

SALTON SEA WATER IMPORTATION SUBMITTAL REVIEW

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Subject Area: Economics

Topic: Potential for marketing salt produced from desalination

This Technical Memorandum (TM) was prepared as part of the Salton Sea Water Importation Proposal Review to provide information to support and reflect the Independent Review Panel's evaluation of submitted ideas to restore the Salton Sea by water importation and provide the Salton Sea Management Program (SSMP) with approaches that are feasible. Parts of this TM may be used in the Panel's Screening Report, Fatal Flaw Report, Feasibility Report, and/or Summary Report (Reports). In the event that any discrepancies are found between the Reports and this TM, the Reports shall take precedence.

1.0 Overview of Salt Market

The total annual production of salt in the U.S. is estimated at about 42 million metric tons in 2019. As surveyed by the National Minerals Information Center, main salt uses are the following:

- Ice Control
- Chemical production
- Culinary
- Agricultural

Chemical production uses include feedstocks for chlorine and caustic soda, and products such as polyvinyl chloride (PVC). In addition to the above uses, there is also 'Boutique Salt' involving culinary "sea salt" production as well as specialty salt from brine, but these are small scale operations totaling 100 metric tons of annual production.

The share of different salt products' uses in total annual consumption is illustrated in the Figure 1:

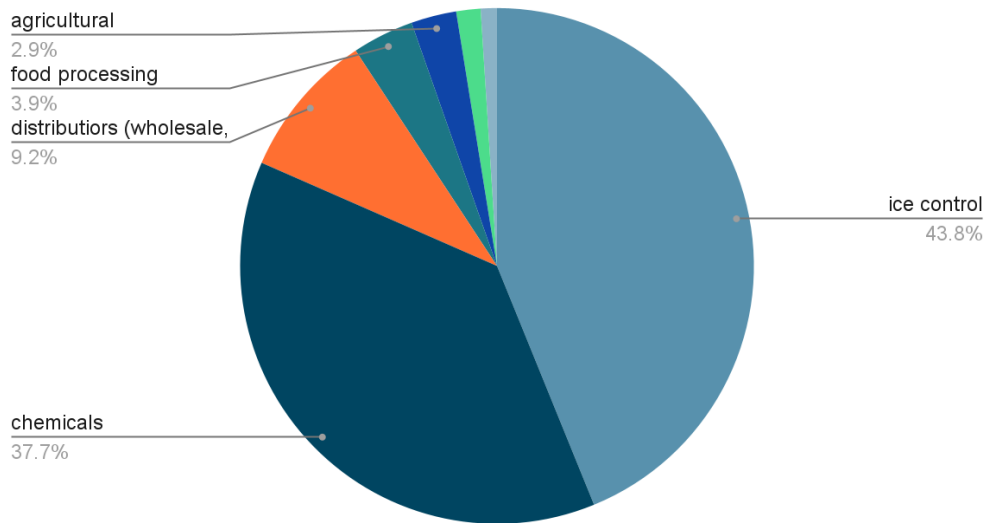


Figure 1: Distribution of salt use by total consumption (USGS 2017)

As indicated in Figure 1, much of the salt in the market is used for de-icing (which mostly takes place in the eastern part of the country) and also as feedstock to production process of chemicals, which combined, account for about 80% of total salt demand in the market (USGS 2017).

1.1 SALT TYPES

The salt products traded in the market can be categorized into the following four types: vacuum pan salt, solar salt, rock salt, and salt brine. Table 1 summarizes the information about each of these salt types.

