
airovation
technologies
Supports the Blue
H2

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THE COLORS OF HYDROGEN

GREEN

Hydrogen produced by electrolysis of water, using electricity from renewable sources like wind or solar. Zero CO_2 emissions are produced.

BLUE

Hydrogen produced from fossil fuels (i.e., grey, black, or brown hydrogen) where CO_2 is captured and either stored or repurposed.

GREY

Hydrogen extracted from natural gas using steam-methane reforming. This is the most common form of hydrogen production in the world today.

PURPLE/PINK

Hydrogen produced by electrolysis using nuclear power.

TURQUOISE

Hydrogen produced by thermal splitting of methane (methane pyrolysis). Instead of CO_2, solid carbon is produced.

BROWN/BLACK

Hydrogen extracted from coal using gasification.

YELLOW

Hydrogen produced by electrolysis using grid electricity from various sources (i.e., renewables and fossil fuels).

WHITE

Hydrogen produced as a byproduct of industrial processes. Also refers to hydrogen occurring in its (rare) natural form.

Applied Economics Clinic

The amounts of hydrogen produced today

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- In recent years an increasing number of countries have committed to achieving net zero emissions. By April 2022 131 countries covering 88% of global greenhouse gas emissions had announced net zero targets.
- Anthropogenic emissions have already led to a global temperature increase of 1.1°C compared to pre-industrial levels.
- There is a broad understanding that net zero by 2050 is imperative to increase the chances of keeping this temperature increase to within 1.5°C.
- This renewed focus means that emissions from all the energy end uses need to be mitigated.
- While energy efficiency, electrification and renewables can achieve 70% of the mitigation needed, hydrogen will be needed to decarbonize end uses where other options are less mature or more costly, such as heavy industry , long-haul transport and seasonal energy storage. Considering these applications, hydrogen could contribute

10% of the mitigation needed to achieve the IRENA 1.5°C Scenario and 12% of final energy demand.

https://www.irena.org/Energy-Transition/Technology/Hydrogen#:~:text=Hydrogen%20is%20produced%20on%20a,of%20a%20mix%20of%20gases

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The amounts of hydrogen produced today

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Hydrogen is produced on a commercial basis today

it is used as a feedstock in the chemical industry and in refineries ,

as part of a mix of gases in steel production, and in heat and power generation.

Global production stands at around **75 MtH2/yr** as pure hydrogen and an additional

45 MtH2/yr as part of a mix of gases.

This is equivalent to 3% of global final energy demand and similar to the annual energy consumption of Germany.

https://www.irena.org/Energy-Transition/Technology/Hydrogen#:~:text=Hydrogen%20is%20produced%20on%20a,of%20a%20mix%20of%20gases

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Supporting Blue hydrogen production

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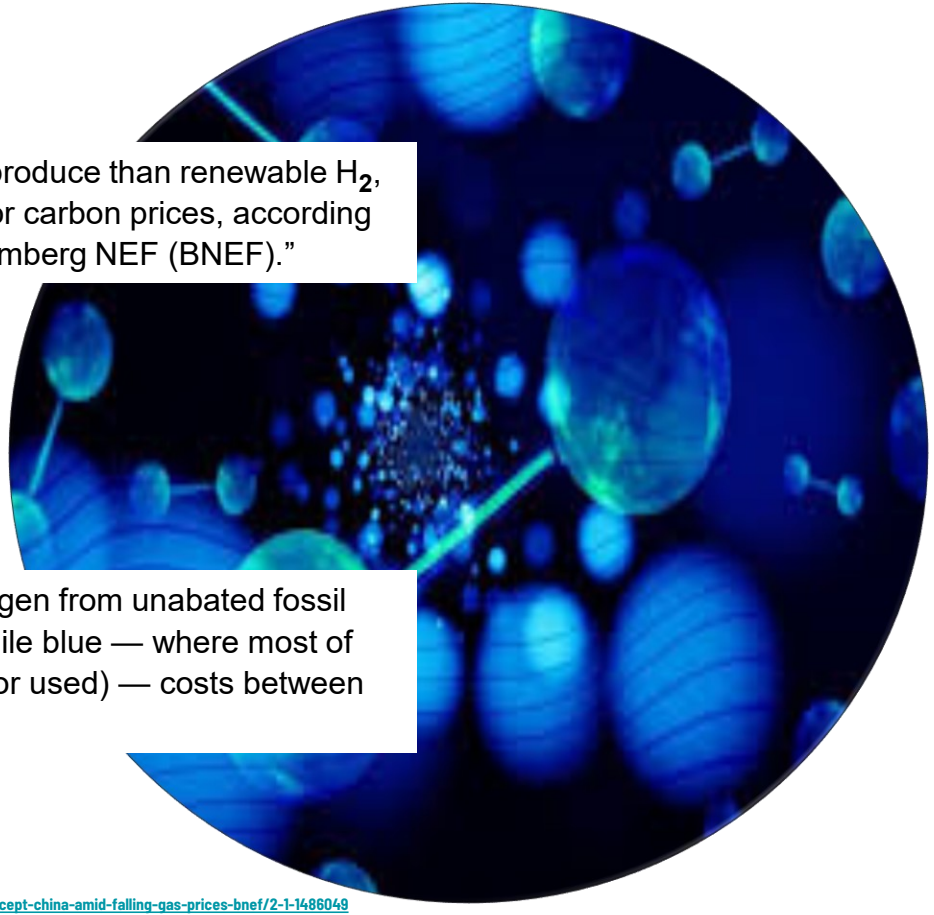


