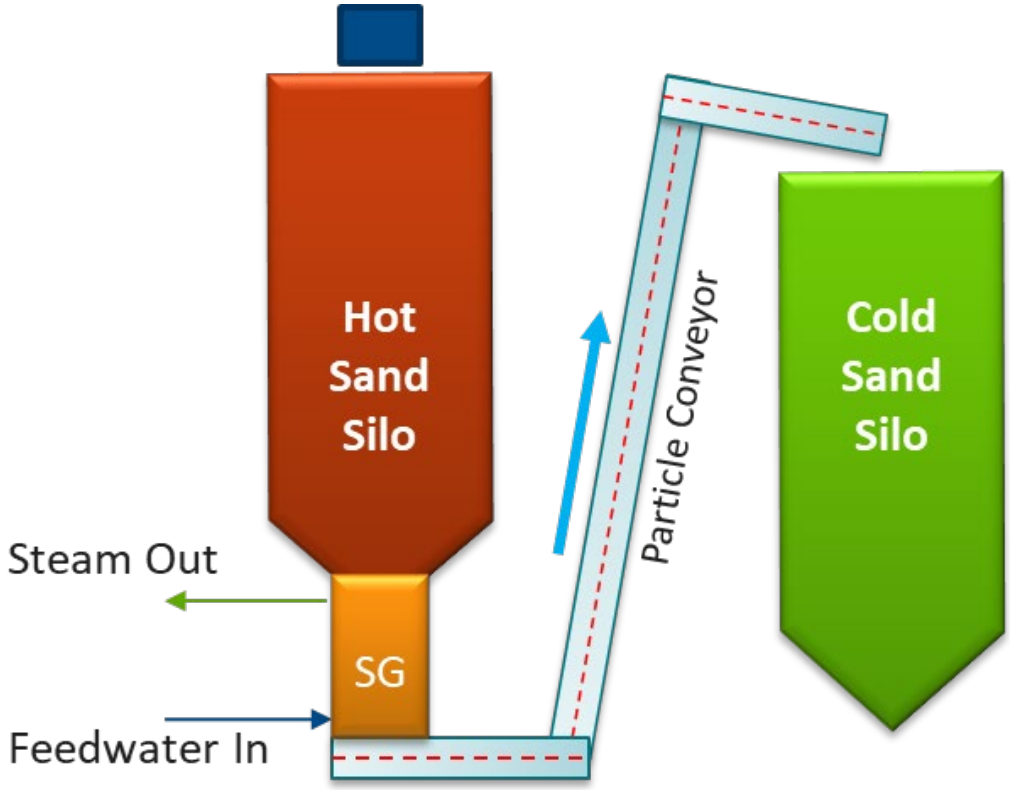
GREEN STEAM DISCHARGE CYCLE (PRODUCE STEAM)

Produce Steam

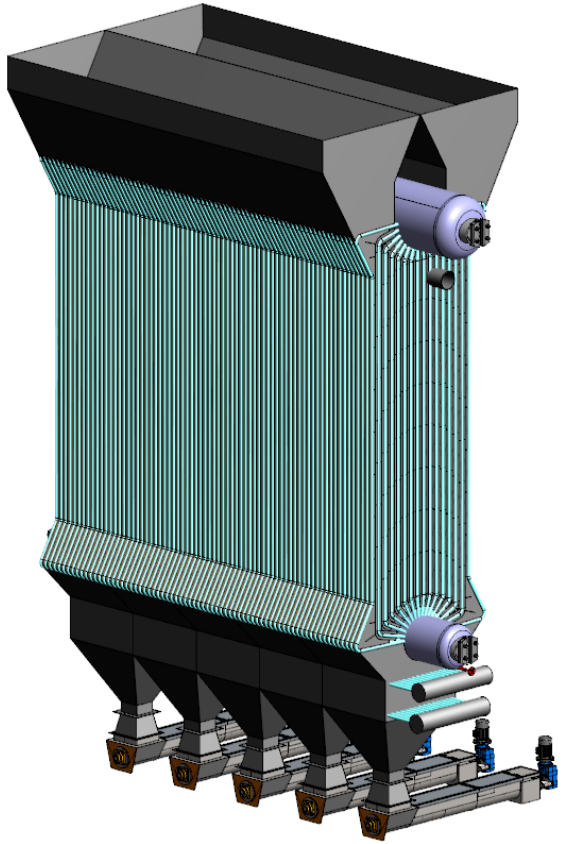
- 24/7 – Load following
- Any typical steam pressure
- Superheat or saturated steam

