



# **HIGH PRESSURE REGENERATION AMINE SYSTEM FOR CCUS IN BLUE HYDROGEN APPLICATIONS**

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Technologies Workshop**

# This is Dow

Every answer starts with asking the right question.

At Dow, these questions and the pursuit of solutions for the world's toughest challenges inspire us to collaborate and use our materials science expertise to create innovative solutions that transform our world and deliver a sustainable future.



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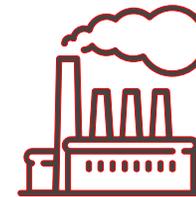
**34,600**



GLOBAL REACH

**29 countries**

in which Dow manufactures products

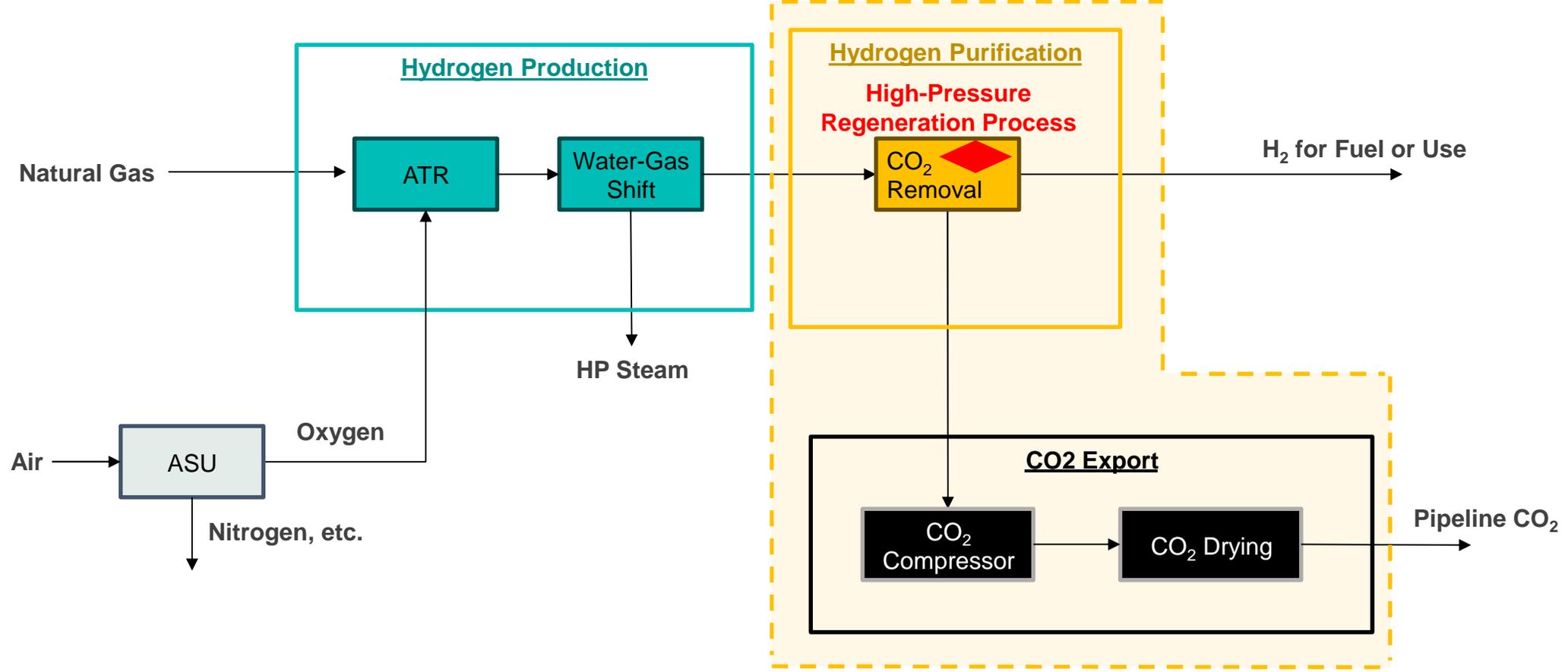


GAS TREATING EXPERTISE

**~75 Years of proven performance**

Note: All data as of December 31, 2025

# Blue Hydrogen Process with Dow's High-Pressure Regeneration Process (HPR)



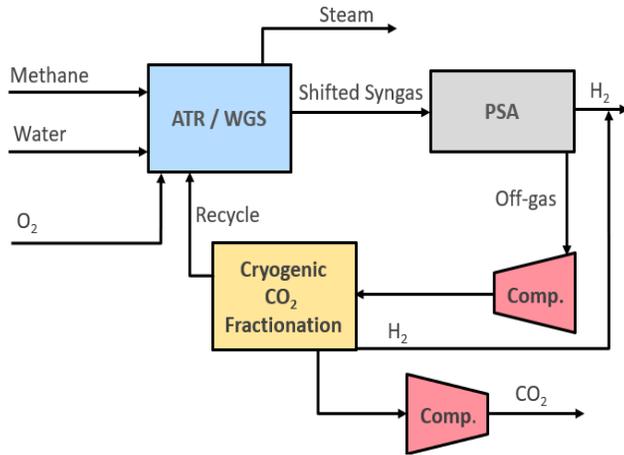
Dow's High-Pressure Regeneration Process (HPR) Process scope includes CO<sub>2</sub> removal as well as compression & dehydration



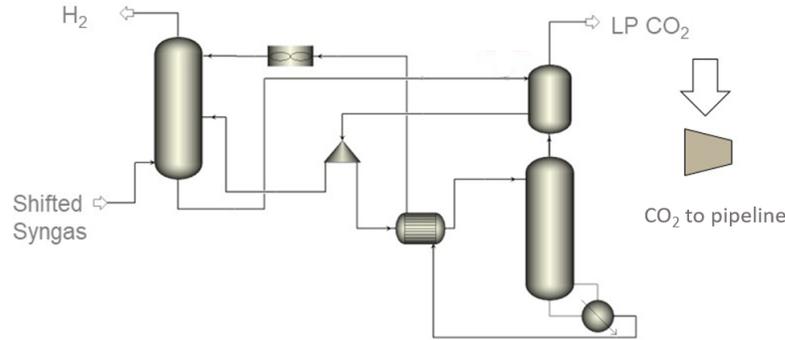
# Key Technologies for Blue Hydrogen Production CCUS