"Blue hydrogen is currently 59% cheaper to produce than renewable H_2, on average, when not factoring in subsidies or carbon prices, according to a recent update from research house Bloomberg NEF (BNEF)."

"The levelized cost of producing grey hydrogen from unabated fossil gas this year ranges from $0.98-2.93/kg while blue — where most of the CO2 produced is captured and stored (or used) — costs between $1.80-4.68/kg."

https://www.hydrogeninsight.com/production/blue-hydrogen-cheaper-than-green-h2-in-all-markets-except-china-amid-falling-gas-prices-bnef/2-1-1486049

Airovation's profitable CCUS solution converts **point-source CO_2 emissions** into **carbon-negative chemicals,** enabling the **production of blue hydrogen** at a competitive price, while **significantly impacting the environmental and carbon footprint** of hard-to-abate industries such as the fertilizer, concrete and steel

https://www.hydrogeninsight.com/production/blue-hydrogen-cheaper-than-green-h2-in-all-markets-except-china-amid-falling-gas-prices-bnef/2-1-1486049

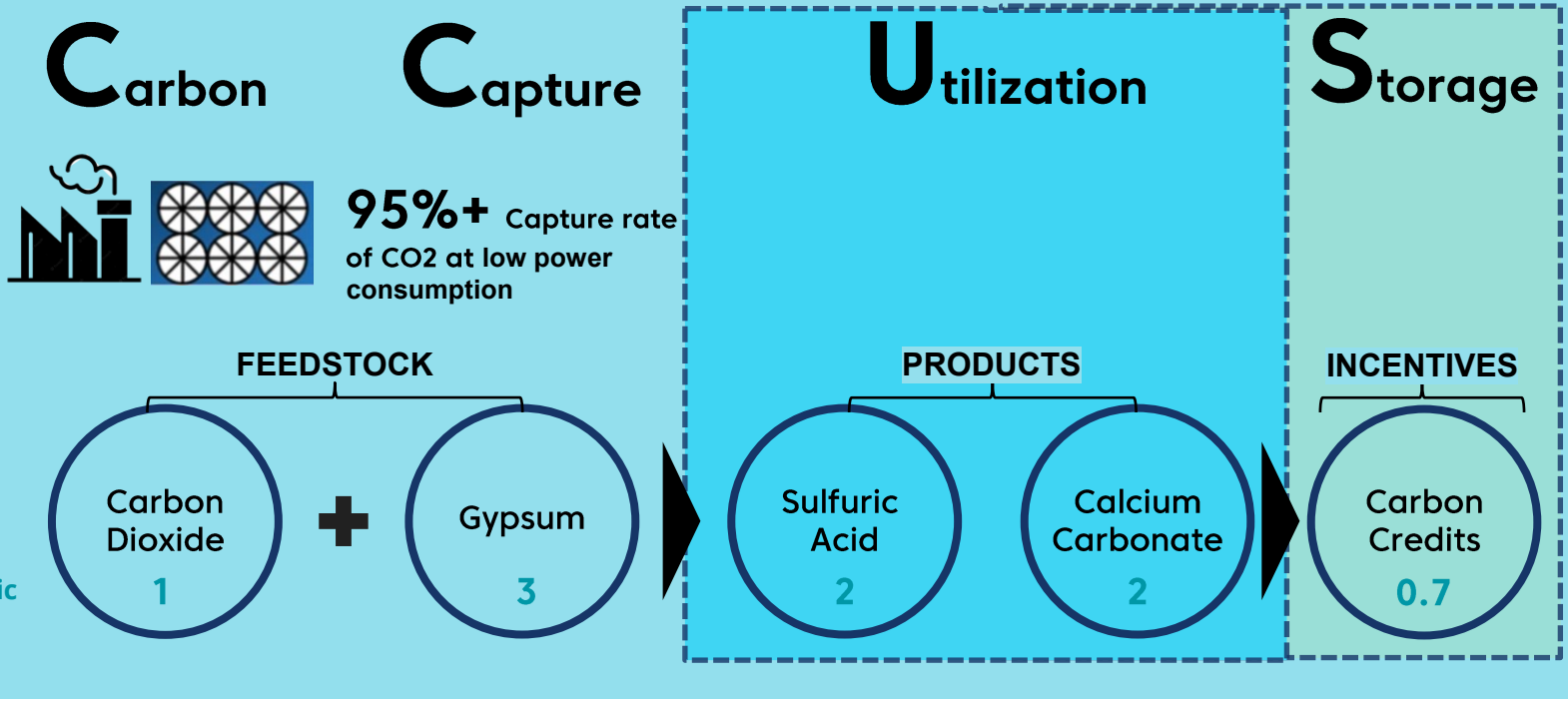
Target Markets

Early Adopters

	Fertilizer	Energy & Hydrogen (1)	Cement Concrete & Steel	Plastics & Paper
				
Massive Markets:	• **USD 285 billion by 2032 with growth rate (CAGR) of 3.30%** • **650** fertilizer manufacturing businesses in the USA • **120** production sites in the EU	• **$262 billion by 2031, growing** • **at a CAGR of 6.8%** • **130** refineries