Tenova Lithium Recovery Technology – One Process for Any Brine Chemistry

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Tenova

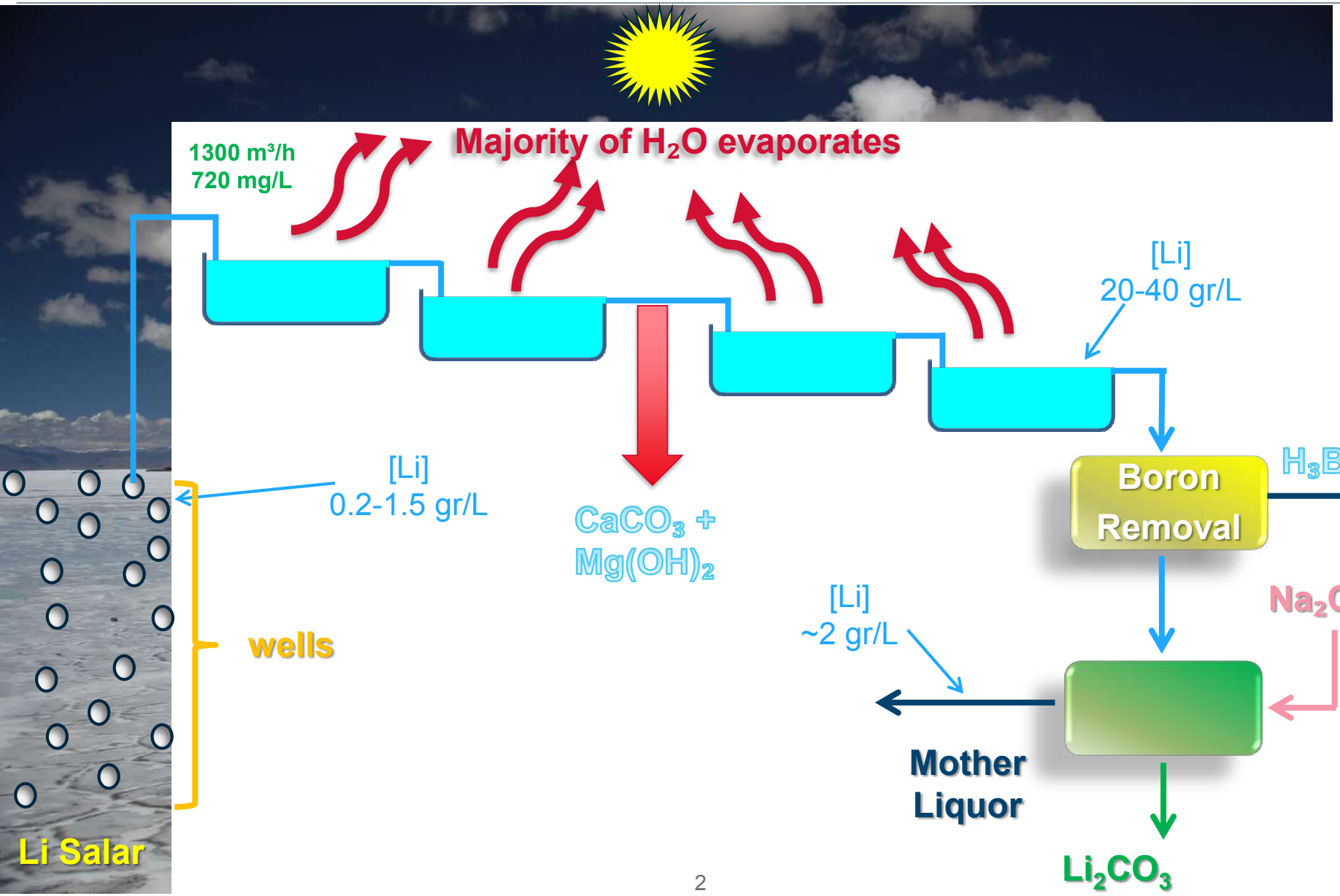
Tenova is a worldwide supplier of advanced technologies, products and engineering services for the mining and metals industries

TAKRAF is an integrated solutions provider to the global mining, bulk materials handling and minerals industries, offering innovative technological solutions as well as process and commodity knowledge along the industry value chains. With the integration of the well-known DELKOR brand of mineral processing and sedimentation products into TAKRAF we bring a complete dry stack tailings management system.

