



# **GYPSUM WALLBOARD WASTE RECYCLING**

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- I. Gypsum chemistry.**
- II. Gypsum wallboard production.**
- III. Gypsum wallboard waste & problems disposing.**
- IV. Gypsum wallboard waste recycling system.**
- V. Opportunities provided through processing recycled gypsum.**

# **I. Over 125 year, we have been making Gypsum wallboard.**

**valuable properties of Gypsum wallboard:**

**Light weight,**

**High strength,**

**Fire proof,**

**Sound dampening,**

**High ductility, and**

**it's convenience in installation.**

# Calcium Sulfate

**$\text{CaSO}_4 \cdot 2 \text{H}_2\text{O}$**       Calcium Sulfate dihydrate

**$\text{CaSO}_4 \cdot 1/2 \text{H}_2\text{O}$**       Calcium Sulfate hemihydrate

*These two are Key components  
in board making process*

**$\text{CaSO}_{4(s)}$**

**$\text{CaSO}_{4(is)}$**

**$\text{CaSO}_4 (is)$**

**Calcium Sulfate Anhydrite**



(CALCIUM SULFATE DIHYDRATE)



(CALCIUM SULFATE HEMI-HYDRATE)

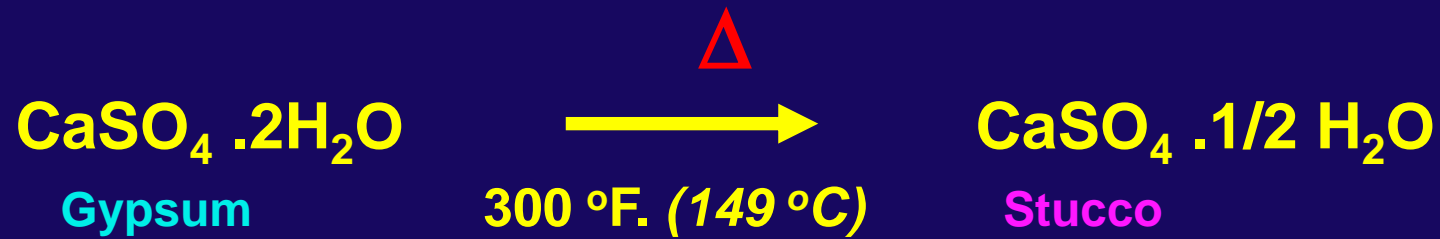
### Commercial name

- GYPSUM
- LAND PLASTER
- SELENITE
- SATIN-SPAR
- ALABASTER
- ROCK GYPSUM

- STUCCO
- PLASTER OF PARIS
- BASSANITE
- HEMIHYDRATE
- CALCINED GYPSUM

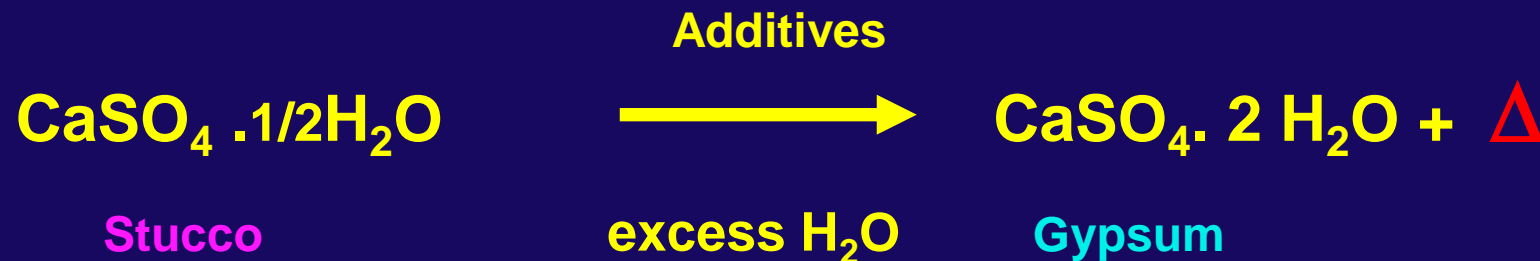
## II. Two steps are involved in wallboard production process