in the USA • **85** refineries in the EU	• **100** cement mills in the USA • Accounts for **30%+** of USA industrial CO_2 emissions	• **13,000** chemical facilities and **950** plastics manufacturing facilities in the USA
The Airovation Advantages:	✓ Use **Phosphogypsum waste** as feedstock – and solve major environmental challenge ✓ Produce **on-site decarbonized** sulfuric acid & calcium-carbonate	✓ **Turn the Gray to Blue** ✓ **2x** value of **grey Hydrogen** ✓ **Produce and sell** valuable carbon-negative products	✓ **1.2x** value for decarbonized steel ✓ **Produce and sell** valuable carbon-negative products	✓ Produce **on-site decarbonized** calcium-carbonate ✓ **Produce and sell** other valuable carbon-negative products
Additional Upside:	*Avoid penalties that can amount to **$100/mt** CO_2 per year*			

Sources: IBIS World, Petrochemical Industry Associations, EIA, US EPA, European Environment Agency.
(1) Steam methane reforming (SMR), which is responsible for ~95% of the global hydrogen production (Science Direct)
https://www.alliedmarketresearch.com/hydrogen-generation-market
https://www.precedenceresearch.com/fertilizer-market#:~:text=The%20global%20fertilizer%20market%20size,USD%2099.85%20billion%20in%202022.

Leverage Point Source CO2 towards profitable utilization



Our Unique Technologies

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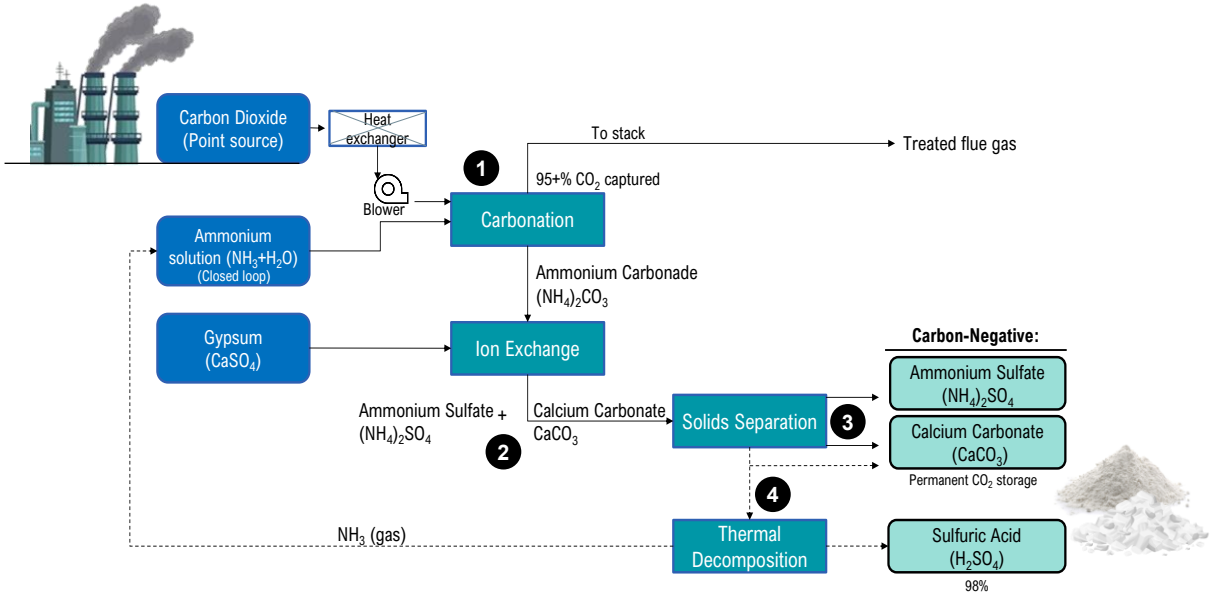
Illustrative Processes