COMMERCIALY AVAILABLE AT SCALE

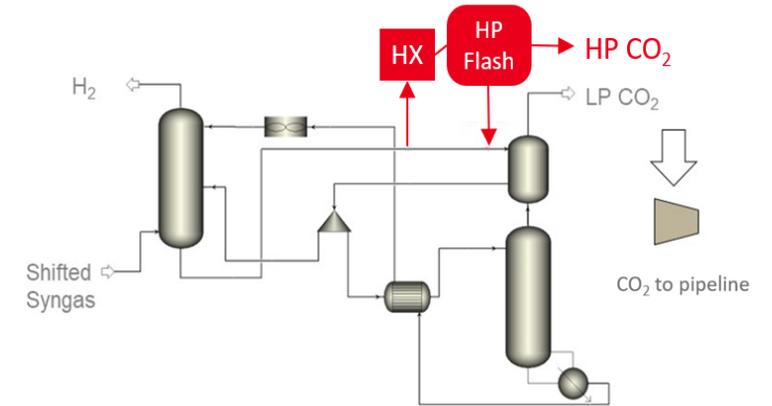
## PSA-Cryo Process



## Conventional Amine Processes

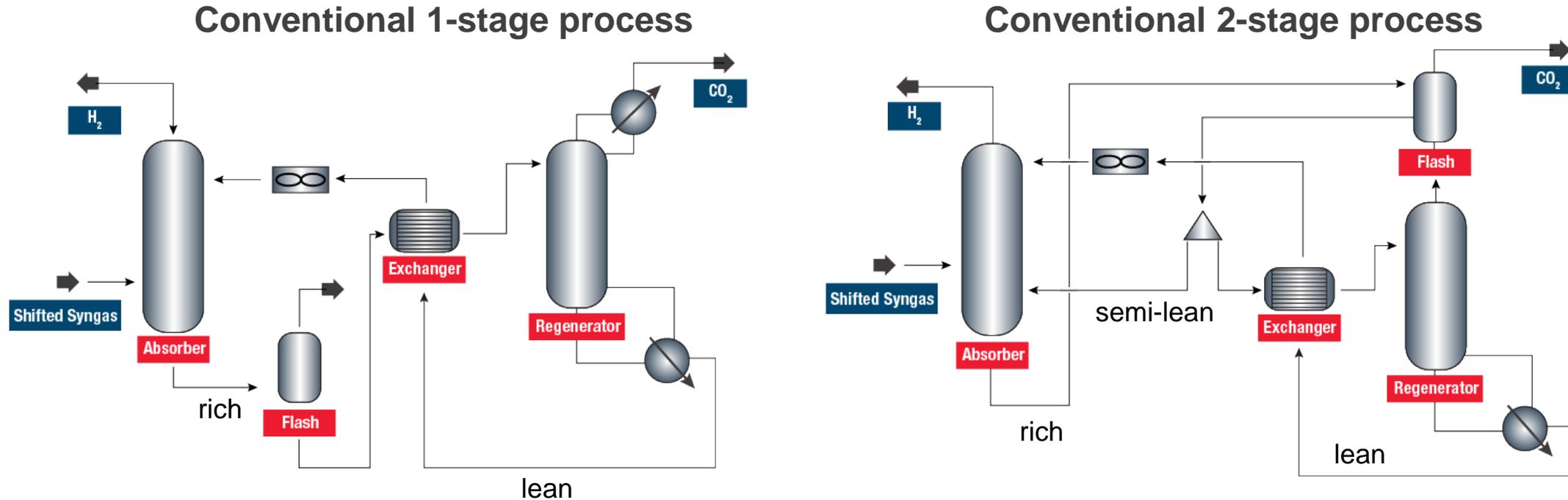


## High-Pressure Regeneration Process (HPR)



Technology providers	Multiple licensors	Major solvent vendors	
Pros	Modularity, high-purity H <sub>2</sub> and CO <sub>2</sub>	Flexible designs enable lower steam usage / power consumption	Flexible design options, lower power, lower capital Greatly reduced compression costs.
Cons	High power consumption, large footprint.	Large vessel sizes, Lower purity H <sub>2</sub> and CO <sub>2</sub>	Lower purity H <sub>2</sub> and CO <sub>2</sub>
CAPEX / OPEX	<p>↑ OPEX: High power consumption</p> <p>↑ CAPEX: Large equipment costs</p>	<p>↓ OPEX: Moderate power consumption</p> <p>↑ CAPEX: Large equipment costs</p>	<p>↓ OPEX: Lower compression power and solvent rate</p> <p>↓ CAPEX: Smaller compressor and amine unit size</p>