### 1. Gypsum rock is milled and Calcined: (Dry process)

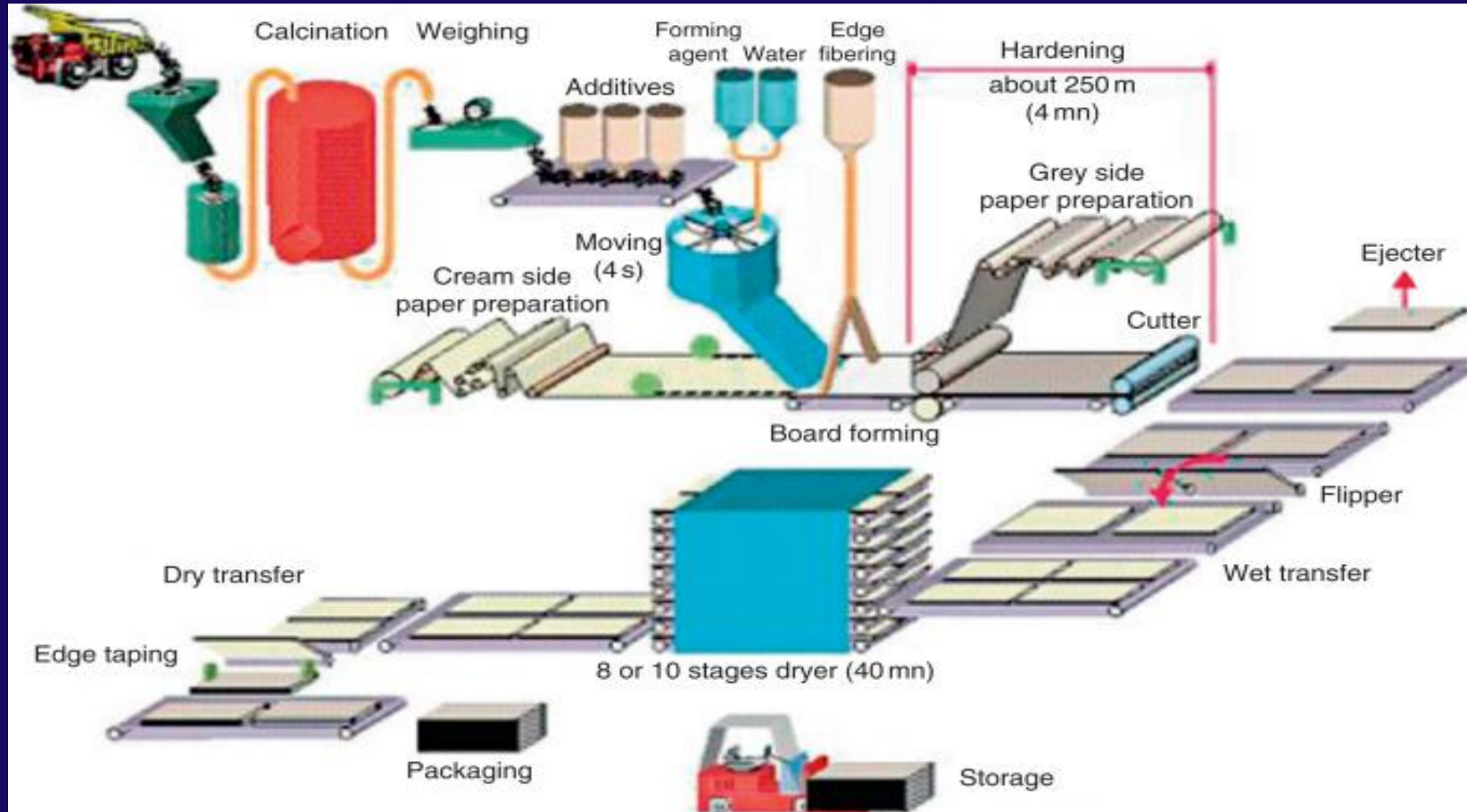


( $\Delta$  = heat)