Carbonation Tech

1. Flue gasses containing CO_2 are **captured at Point Source** and injected into our reactor

The CO_2 reacts with ammonia in a **proprietary 95%+ carbonation process** to form ammonium carbonate

Mineralization Tech

2. Further reactions in a second reactor, using gypsum to form **carbon-negative ammonium sulfate** and **calcium carbonate**

3. Dry process make minerals ready for sale

Thermal Decomposition

4. Recycle ammonia and produce **carbon-negative sulfuric acid** and **calcium carbonate**

Path to Commercialization

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Leading the way

Getting global interest

In-House Pilot
100
tons CO_2 per year

Field Pilot
1,000-2,500
tons CO_2 per year

Commercial
30-40K
tons CO_2 per year

1st Commercial Facility
100K
tons CO_2 per year

ICL

ICL

TOYOTA TSUSHO

TOYOTA TSUSHO

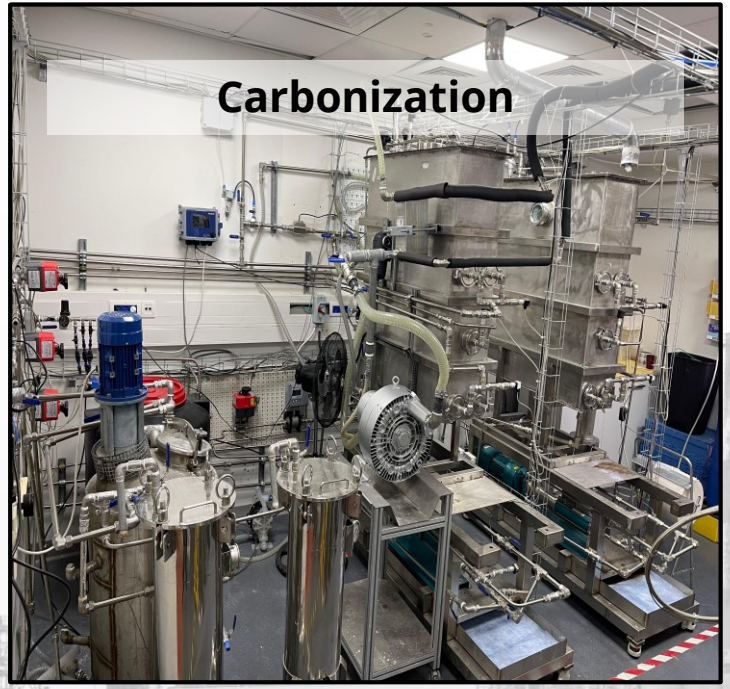
ENEOS

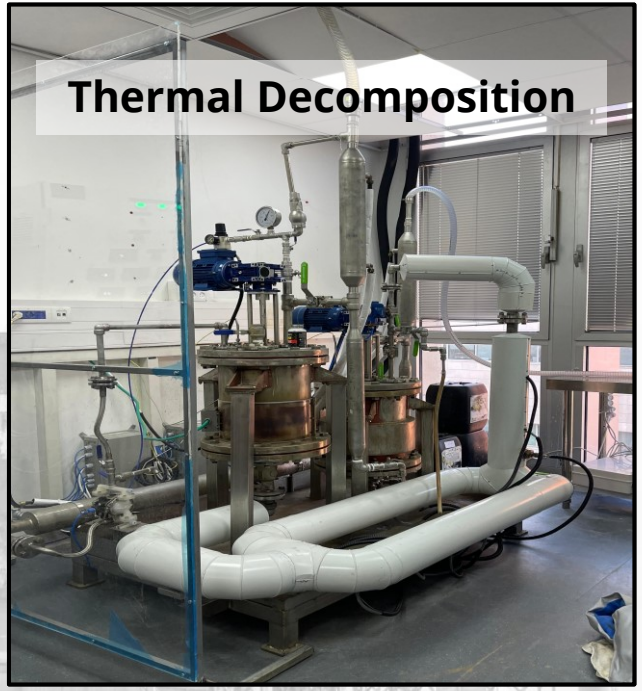
Marubeni

HALLIBURTON LABS

In-House Pilot Facility

100
tons CO_2 per year





Phosphogypsum Feedstock

Israel Dead Sea- ICL

Korea Yeosu- Namhae Chem

~280M tons	Global Phosphogypsum waste stacked *every year*
>1B tons	Phosphogypsum waste currently stacked in *Florida*
>7B tons	Phosphogypsum waste currently stacked *around the world*