B&W Steam Generator

- B&W Design
- Hot Sand In → Cold Sand Out
- Feedwater In → Steam Out



GREEN STEAM PARTICLE HEAT EXCHANGER



- Novel moving bed HX concept
  - Sand flows by gravity
  - Sand flow controlled by outlet drain screws
  - True counterflow heat exchanger
- Integrated Economizer, Generating Bank, and Superheater (if needed)
- Mounts directly to bottom of hot sand storage silo
- Individual vertical sand flow lanes improves temperature control

BRIGHTLOOP

PROJECT PIPELINE

BRIGHTLOOP™ PROJECT PIPELINE

B&W is actively developing a diverse pipeline of hydrogen production opportunities beyond the initial projects in Louisiana and Wyoming

Project – Feedstock	1st Phase H_2 TPD	2nd Phase H_2 TPD	NTP	COD	Industry	Stage	Commentary
Baton Rouge, Louisiana – **Biomass**[1]	15	200	2023	2024	Transportation Fuels	Contract Negotiations	• Site adjacent to Grön Fuels project for production of renewable aviation fuel
Black Hills Energy (BHE), Wyoming – **PRB Coal**	15	200	2023	2024	Power Gen	Feasibility Study	• Facility will be located next to existing gas turbine power plant; H_2 would be blended with existing gas supplies
Alberta, Canada – **Natural Gas / Petcoke**[2]	15	240	2023	2025	Oil Refining & Upgrading	Feasibility Study	• Techno-economic analysis completed by 3rd party; front-end engineering design kicked-off
Navajo Transitional Energy Company, Wyoming – **PRB Coal**	3	200	2023	2024	Chemicals and Fuels	Project Development	• Consortium lead by NTEC developing natural resources refining facility which is anchored by BrightLoop
NRG Power, South Korea – **MSW**[2]	TBD	TBD	2024	2025	Power Gen	Project Development	• NRG developing hydrogen fuel cell power plant for electricity generation
Port Anthony, Australia – **Biomass**	6	100	2024	2025	Transportation Fuels	Project Development	• Plant expected to be part of largest green hydrogen hub in southeastern Australia

1. *Plant expected to run on natural gas for first few months of operations before transitioning to biomass for duration of operations*
2. *Plant CAPEX anticipated to be funded directly by customer / developer.*

Note: PRB = Powder River Basin; MSW = Municipal Solid Waste.

