

Salt Partners

Industrial salt supply status in Asia-Pacific

Review of Salt Supply Developments in Asia-Pacific Region

Vladimir M. Sedivy MSc (Hons) Chem Eng, IMD
President
Salt Partners Ltd, Zurich, Switzerland

Salt Partners

February 2009: Flight over Australian Saltfields



On 2. and 3.2.2009, Salt Partners flew over some of the world largest solar saltfields. Isabella Sedivy was shooting pictures.

GOOGLE EARTH

Salt Partners

Shark Bay Salt Stockpiles

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



At Shark Bay, the stockpiles are 200m long and 60m wide. Their design capacity is 250'000 t. They were less than half full.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Lake McLeod Salt Stockpile

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



At Lake McLeod, the stockpile next to the wash plant has a design capacity of 1'500'000 t. It was about 12% full.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Lake McLeod Shipping Stockpile

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



The Lake McLeod shipping stockpile is designed for up to 270'000 t. The heap was holding about 7'000 t.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Onslow Salt Stockpile

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Onslow stockpile was designed for 500'000 t of salt. On 2.2.2009, there was virtually no salt left. The picture shows the last salt shipment from Onslow in February 2009.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Onslow Crystallisers

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



The Onslow saltworks were flooded. Salt in one crystalliser was visible and was being harvested. Other crystallisers were inundated.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Onslow Brine Ponds

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



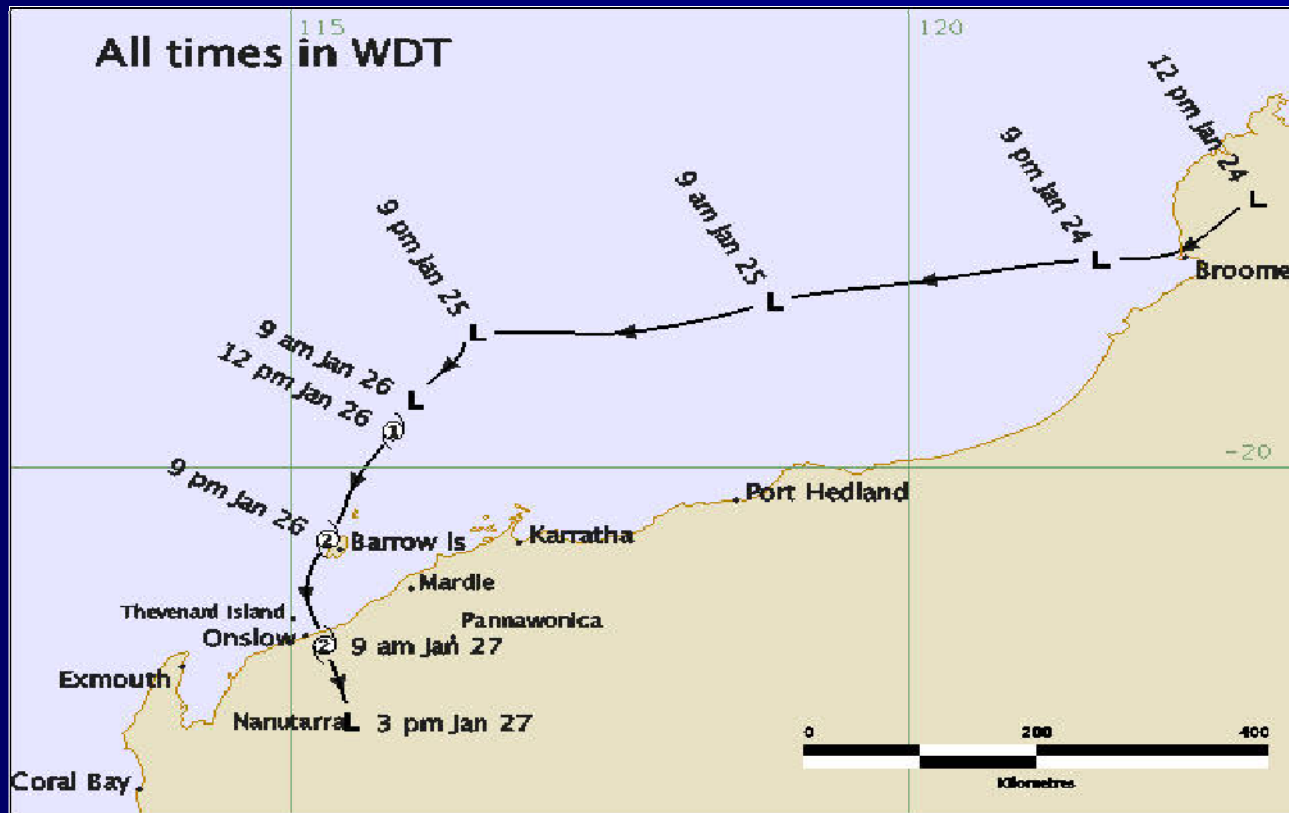
Onslow brine pond one week after it was hit by cyclone Dominic. Dykes were broken through at three locations. Brine was flowing out, to the sea. It took many months to restore full production.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Tropical Cyclone Dominic