VISION: blue hydrogen valley

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Blue Hydrogen & Wasteless Phosphate Fertilizer Ecosystem

Fertilizer Plant

2 mt/y Phosphogypsum

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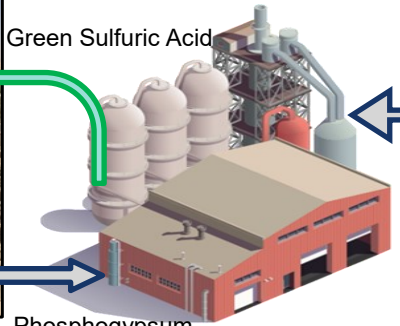

SMR/ H2 Provider

80kt/y H_2 = 680kt/y CO_2

Hydrogen

80 kt/y H_2

$4/k H_2

$320M

Carbon monetization

Calcium Carbonate

1.4 M/t/y Green sulfuric acid	**$120M**
1.45 M/T/Y Green Calcium carbonate	**$35M**
476 K/T/Y Carbon monetization	**$25M**

Total $500M

Sources: IBIS World, Petrochemical Industry Associations, EIA, US EPA, European Environment Agency.
(1) Steam methane reforming (SMR), which is responsible for ~95% of the global hydrogen production (Science Direct).

The need for Wasteless Phosphate Fertilizer Ecosystem - Phosphate reservoirs and Norway 70 B/Ton

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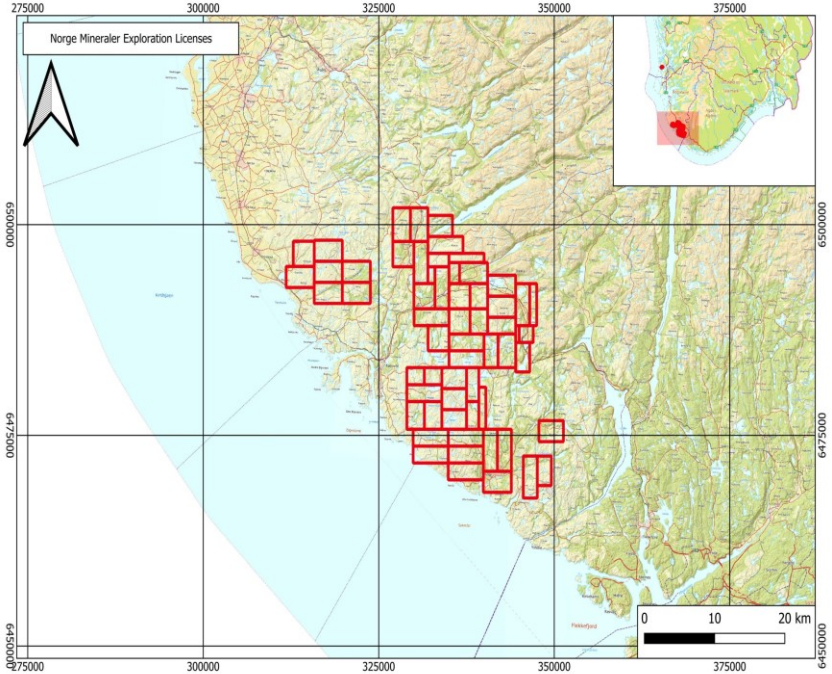