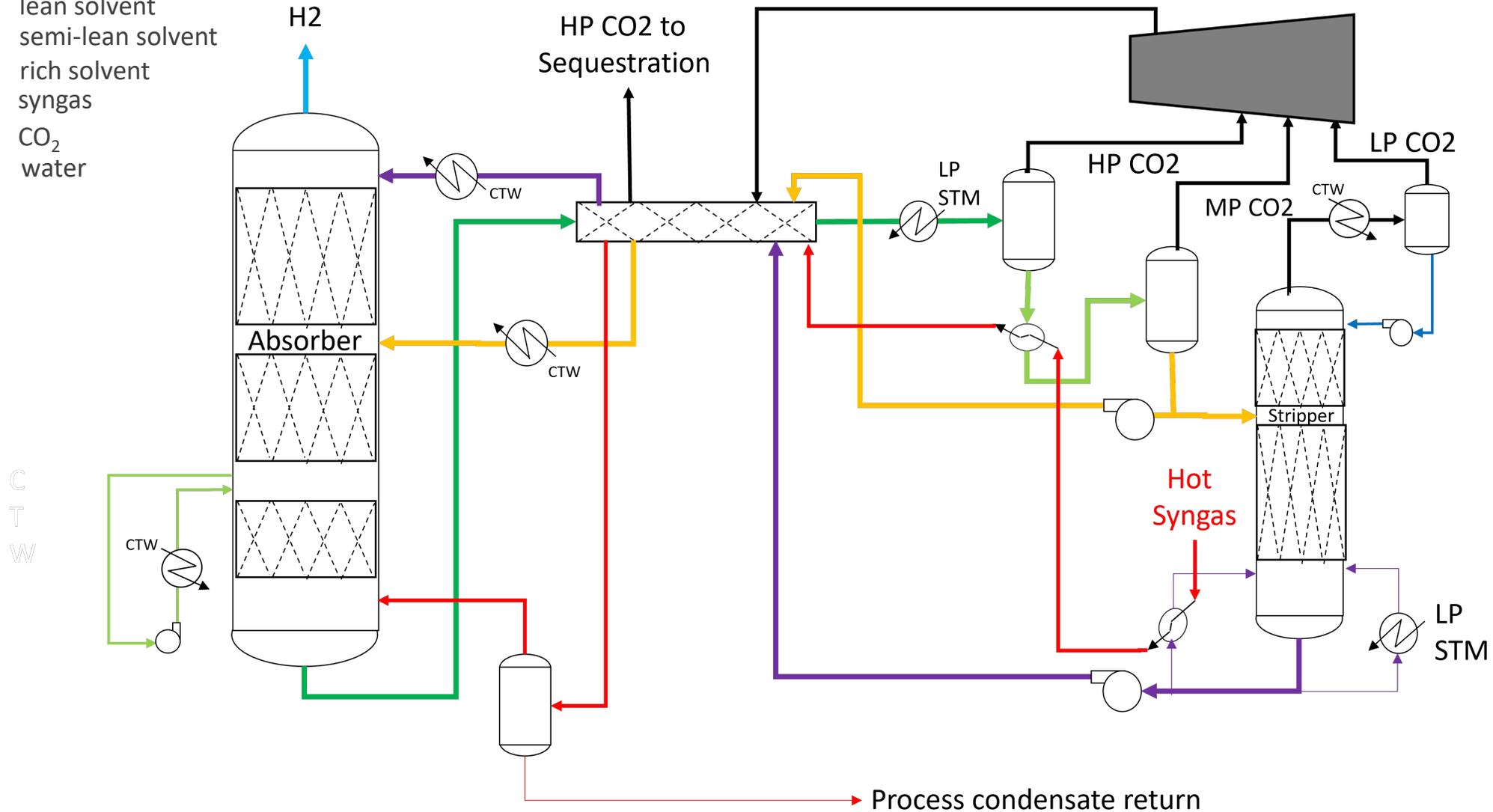
# Conventional Gas Treating Designs



- Conventional gas treating designs established for CO<sub>2</sub> removal in H<sub>2</sub> applications for many decades.
- The 1-stage process offers the lowest capital costs but requires high steam usage.
- The 2-stage process offers significantly reduced steam usage but requires higher capital costs
  - This is especially true in blue H<sub>2</sub> applications, as the circulation rates grow exceptionally high due to the high CO<sub>2</sub> content of the feed gas

# Dow's High-Pressure Regeneration (HPR) Process

- lean solvent
- semi-lean solvent
- rich solvent
- syngas
- CO<sub>2</sub>
- water



# Key Features of the Dow's High-Pressure Regeneration (HPR) Process

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1. High-pressure delivery of CO<sub>2</sub>
  - > 50% of the CO<sub>2</sub> product is delivered from the high-pressure flash at ~15 bar(a), reducing compression power
  - The low-pressure (LP) regenerator is operated at 3 bar(a), reducing LP compression costs
2. Low circulation rates
  - Syngas heat integration greatly reduces circulation rates to ~1/3 of conventional two-stage designs
    - → significant reduction in absorber ID as well as other vessel sizes, lowering capital costs
3. All unit operations are well-proven in gas processing applications
4. Known, commercialized chemistries (solvent is not new to gas treating)
  - Optimized solvent with multiple references in related applications operating today
  - Preferred solvent is specially formulated for its enhanced ability to flash CO<sub>2</sub>
  - All operating conditions are within the known operating window for the solvent