### 2. Hydration: (Wet process)



# Gypsum wallboard production.\*



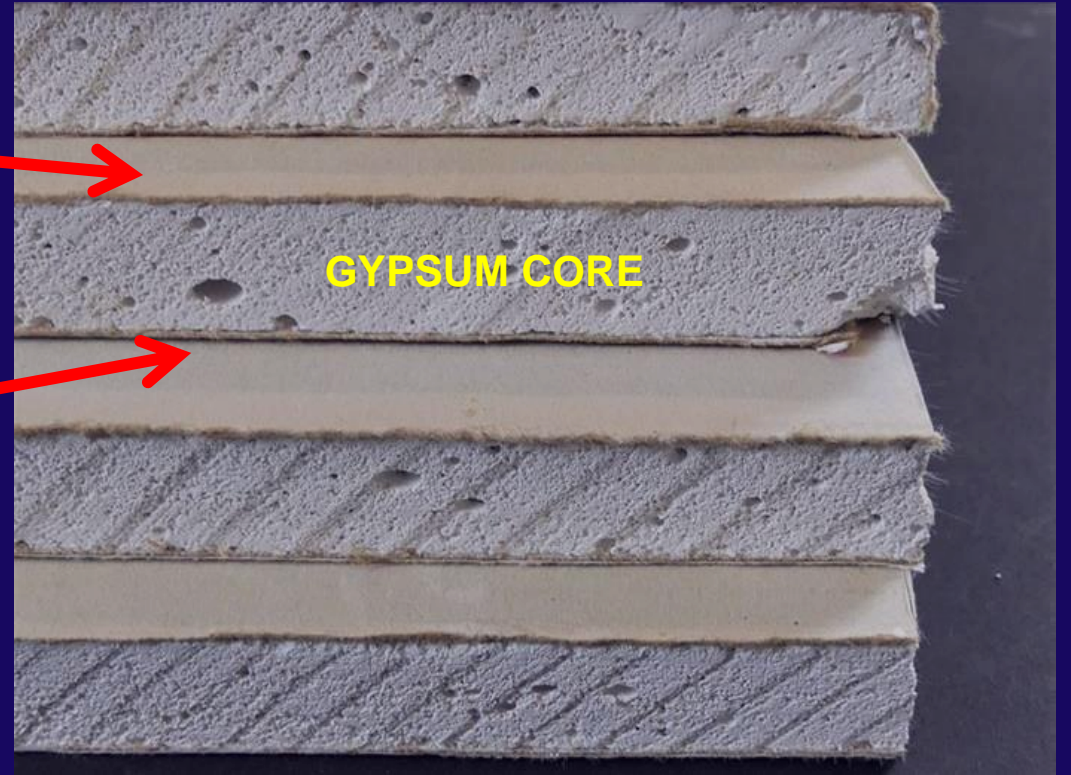
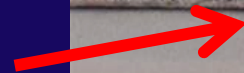
\* Science Direct 2016



Face paper



Back paper



Length		Thickness	
8'	2.43 m	1/2"	12.70 mm
12'	3.65 m	5/8"	15.87 mm
16'	4.88 m	1"	25.40 mm



# Gypsum Wallboard

Gypsum wallboard consists of

**90% to 93 % gypsum** *(depends on type of product)*

**5% paper** *(face and back paper)*

**2 % to 5% various raw materials\***



*\* (RETARDER, DISPERSANT, SURFACTANT, DEXTROSE, POTASH, PAPER, ACCELERATOR, STARCH, POLYMER, WAX EMULSION / SILICONE, TARTARIC ACID, VERMICULITE, FIBER GLASS, etc.*

**There are about 500 gypsum wallboard plants.**

**78 countries produced gypsum wallboard in 2021.**

Mine production of natural gypsum rock (million tons)*	2020 yr.	2021 yr.
World total	144	150
US	21.2	23
Australia	>3.5	4.0