https://www.mining-technology.com/news/norway-giant-phosphate-deposit/

Attractive Levelized Unit Economics

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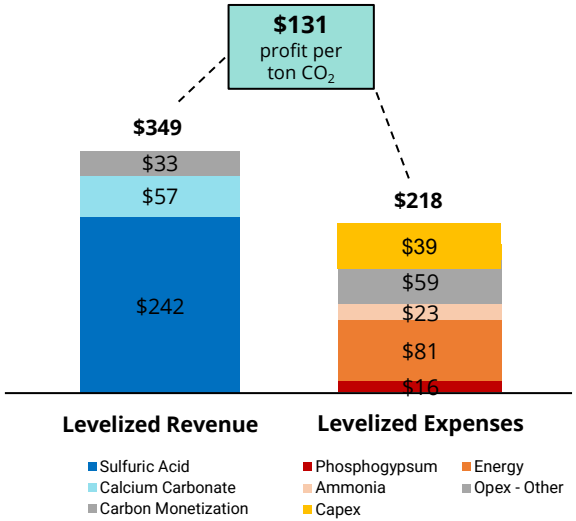
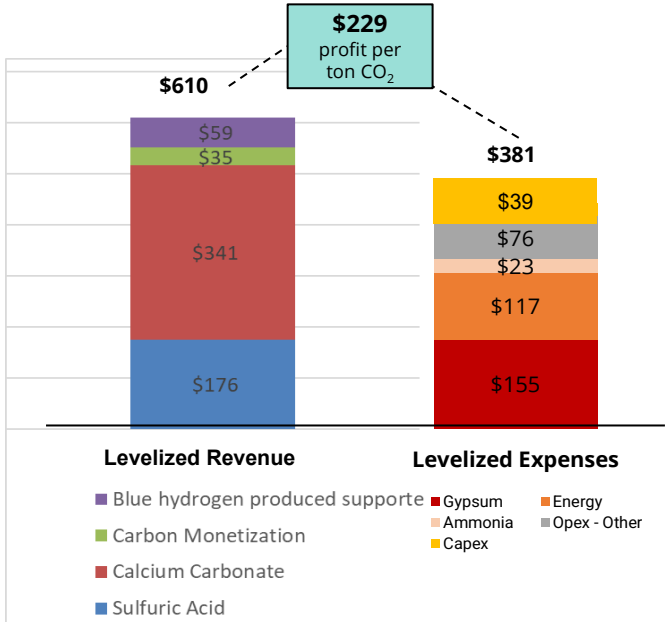
Illustrative economics per ton CO_2 captured

Phosphogypsum Feedstock (fertilizer ICL)



Key Assumptions:		
	Assumes 100k tons CO_2 captured annually	$110/t sulfuric acid
	17% CO_2 concentration	$25/t calcium carbonate
	$5/t Phosphogypsum	$50/t carbon monetization

Gypsum Feedstock (Blue hydrogen Japan)



Key Assumptions:		
	Assumes 100k tons CO_2 captured annually	$80/t sulfuric acid
	17% CO_2 concentration	$150/t calcium carbonate
	$50/t gypsum	$50/t carbon monetization
		$0.5/k H2

Attractive Single Plant Economics

Illustrative economics by type of feedstock

Phosphogypsum Feedstock (fertilizer ICL)

Plant Level Data	
Flue Gas Volume (M^3/hr) / % of CO_2	40,000 / 17%[1]
Carbon Captured (mt/year)	100,000
Phosphogypsum (mt/year)	310,000
Project Capex (Equity & Debt) ($M)	$55

($M)	Annual	Carbon Upside[2]
Revenues	$30.4	+$3.4
Feedstock	(12.2)	
Opex	(8.7)	
EBITDA	**$9.5**	**$12.9**

Potential **avoided penalties** of $10M per year ($100/mt)

Multiple revenue streams: Two minerals and carbon credits

Gypsum Feedstock (Blue hydrogen Japan)

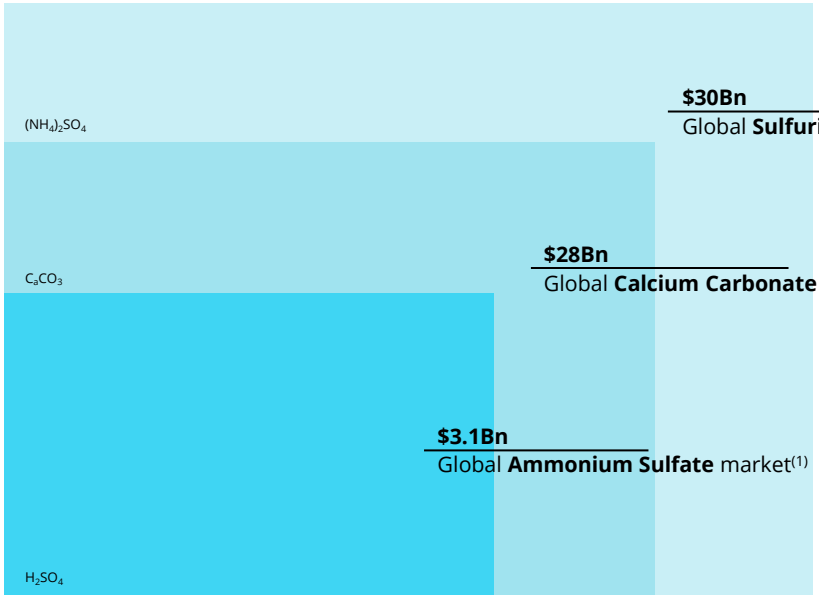
Plant Level Data	
Flue Gas Volume (M^3/hr) / % of CO_2	40,000 / 17%[1]
Carbon Captured (mt/year)	100,000
Gypsum (mt/year)	310,000
Project Capex (Equity & Debt) ($M)	$55

($M)	Annual	Carbon Upside[2]
Revenues	$50.8	+$3.4
Feedstock	(30.1)	
Opex	(10.5)	
EBITDA	**$11.6**	**$15**

(1) Plant economics vary by region, feedstock, and chosen product. (2) Assuming $50/t, per European Union Emission Trading System.