  - Solvent replacement costs are small relative to operational savings in power consumption

# Case Study

Shifted Syngas		
Property	Units	Value
Pressure	bar(a)	23
Temperature	°C	155
Flow rate	Nm <sup>3</sup> /hr	571300
Composition		
Water	mol-%	24.7
Hydrogen	mol-%	55.7
Carbon Dioxide	mol-%	18.7
Carbon Monoxide	mol-%	0.6
Methane	mol-%	0.3

← Basis is a shifted syngas after WGS and heat recovery

Three process designs are compared:

1. Conventional 1-stage
2. Conventional 2-stage
3. Dow's High-Pressure Regeneration Process (HPR)

Key outputs are compared, including:

1. Total power + power lost,  $w_{tot}$ , which is defined as

$$w_{tot} = w_{pump} + w_{comp} + w_{lost}$$

where  $w_{lost}$  is lost power due to steam usage

2. Absorber, HX, pump, and compressor capital

Assumptions and specifications for all processes:

1. Design to a CO<sub>2</sub> specification of 100 ppmv in the treated H<sub>2</sub> gas
2. Syngas waste heat is used to drive the reboiler to the extent possible; remaining duty is LP steam
3. Conventional designs do not use syngas waste heat after the reboiler
  - Cooling duty is reported but impact on electrical and capital are not included in comparison so as not to penalize for this assumption

# Key Results

Parameter	Units	Conventional 1-stage	Conventional 2-stage	HPR Design
Solvent Circulation Rate	m <sup>3</sup> /hr	1720	6939	2745
Absorber ID (bottom)	m	4.2	6.1	4.9
Absorber ID (top)	m	3.6	3.1	2.6
Cooling Duty	MW <sub>t</sub>	213	165	149
Steam Duty	MW <sub>t</sub>	83.0	32.8	22.6
Operating Power Consumption				
Pump Power	MW	1.5	5.8	1.9
Power Recovered	MW	0	-2.2	0
Compression Power	MW	18.7	19.0	11.1
Power Lost (Steam usage)	MW	18.2	7.2	4.9
<b>Total Power + Power Lost</b>	<b>MW</b>	<b>38.4</b>	<b>29.8</b>	<b>17.9</b>