The Onslow saltfield was hit by tropical cyclone Dominic on 27.1.2009. Dominic was a moderate, category 2 cyclone with wind gust 140 km/h and 240 mm rainfall.

Australian Bureau of Meteorology

Salt Partners

Dampier Original Drying Stockpile

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



At Dampier, the original drying stockpile was designed for up to 2'000'000 t. It is not being used any more. Harvested salt is hauled to the new washing plant near the sea shore.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Dampier Original Intermediate Stockpile

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



The two Dampier original intermediate stockpiles are now used to dry the salt washed in a new washing plant. They are 400 m long and 55 m wide. They can hold up to 500'000 t. The pictured stock is estimated at about 170'000 t or 36% of design capacity.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Dampier Shipping Stockpile

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Dampier shipping stockpile could hold more than 250'000 t. The picture shows less than 100'000 t of salt ready for shipment.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Port Headland Stockpiles

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Port Headland stockpiles are large enough to hold about 1'400'000 t. In February 2009, they were less than 60% full.

SALT PARTNERS



2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Australian Salt Stockpiles in February 2009

Salt Producer	Stockpile	Stockpile Capacity	Salt on Stock	Percent Full
		(t)	(t)	(%)
Shark Bay		275'000	133'000	48%
Onslow		652'000	1'000	0%
McLeod	Drying	1'520'000	180'000	12%
	Shipping	267'000	7'000	3%
Dampier	Drying	1'896'000	0	0%
	Intermediate	475'000	169'000	36%
	Shipping	264'000	96'000	36%
Port Headland	Drying	999'000	567'000	57%
	Shipping	384'000	199'000	52%
Total		6'732'000	1'352'000	20%

Salt Partners

Australian Salt Production Capacity and Design Stockpiling Capacity

Salt Producer	Production Capacity	Stockpiling Capacity	Percent
	(t/y)	(t)	(%)
Shark Bay	2'200'000	275'000	13%
Onslow	2'500'000	653'000	26%
McLeod	2'300'000	1'787'000	78%
Dampier	4'000'000	2'635'000	66%
Port Headland	3'500'000	1'384'000	40%
Total	14'500'000	6'734'000	46%

SALT PARTNERS

Salt Partners

Australian Salt Production Capacity and Salt on Stockpile

Salt Producer	Production Capacity	Salt on Stockpile	Percent
	(t/y)	(t)	(%)
Shark Bay	2'200'000	133'000	6%
Onslow	2'500'000	1'000	0%
McLeod	2'300'000	187'000	8%
Dampier	4'000'000	264'000	7%
Port Headland	3'500'000	765'000	2%
Total	14'500'000	1'352'000	9%

SALT PARTNERS

Salt Partners

Drip-off Belts

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Most Australian wash plants employ drip-off belts. This picture shows that at the end of such belt, the salt is still dripping wet.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Salt Drying on Stockpiles



Drip-dried salt is wet when stockpiled. The brine flows slowly to the ground and out of the stockpile (see bottom left).

Salt Partners

Salt on Stockpile, Humidity vs. Time



Magnesium salts are hygroscopic. They absorb moisture from the air. The brine so formed dilutes the magnesium. As long as the salt is more than 3% humid, the brine flows with the magnesium out of the stockpile. After the magnesium is removed, the salt can dry up. The drying process takes about 3 months.