Producing Valuable Products

Large and Growing Markets



$30Bn
Global **Sulfuric Acid** market(3)

- The World's most used inorganic chemical
- Primarily used to feed the world (Fertilizer) and accelerate the energy transition (metal processing – high and rapidly growing demand)

$28Bn
Global **Calcium Carbonate** market(2)

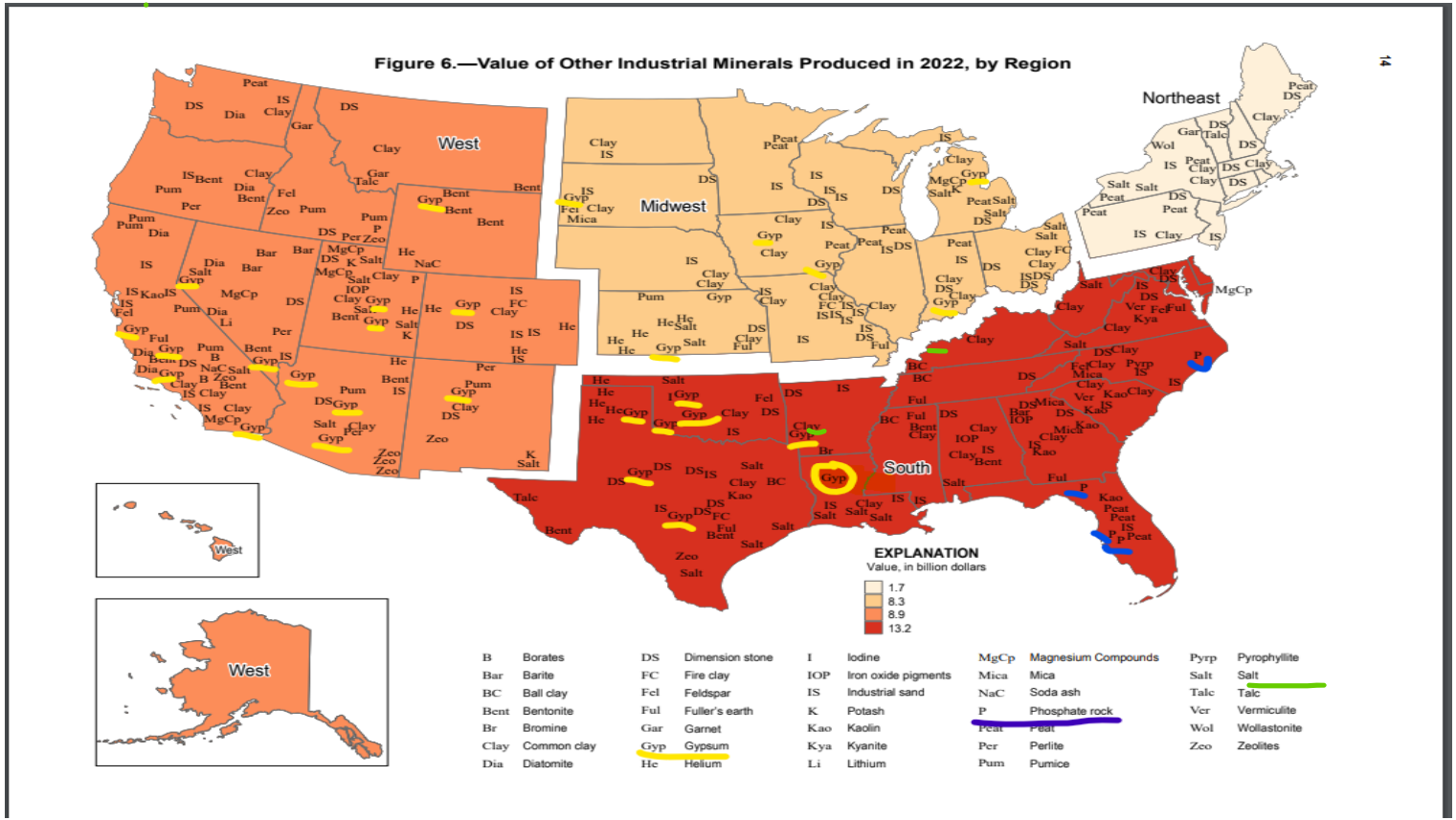
- Highly versatile chemical – mined or synthetically produced
- Primarily used in the paper & pulp, paints & coatings, construction and plastic industries
- Market is expected to continue to grow at ~5% CAGR (2023-35)