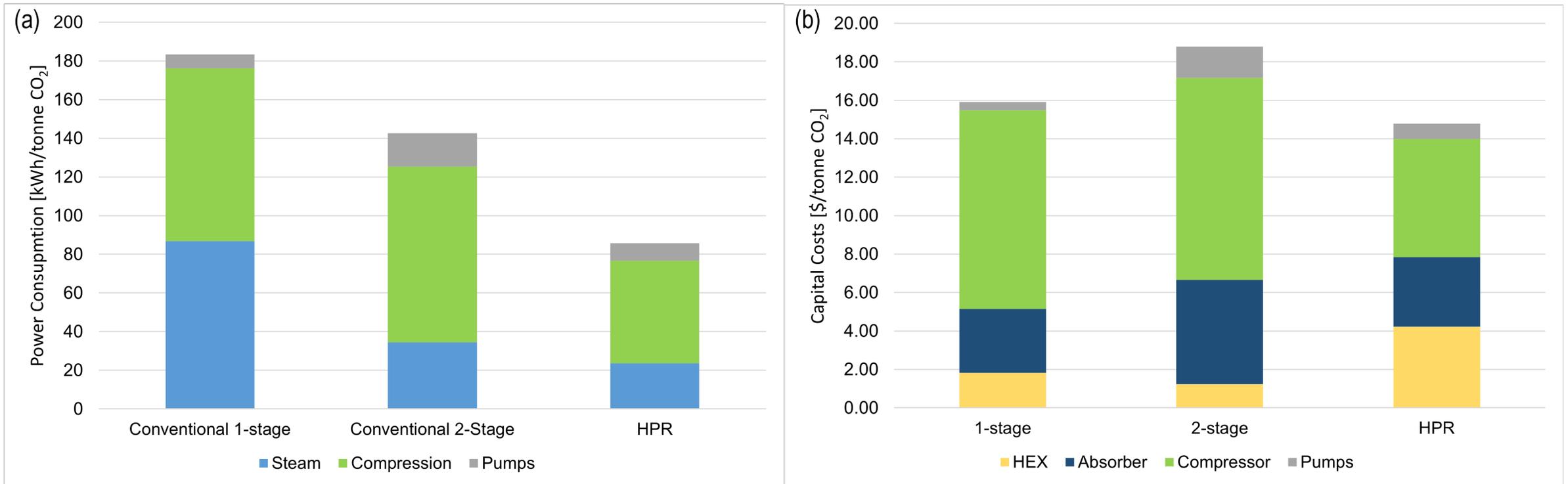
HPR vs. 2-stage

60% rate reduction

Reduced abs. ID, HX added

40% reduction in compression and total power +

# Impact to Operating, Capital, and CCS Costs



- Dow's High-Pressure Regeneration (HPR) Process offers a 40% reduction in OPEX vs. 2-stage and >50% vs. 1-stage:
  - Driven primarily by reduced compression power consumption, also lower steam usage
- The increased capital for HX in HPR is more than offset by reduced absorber and compressor capital

The HPR process offers significant reduction in OPEX without increasing capital compared to conventional designs

# Carbon Dioxide Product Composition

Carbon Dioxide to Pipeline				
Property	Units	1-stage	2-stage	HPR
Temperature	°C	40	40	40
Pressure	bar (a)	180	180	180
Flowrate	tonnes/hr	209	209	209
Composition (dry)				
Carbon Dioxide	mol-%	99.810%	99.100%	99.620%
Hydrogen	mol-%	0.187%	0.883%	0.370%
Carbon Monoxide	mol-%	0.002%	0.007%	0.002%
Methane	mol-%	0.002%	0.008%	0.007%

HPR vs. 2-stage

Lower circulation rate leads to lower H<sub>2</sub> co-absorption

Additional features can be added to further reduce co-absorption and generate higher purity CO<sub>2</sub>

# Conclusions

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**Dow's High-Pressure Regeneration (HPR) Process is a new offering for reducing carbon capture costs in Blue H<sub>2</sub> production:**

1. Licensed process covering amine unit scope + compression and dehydration
2. Upwards of 40% reduced compression costs and overall power consumption
3. Greatly reduced circulation rates, reducing absorber diameter and capital as well as other equipment
4. Relies on an established, proven solvent combined with an optimized process for heat recovery in blue hydrogen applications.

Dow is actively working on cases for HPR implementation!  
Please contact us for more information.





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