Salt Partners

Residual Magnesium in Salt after Washing

- Magnesium in bitterns: 2.64%
- Magnesium in 10% humid salt after harvest: 0.26%
- Magnesium in sea water: 0.14%
- Standard magnesium content in salt: 0.02%

Washing with sea water	Magnesium in 10% humid salt	Magnesium in 2.5% humid salt	Salt losses by dissolution
(l/t of salt)	(%)	(%)	(%)
100	0.139	0.035	3
200	0.097	0.024	7
300	0.076	0.019	10

Salt Partners

Consequences of Insufficient Salt Stock on Stockpile

- Insufficient reserve to overcome temporary production shortage
- Excessive humidity and magnesium, salt not up to specification
- Higher wash water consumption, thus excessive salt losses
- Reduced production rate

Insufficient Salt Stock is Undesirable

Salt Partners

Salt Production World-wide

Salt type	World production
Solar salt	100,000,000 t/y
Rock salt	80,000,000 t/y
Brines	80,000,000 t/y
Total	260,000,000 t/y

SALT PARTNERS

Salt Partners

Salt Consumption World-wide

Salt user	Salt consumption
Chemical industry	155,000,000 t/y
Food	45,000,000 t/y
De-icing	30,000,000 t/y
Other	30,000,000 t/y
Total	260,000,000 t/y