Table 1: Commercial salt types and US market

Salt Type	Description	Production (2017) (Mt)	Capacity (2017) (Mt)
Vacuum pan salt	from mechanical evaporation of a purified brine feedstock	4.12	5.48
	virtually all domestic vacuum pan salt is obtained from solution mining of underground salt formations (even though rock salt, solar salt, and salt brine can be used to produce vacuum pan salt)		
	final product is usually flake shaped rather than the typical cubic form. Flake salt is preferred for the production of baked goods, butter, and cheese		

Salt Type	Description	Production (2017) (Mt)	Capacity (2017) (Mt)
Solar Salt	from solar evaporation of seawater, landlocked bodies of saline water, or primary or byproduct brines	3.34	5.32 ¹
	For this type of salt product, evaporation rates must exceed precipitation rates. Climatic conditions and geographic locations of solar evaporation facilities are critical to the successful production and harvesting of solar salt		
	Solar salt is often used for water softening since it's more easily dissolved [3]. This property is also used for making brine out of solar salt which subsequently is used in the chemicals production processes [4].		
Rock Salt	from surface or underground mining of halite deposits	16.5	26
	mined by the room-and-pillar method, which is similar to that used in coal and trona mining Mostly used for de-icing, hence production partly dependent on weather patterns		
Salt Brine	Can be thought of as an input for vacuum pan salt production	15.6	16.9
	solution mining of underground halite deposits		
	solution mining is used to obtain a sodium chloride feedstock for vacuum pan salt production and for chlorine, caustic soda, and synthetic soda ash manufacture chemical industry is the leading consumer of salt brine worldwide		

1. Based on the historical evaporation patterns within a region and differ depending on the location and the surface acres of the evaporation ponds

As illustrated in Table 1, there is excess capacity in production of all four types of salt in the market surveyed by the National Minerals Information Center. Figure 2 shows production and capacity of each type salt in 2017.

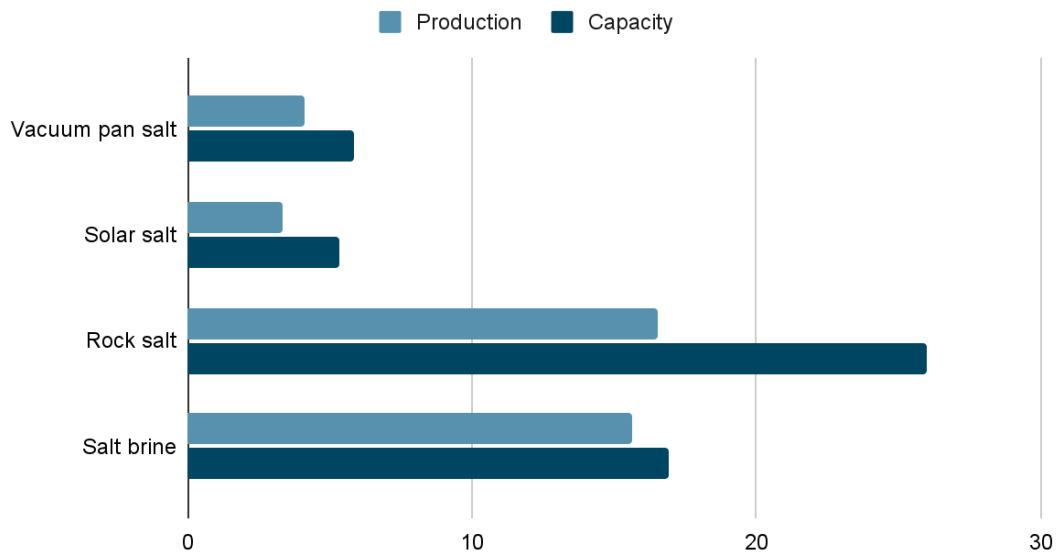


Figure 2: Salt production and capacity (million tons) in 2017 by salt type

This clearly indicates the excess capacity in all four types of salt in the market. This excess production capacity can be as large as one-third of available capacity as in the case of vacuum pan salt, solar salt, and rock salt. Existing excess capacity suggests that introduction of a new salt source to the market may be challenging.