**US produced 34 billion sqft\*\* (3.16 B m<sup>2</sup>) wallboard in 2021**

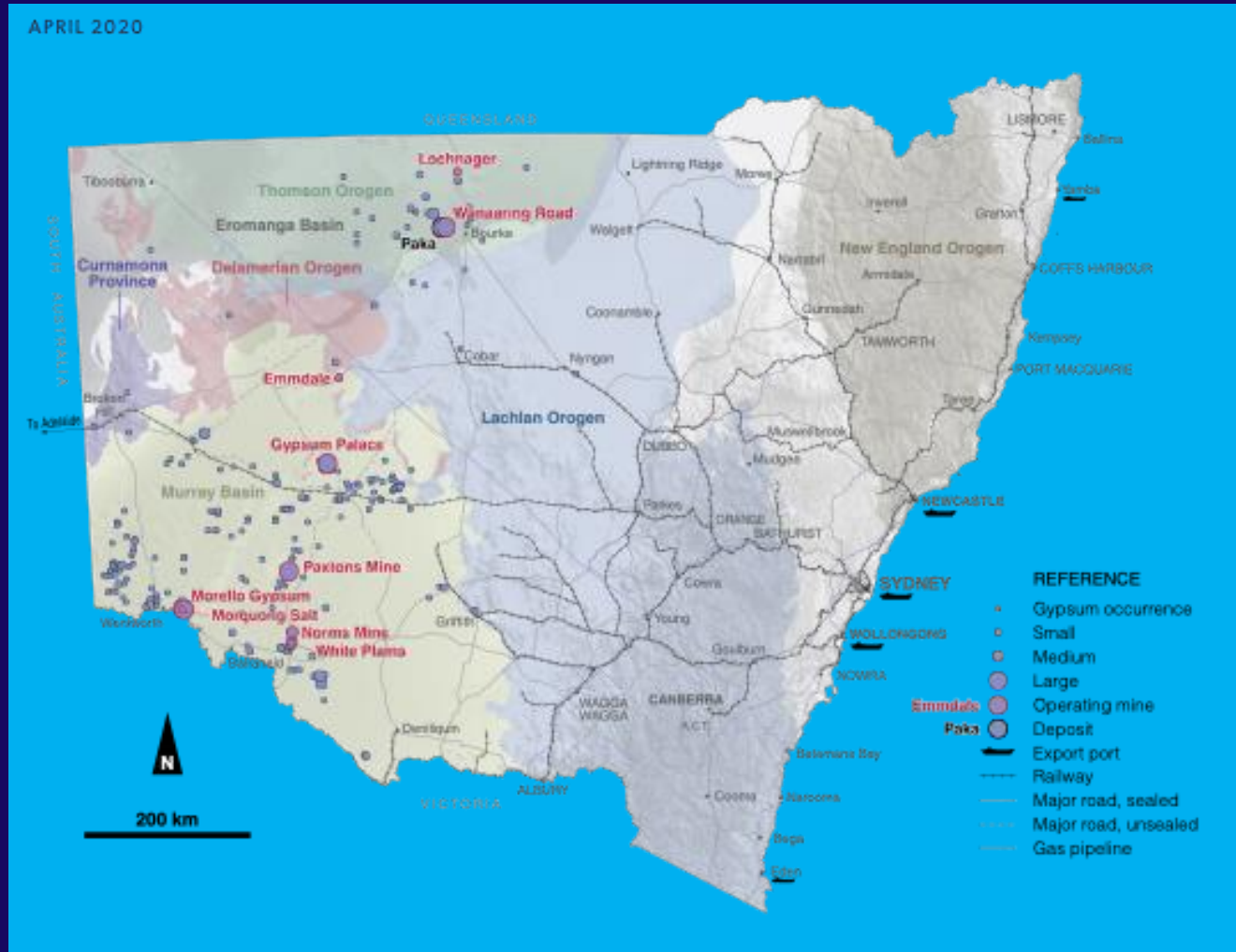
US (million tons)*	2020 yr.	2021 yr.
mined natural gypsum rock	21.2	23,
FGD	13	13
Import	6	6.9
<b>Total usage</b>	<b>40.2</b>	<b>42.6</b>

**\*\*Divide sqft. by 10.76 to get sqm**



*\*U.S. Geological Survey, Mineral Commodity Summaries, January 2022*

# Major Gypsum deposits in Australia are in New South Wales.



## Gypsum wallboard production in the U.S. (2021)

- **Over 28 million tons of wallboard sold**
- ***34 billion sqft\*\* (3.16 B m<sup>2</sup>).***

Recycling: Approximately 700,000 tons of gypsum scrap that was generated by wallboard manufacturing was recycled onsite. The recycling of wallboard from new construction and demolition sources also took place, although those amounts are unknown.

**\*\*U.S. Geological Survey, Mineral Commodity Summaries, January 2022**

### III. Gypsum wallboard waste generators.

<b>New constructions</b> <i>(residential/commercial)</i>	<b>64%</b>
<b>Demolition</b>	<b>14%</b>
<b>Manufacturing</b>	<b>12%*</b>
<b>Renovation</b>	<b>10%</b>

## Key issues related to Gypsum Wallboard Waste.

- **Hydrogen sulfide gas may produced when landfilling due to the following conditions.**

*moist condition - humidity*

*anaerobic environment*

*pH (acidic condition)*

*(...biological reactions can occur that have the potential for adverse environmental impacts.)*