SALT PARTNERS

Salt Partners

Bulk Salt Trade in Asia-Pacific

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland

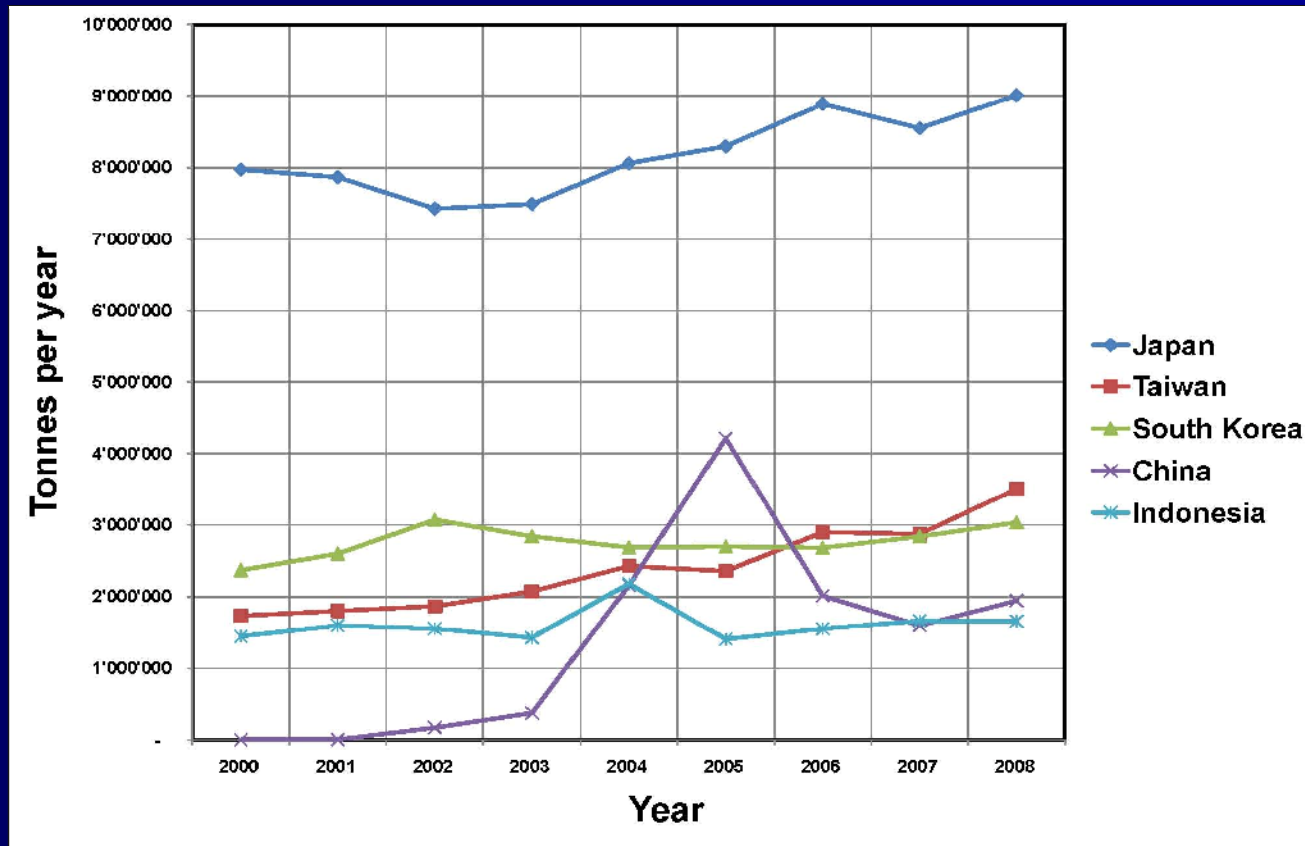


SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

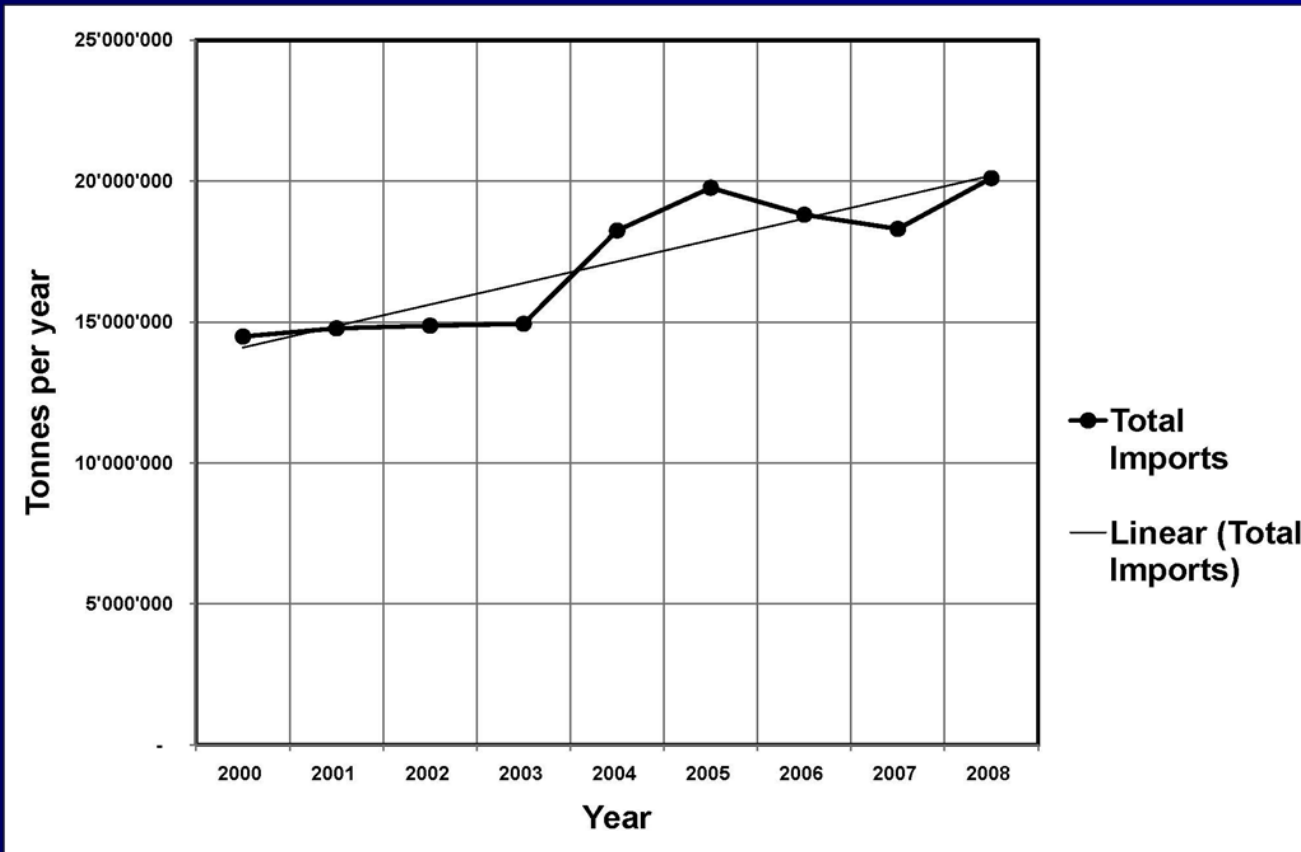
Largest Salt Imports in Asia-Pacific



Salt imports by the five largest salt importers in Asia Pacific region. Between 2000 and 2008, all countries have increased their salt imports.