1.2 SALT MARKET: PRICE AND VOLUME

Next, the salt market is quantified in terms of price and volume. Concretely, the share of each salt type in the market (by volume) and the price of each type is visualized. First, the following chart illustrates the (volumetric) share of each salt type in the market.

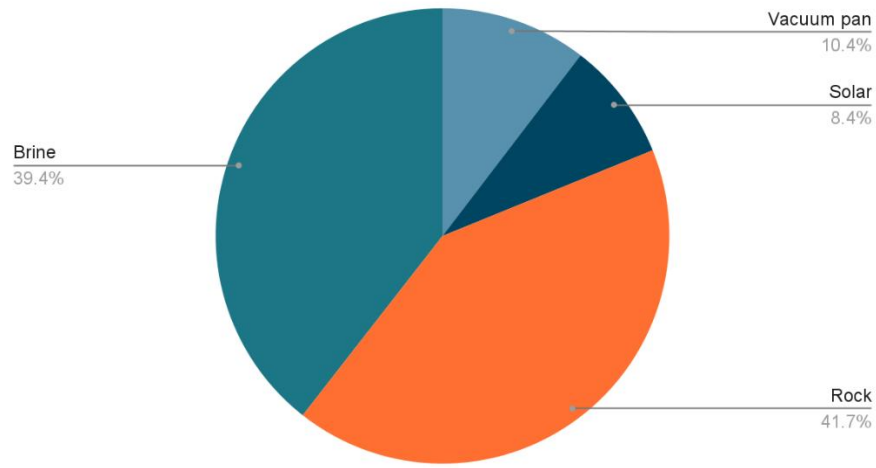


Figure 3. Share of each salt type in the US market

The chart illustrates that brine and rock salt, combined, make up over 80% of the supply in the market. Vacuum pan salt is third with about 10% and solar salt has a share of only about 8%.

Vacuum pan salt is the most expensive type of salt at over 200 \$/Mt, followed by solar salt priced at about half that and only 100 \$/Mt (Figure 4). Rock salt and brine are the cheapest salt types in the market priced at about 50 and 10 \$/Mt, respectively.

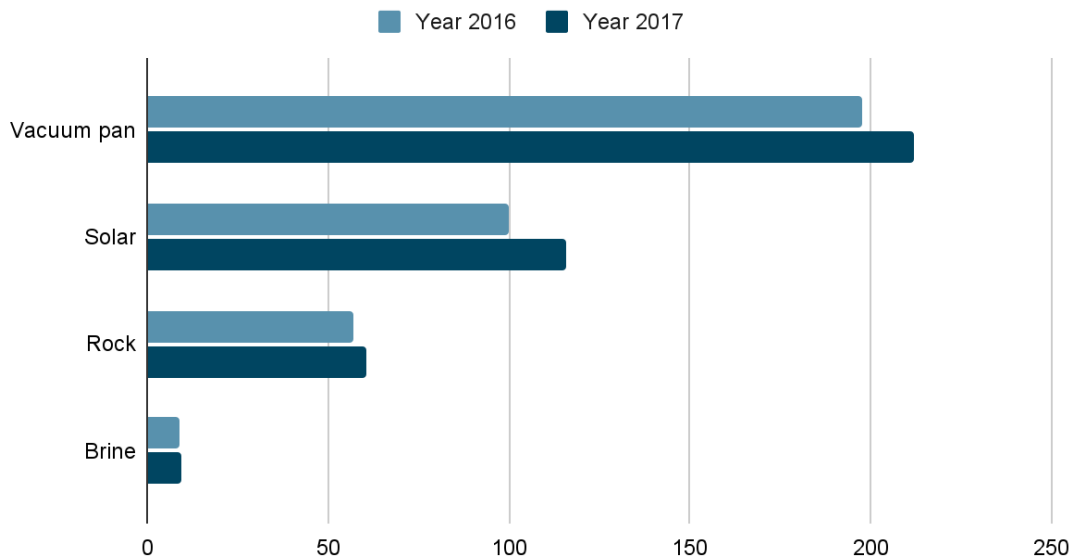


Figure 4. National average value of salt types (\$/metric ton)