- **Wallboard waste occupies most space in the landfill.**
- **Tipping fee.**

*Some landfills do not accept gypsum waste due to these issues.*

*H<sub>2</sub>S gas is toxic at high concentration ~1000 ppm is toxic.*

## Tipping fees per Ton – Landfill.

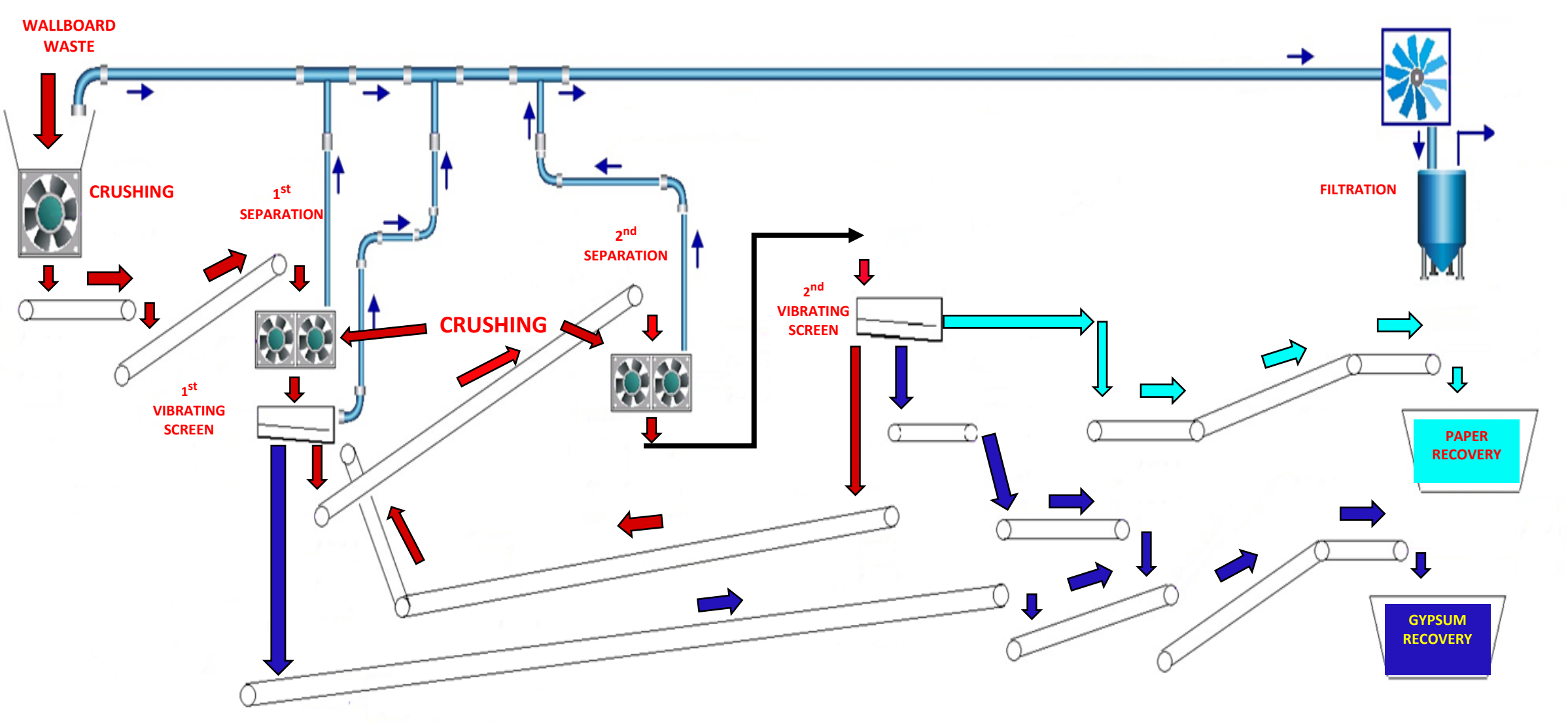
- Range between \$40 to \$120 *depends on the state and county in the US.*
- Australia: range between \$45 and \$105.
  - NSW mined gypsum costs \$15.00.
  - Agriculture Gypsum \$ 85 - \$ 200/Ton

## **IV. Gypsum wallboard waste recycling system**

- 1. Hopper - wallboard waste feed**
  - Metal/wood/plastic objects separation*
- 2. Pulverized/Crushed**
  - nails other objects separation – Magnet...*
- 3. Passed through separator (sieve) to separate paper and gypsum**
- 4. Paper separated in small pieces**
- 5. Gypsum separates as powder.**



# Normal gypsum recycling system

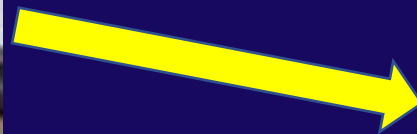


Eco Avant-Garde gypsum recycling system

# Gypsum wallboard waste



*After separation*



## **V. Existing opportunities for drywall waste.**

- **Economical opportunity**
- **Reduce the impact on Environment**
- **Innovate an efficient gypsum recycling system**