Salt Partners

Total Salt Imports in Asia-Pacific



In the eight years between 2000 and 2008, total salt imports in Asia Pacific region have risen by 6 million tonnes, equal to 40%, or equal to 4.3% per annum.

Salt Partners

Salt Supply Situation in other Regions

- Indian salt quality is not up to the “Australian standard”
- Due to shortage, Indian salt prices moved from INR 200/t to 600/t
- In the south of Africa, salt stockpiles are depleted
- Mexican salt production is at maximum and unlikely to expand
- Chilean salt has limited acceptance in the chloralkali industry
- Brazil is too far away from Asia-Pacific region

Salt Partners

Conclusion

Insufficient salt on stockpiles in Australia, together with signs of limited salt availability elsewhere, indicates that the present high quality solar salt production capacity is insufficient. The shortage is likely to accentuate when the present economic slowdown comes to an end and the high growth rates in the Asia-Pacific region are re-established.

Salt Partners

Remedy Option No.1:

Compensate shortage with poor quality salt

This option is undesirable:

- **Impurities increase the cost of brine treatment in chloralkali plants**
- **Poor quality salts cause excessive contaminated effluent discharge**

Salt Partners

General Cost of Salt and Impurity Removal

	Cost of brine treatment and sludge disposal	Cost of salt, brine treatment and sludge disposal
	(USD / t salt)	(USD / t salt)
Minimum	1.50	10
Average	10	25
Maximum	30	50

SALT PARTNERS AT GANDHIDHAM 2008 SALT CONFERENCE

Salt Partners

Remedy Option No. 2

Compensate shortage with vacuum salt

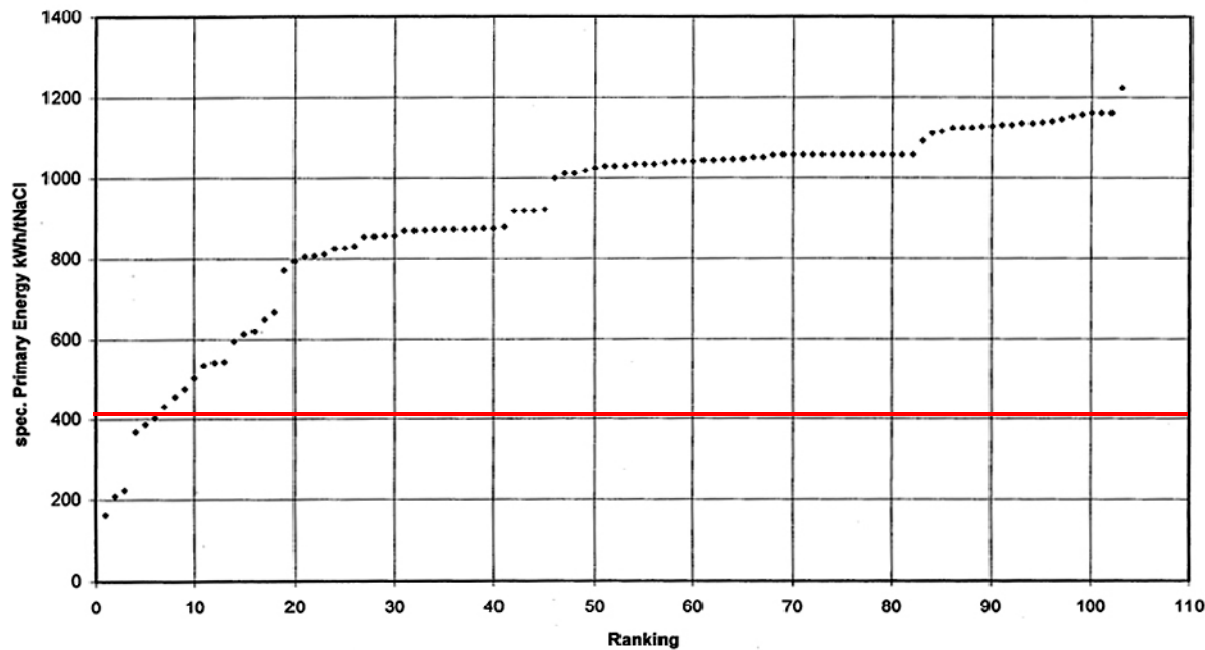
This option is undesirable:

- **Vacuum salt is expensive**
- **Vacuum salt production is mostly energy inefficient**
- **1 ton of CO₂ per ton of salt may emanate when burning black coal**
- **Burning black coal frequently causes pollution**
- **CO₂ in the atmosphere causes global warming and climatic change**

Salt Partners

Energy Consumption Benchmarking Study

Benchmarking Study 2000



96 out of 103 thermal salt evaporating plants use more than theoretical amount of energy.