One take-away from these two illustrations is that the share of salt type in the market is largely offset by the price of each type in the market. Particularly, brine and rock salt that make up over 80% of the market are priced at a fraction of vacuum pan and solar salt. Conversely, vacuum pan salt, the most expensive salt type, only claims about 10% of the market. It should also be noted that rock salt, which has the highest demand, also has the highest excess production capacity and a comparably low market price. Figure 5 shows the share of market value (price times quantity) for each type of salt.

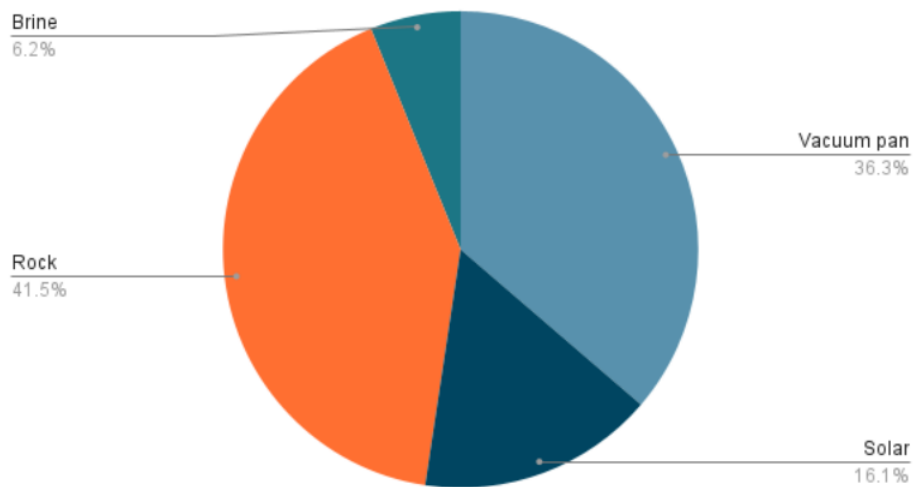


Figure 5. Share of market value by each salt type (2017)

2.0 Salt Market Growth Quantification

Figure 6 shows the production levels for different salt types in the US from 1990 to 2017 (USGS 2017; USGS 2015). Solar and vacuum pan salt have had a relatively stable production level from 1990 to 2017. These two type salts are also the most expensive (and least proliferated in the market— account for 20% of market combined) types of salt.

On the other hand, brine and rock salt (that are the cheapest and make up 80% of the market combined) have a production pattern that has been volatile at times. For brine, the cheapest salt type in the market, the long-term trend appears to be decreasing. For rock salt, the trend is less monotonic but appears to show a slight increase in the longer term. Intuitively, none of the salt types show a trend of a market that is substantially growing in size.

With a relatively constant and stable salt market in recent decades, it should not be assumed that the market will support a large influx of newly available salt (USGS 2017).