## Economical opportunity : Gypsum powder

- Gypsum powder can be recycled back in to *drywall production once most of the paper is removed.*
- It is used in soil amendment.
  - in *General agriculture* as a soil conditioner / fertilizer
  - as an additive in the production of compost
  - as an additive in soil mixtures for floriculture (*Nurseries*).
  - *Mushroom growing, Residential lawn (sod), Golf courses, athletic field marking, grease absorption.*
- *Cement Industries.*
- *Sedimentation process in water treatment facilities.*

*(Recycled Gypsum are sold \$ 85 - \$ 200/Ton)*

## Economical opportunity : Paper

- Bedding in poultry industry
- Insulation purpose
- Egg carton
- Agriculture
- Ceiling tiles, etc.

# Innovate efficient recycling systems

- Improve the output.
- Improve gypsum/paper separation.
- Portable system
  - can be separate on site,
  - currently waste samples are transported to the plant.
- Pelletization.
- Incorporate packaging system.



# Reduce the impact on Environment:

- **Eliminate Hydrogen sulfide gas formation**
  - *moist condition - humidity*
  - *anaerobic environment*
  - *pH (acidic condition)*
- **Reduce landfill issues.**



**Gypsum wallboard waste**



**After separation**

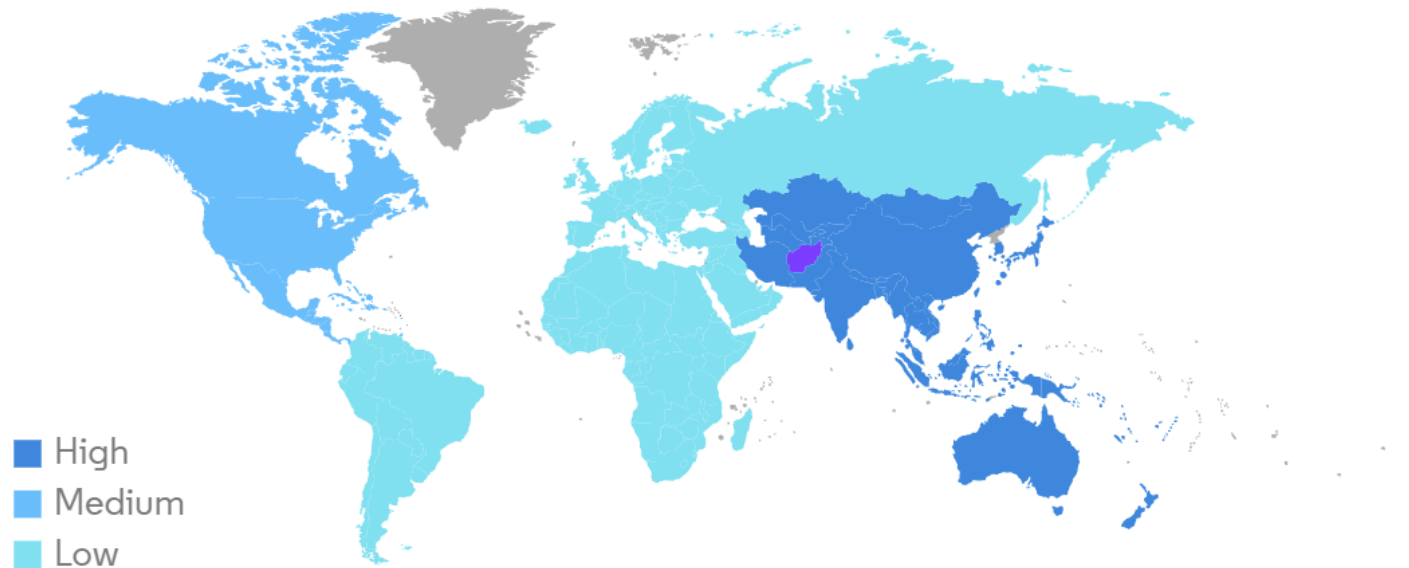


**Pelletized Gypsum powder**



# Future Outlook

Gypsum Board Market - Growth Rate by Region, 2022-2027



Source: Mordor Intelligence



**Global CAGR - 3.5 to 6%**  
*(cumulative annual growth rate)*

## Cave of Crystals – Mexico. (> 500,000 yrs)





**Thank you very much**

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