Salt Partners

Air Pollution

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



In China, black coal is burned to make steam for vacuum salt production.

WU HONG / EPA

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Global Warming

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Hurricane
"Katrina" in the
Gulf of Mexico on
29.8.2005.

NASA

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Destructive Climatic Change

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Hurricane "Katrina" destroyed large parts of New Orleans and surroundings. Increased hurricane activity is believed to be caused by global warming.

Groenteman

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Remedy Option No. 3

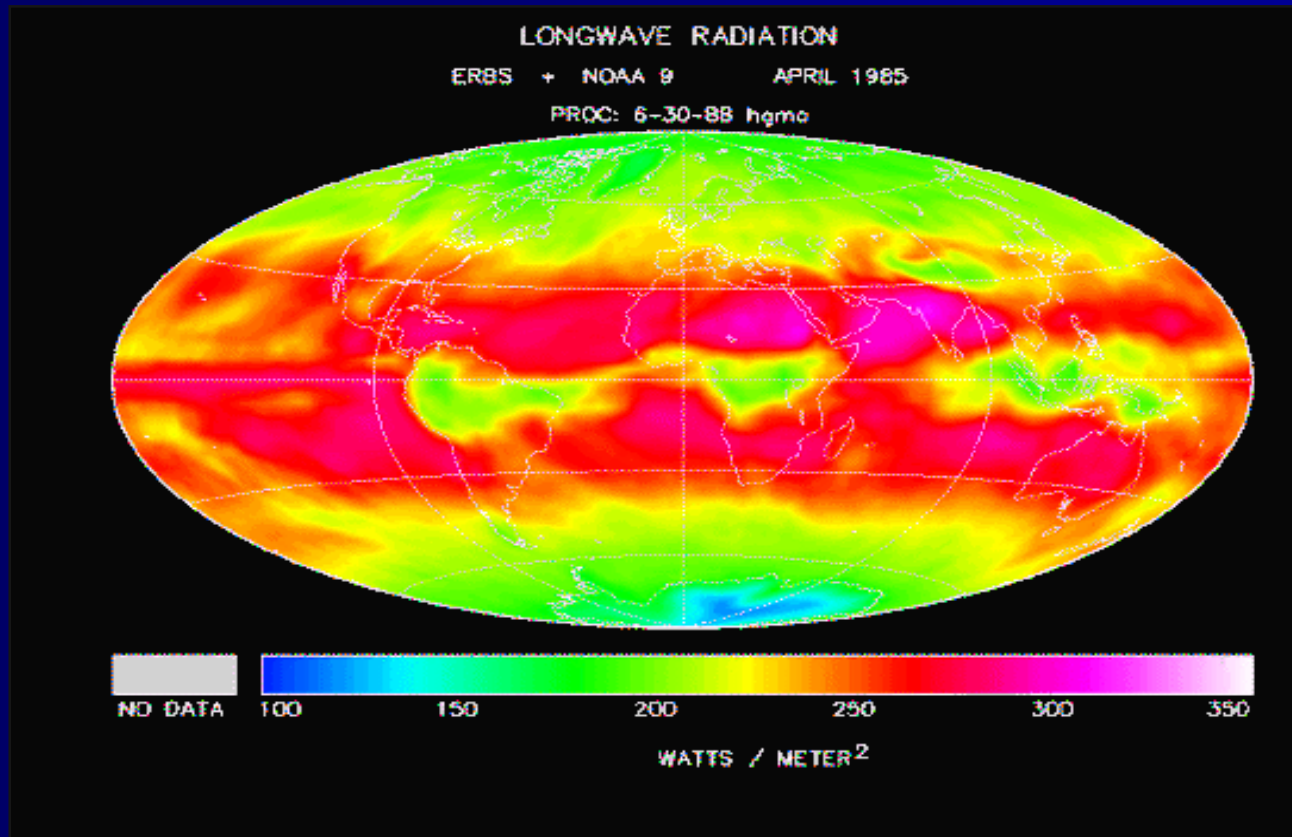
Compensate shortage with additional high quality solar salt production capacities

This option is highly desirable:

- **High quality solar salt is inexpensive**
- **Solar salt production employs renewable energy most effectively**
- **Solar saltfields are environmentally beneficial wetlands**

Salt Partners

Solar Energy on the Planet Earth



Locations with highest rates of evaporation, suitable for solar salt production:

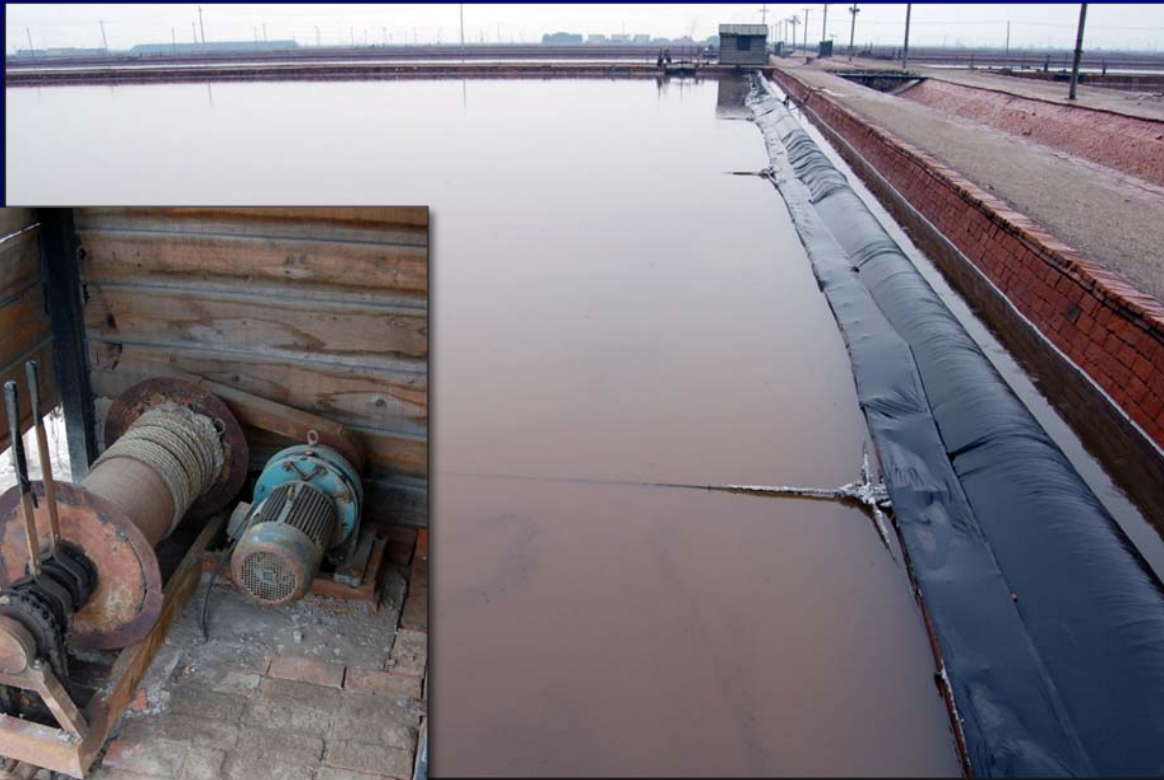
**Caribbean Sea
North Africa
South Africa
Middle East
Western India
Western Australia**

In China, the Gulf of Bohai receives only half the solar energy available at the most suitable locations.

NASA

Salt Partners

Chinese Solar Salt Production Method



At the Gulf of Bohai, sudden rain storms are frequent and heavy. Saturated brine is being protected against dilution with plastic foils. The plastic is pulled over the brine, rain water is drained when the storm is over and the plastic foil is rolled back using electric motors.

SALT PARTNERS

Salt Partners

Chinese Salt Production Method is Labour Intensive

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Large workforce is required to live inside the saltworks to pull the plastic quickly, within an hour of the storm warning and drain the rain water when the storm is over. How long will the workforce be available at the present low cost?