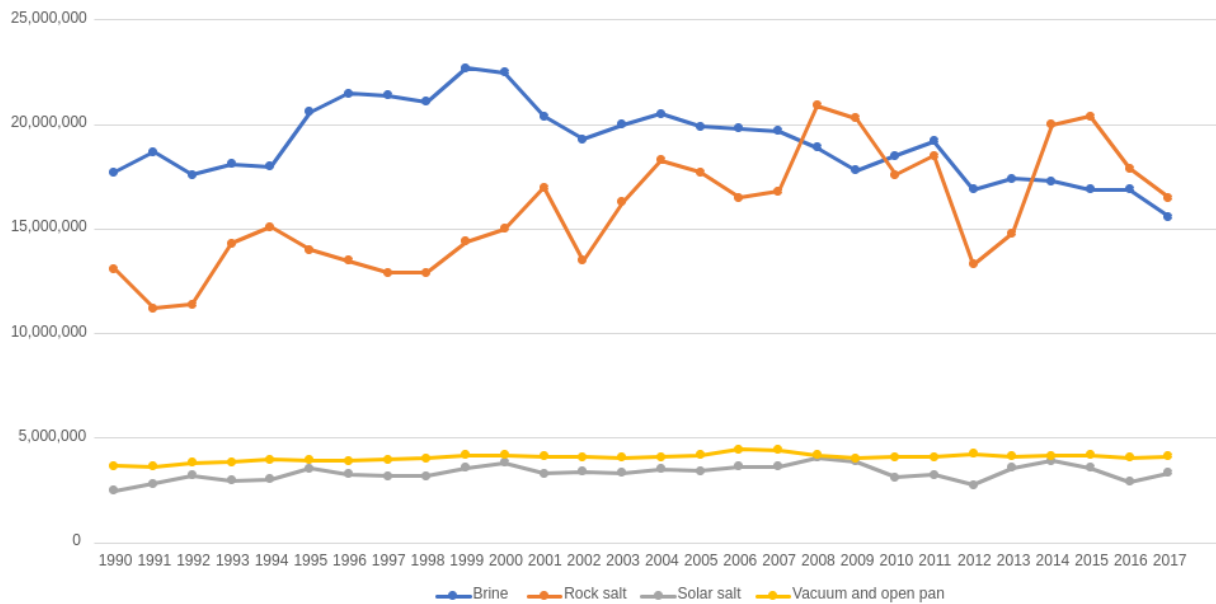


Figure 6. US salt production by type (metric tons)

3.0 Salton Sea-related salt production

Desalination of water from the ocean or the Salton Sea will produce salt, likely as a brine solution. Salt deposition at the Salton Sea is about 4 million metric tons a year through the existing inflows. Import of seawater would result in between 20 to 100 million metrics tons per year depending on the flow of imported seawater. For comparison, the existing total US salt production of about 40 million metric tons annually.

To date, brines from existing desalination facilities have not been a source for commercial salt markets due to the presence of other constituents and the salt’s lack of purity. Furthermore, much of the brine produced domestically is used in the chemical production industry that is mostly located in the Gulf region. Shipping costs would therefore be a significant challenge in the sale of brine produced at the Salton Sea. The most likely market segment in which salt production from Salton Sea could participate is solar salt.

A number of responses mention salt sales as a source of revenue generation. R2 assumes an annual \$48M revenue from salt sales but does not mention salt type or production quantity (or technology). Assuming this is solar salt, the most viable option as discussed earlier, considering the price and market share of solar salt in the US salt market, it would be equal to about 13% of the total market value for solar salt. R8 proposes an annual sale of 3 million tons of sea salt which roughly equals the total US production of solar salt (see table above). R9 includes 2 to 8 million tons of solar salt which, compared with the current total market supply of 3 million tons, would be two-thirds to over twice current levels

of solar salt production. This response also considers refined salt productions ranging from 0.5 to 6 million tons of refined salt which would be about 10 to 150 percent of current market size for vacuum pan salt. Note, however, that vacuum pan salt is primarily produced from solution mining brine used as input [1,4]. R13 also included salt sales in its proprietary proposal.

4.0 References

[1] USGS, 2017. Minerals Yearbook. *National Minerals Information Center*.

<https://www.usgs.gov/centers/nmic/salt-statistics-and-information>

[2] USGS, 2015. Historical Global Statistics for Mineral and Material Commodities, *National Minerals Information Center*. Data Series 896

<https://www.usgs.gov/centers/nmic/historical-global-statistics-mineral-and-material-commodities>

[3] How are rock salt and solar salt different?

<https://www.cargill.com/how-are-rock-salt-and-solar-salt-different>

[4] Material Flow of Salt, *US Bureau of Mines, 1993*

<https://pubs.er.usgs.gov/publication/70005372>