Advanced development projects *Early stage projects*

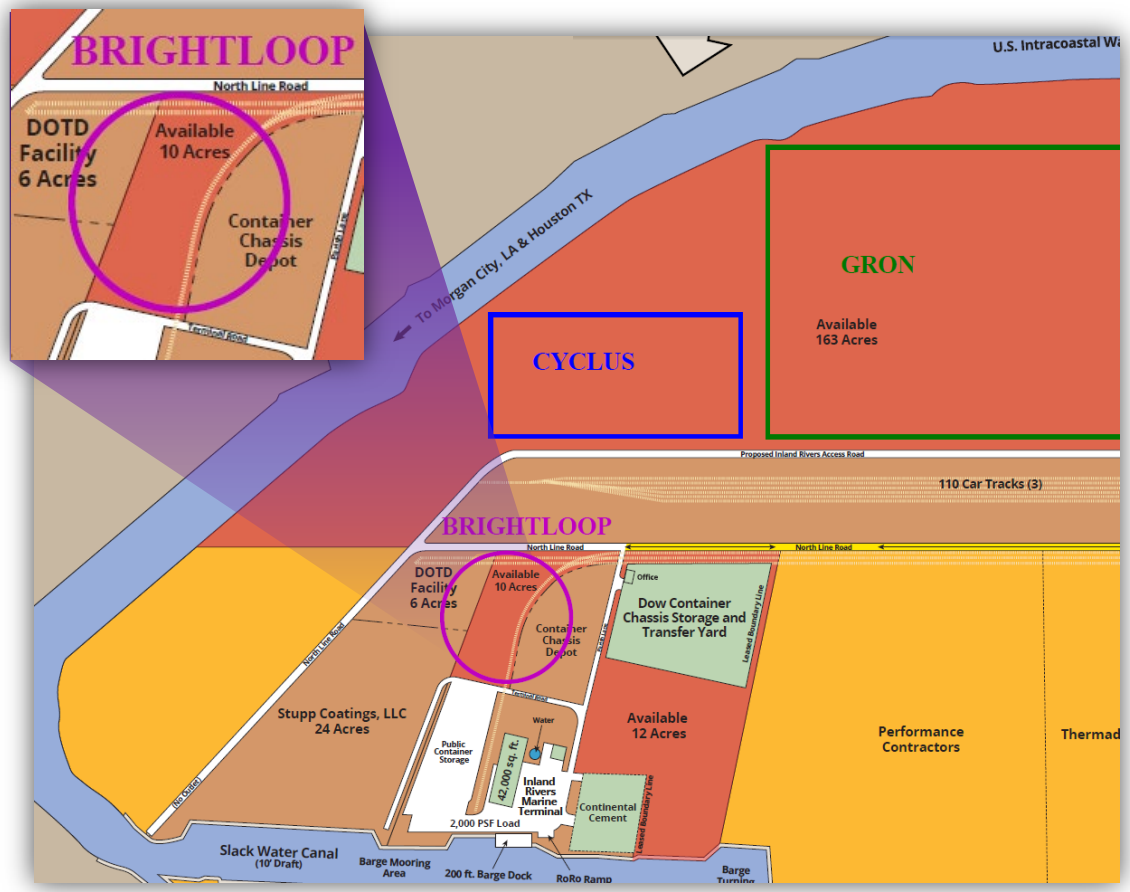
BRIGHTLOOP™ AT BATON ROUGE, LA

Economy

- ✓ High-potential H_2 and CO_2 off-takers
- ✓ Local and diverse industries with varying needs for decarbonization
- ✓ Local jobs and economy boost
- ✓ Showcase plant for the world

Site

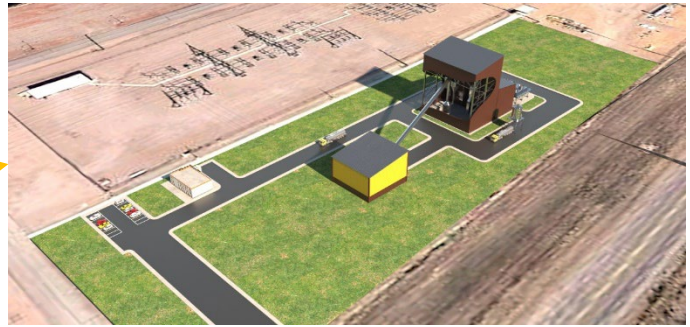
- ✓ Biomass availability
- ✓ Local geological carbon sequestration
- ✓ Barge access with truck and rail options
- ✓ Required land and utilities available
- ✓ 4 acres required for Phase 1
- ✓ Additional land available for expansion

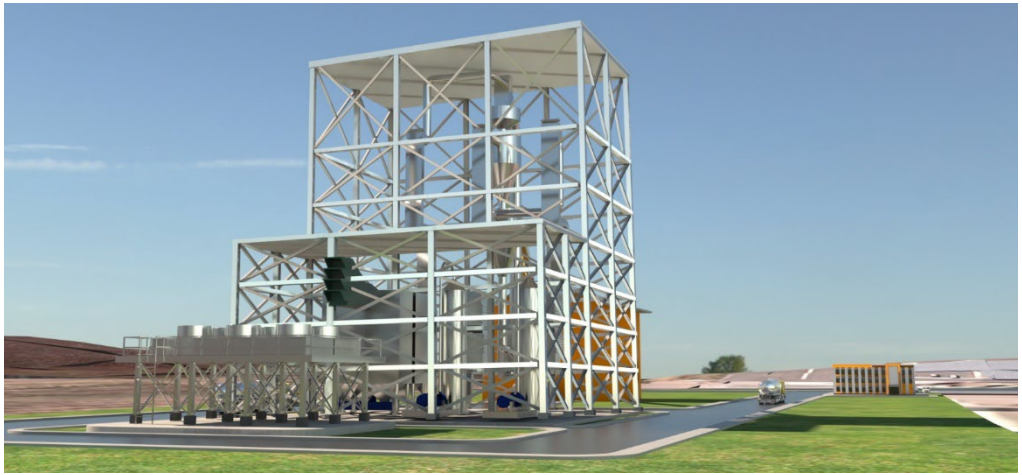


BRIGHTLOOP™ AT BATON ROUGE, LA

BRIGHTLOOP™ AT GILLETTE, WY

Black Hills Energy Renderings

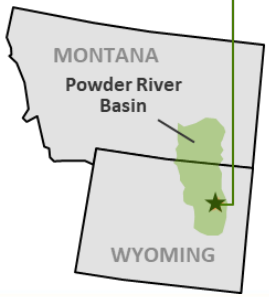




SITE ADVANTAGES:

- Local partner BHE Energy and state of Wyoming very supportive
- Carbon crushing and handling facility
- Ready for development adjacent existing power plant
- Power, water and utilities
- Extensive rail network to markets
- Just outside Gillette, Wyoming
  - Skilled energy industry workforce
  - Extensive vendor/contractor base
  - Positive permitting and construction environment

SITE
Powder River Basin "PRB" is the largest source of low cost carbon in the U.S.

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