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

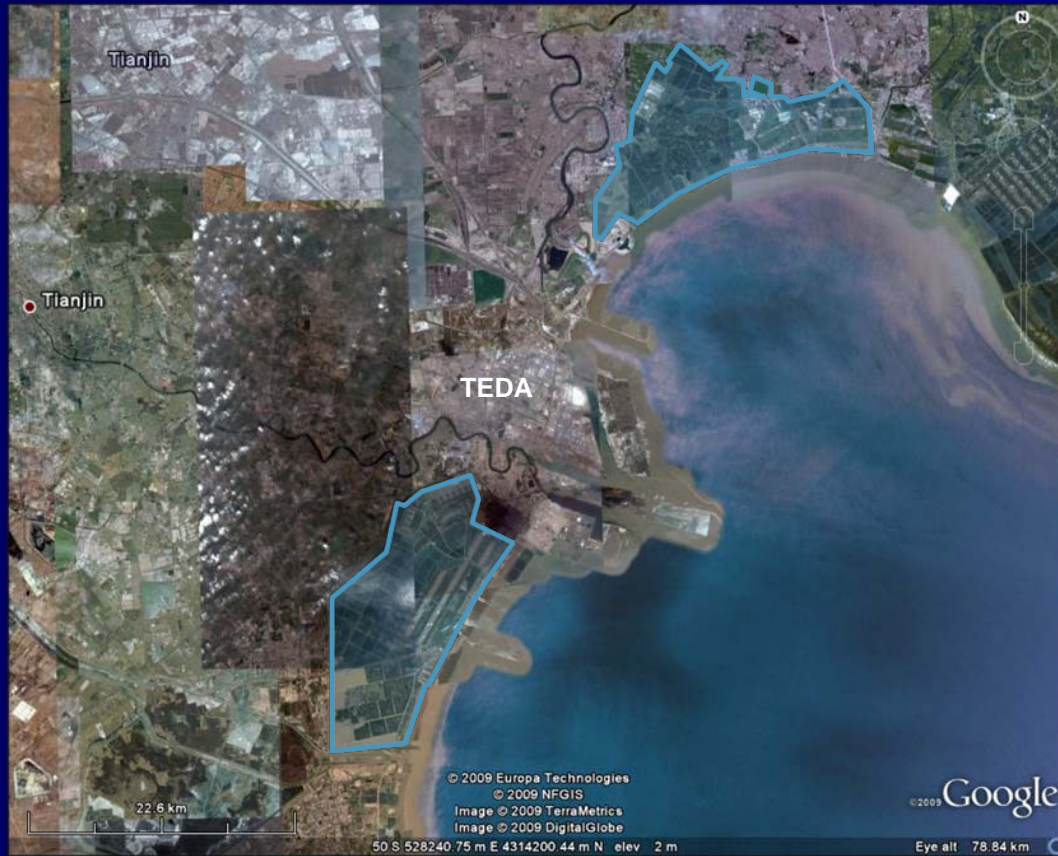
Australian and Chinese Saltworks Productivity

Salt Producer	Production Capacity	Saltworks Area	Productivity
	(t/y)	(km2)	(t/km2)
Shark Bay	2'200'000	70	31'400
Onslow	2'500'000	86	29'000
Dampier	4'000'000	100	40'000
Port Headland	3'500'000	92	38'300
Hangu Changlu	1'000'000	135	7'400

SALT PARTNERS

Salt Partners

Solar Salt Production in the North of Bohai Gulf



Two major Tianjin saltworks occupy approx. 400 km² of land adjacent to the booming TEDA (Tanggu Economic Development Area).

To the north of TEDA, the Hangu Changlu Saltern produces 1'000'000 t/y of solar salt on 135 km² of land.

In the middle, one of the largest Chinese ports is being developed.

Saltworks land in the south of TEDA, next to the harbour, has already been converted to a coal storage (see the black spot).

Salt Partners

Conversion of Solar Saltworks to Industrial Parks

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Parts of the Hangu Changlu Saltern have already been converted to an industrial park.

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

Salt Partners

Conclusion

Solar salt production in the Gulf of Bohai has a limited future potential:

- Present production method is too labour intensive
- Climatic conditions are unfavourable
- Land is required for more productive use

High quality solar salt should be produced in more suitable regions more efficiently and imported to China.

Salt Partners

Salt Partners Prospect New Solar Saltfields

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Salt Partners assist their clients to prospect sites where new solar saltfields could be established.

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009

SALT PARTNERS

Salt Partners

Vladimir M. Sedivy
Salt Partners Ltd, Zurich, Switzerland



Why not turn
your solar
salt into
gold?

SALT PARTNERS

2009 Asia Salt Chemical Summit, Sanya, Hainan Island, China, 3.12.2009