$3.1Bn
Global **Ammonium Sulfate** market(1)

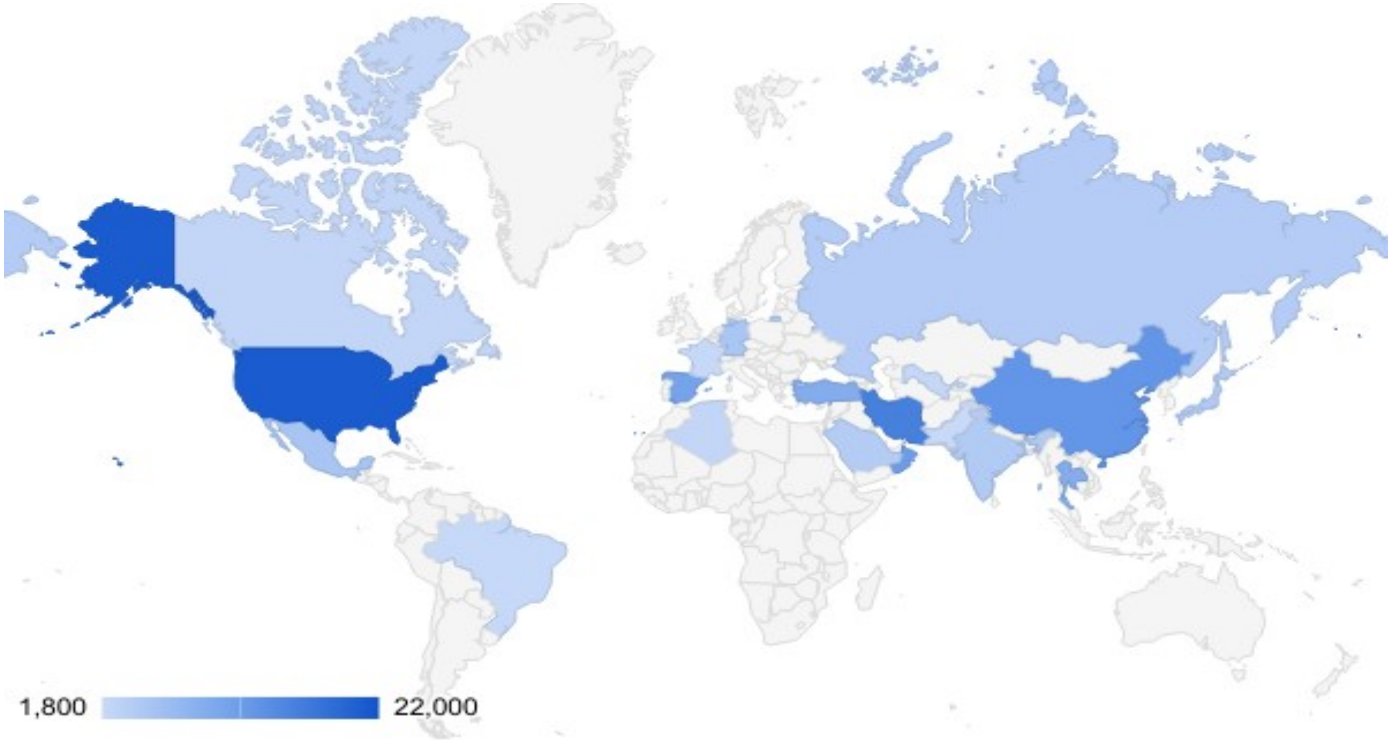
- Primarily used for formulating nitrogenous fertilizers, which are extensively used in the agricultural sector
- Also used in the pharmaceutical industry as an intermediate to fractionate and precipitate protein
- Market is expected to continue to grow at 7% CAGR (2024-30)

(1) Grand View Research, 'Ammonia Sulfate Global Market 2024-2030' report. (2) 2022 TAM Market And Markets. (3) 2023 TAM Market And Markets.

Domestic Mining of Gypsum, Phosphate Rock



Global Gypsum Production (2022)



Country	Production (thousand MT)
World	150,000
Other	22,000
United States	21,000
Iran	16,000
China	13,000
Oman	12,000
Spain	11,000
Thailand	9,300
Turkey	9,300
Mexico	5,400
Germany	5,200
India	4,300
Japan	4,300
Russia	4,100
Saudi Arabia	4,000
Algeria	2,500
Canada	2,400
Uzbekistan	2,200
Brazil	2,000
France	2,000
Pakistan	1,800

- The United States, the world's leading crude gypsum producer, produced an estimated 21 million tons in 2021
- Japan is #10, producing 4.3m tons