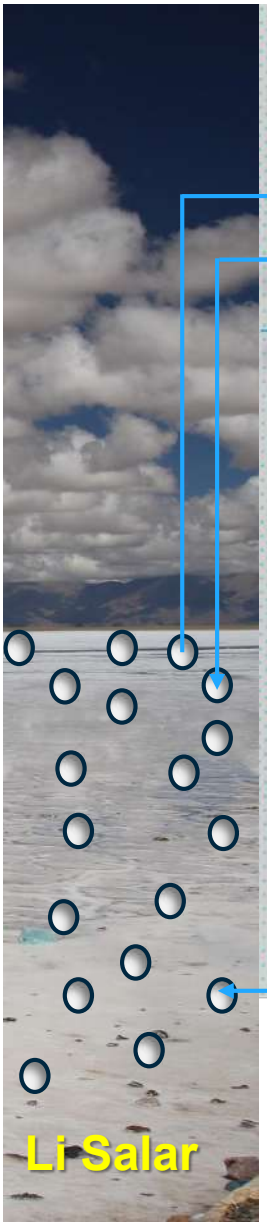
Tenova Delkor is an industry specialist in solid / liquid separation and mineral processing applications for the minerals, chemical and industrial markets

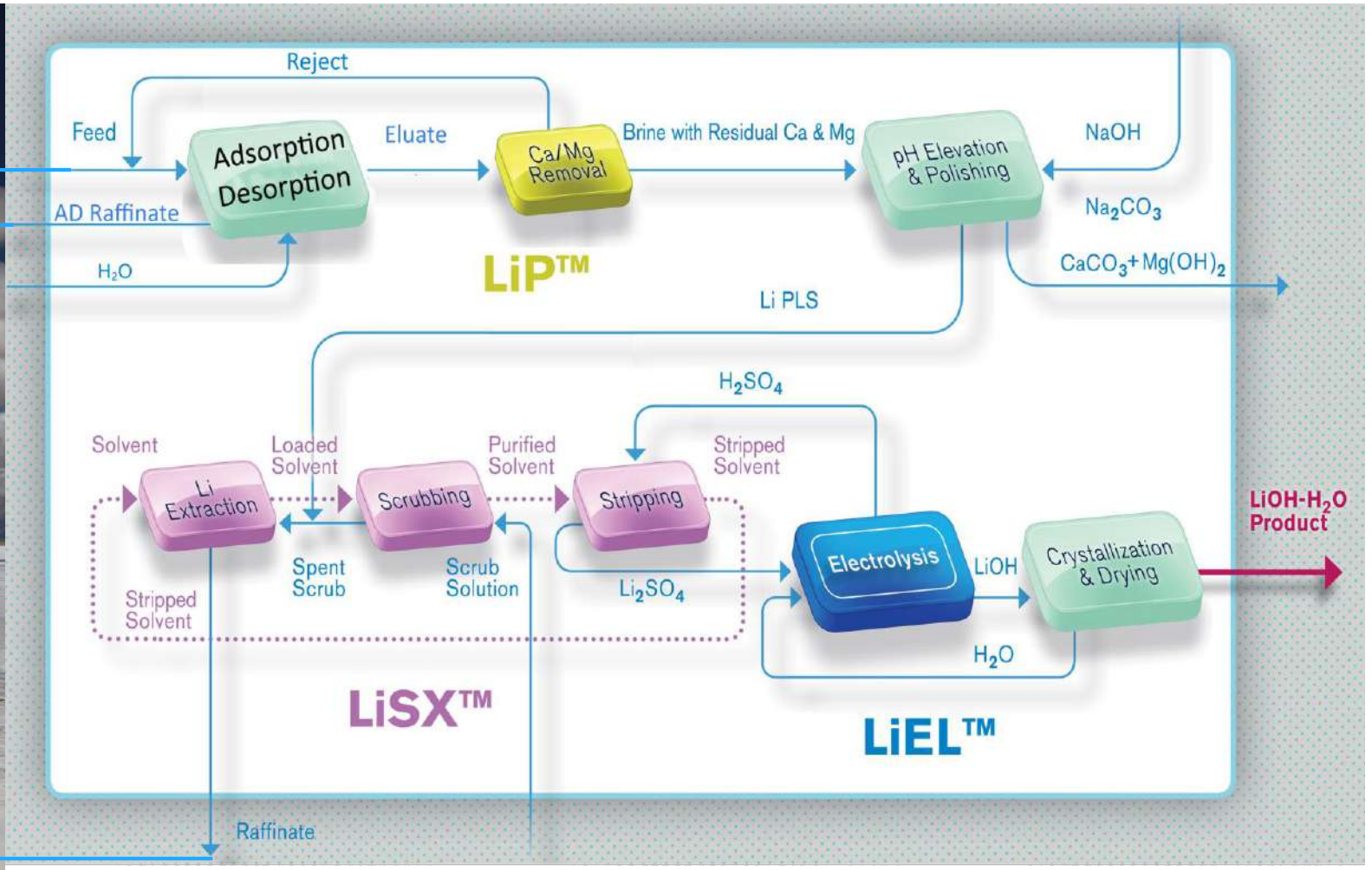
Tenova Advanced Technologies (TAT) offers project-specific process technologies, equipment design and project execution. Advanced solutions include solvent extraction (SX) for hydrometallurgical and bio-processing, electrowinning (EW), membrane circuits, in-house state-of-the-art R&D facilities, expertise in minerals beneficiation and in phosphate processing from ore to phosphoric acid and salts. TBT is at the forefront of new Lithium extraction technologies.

The Conventional Process

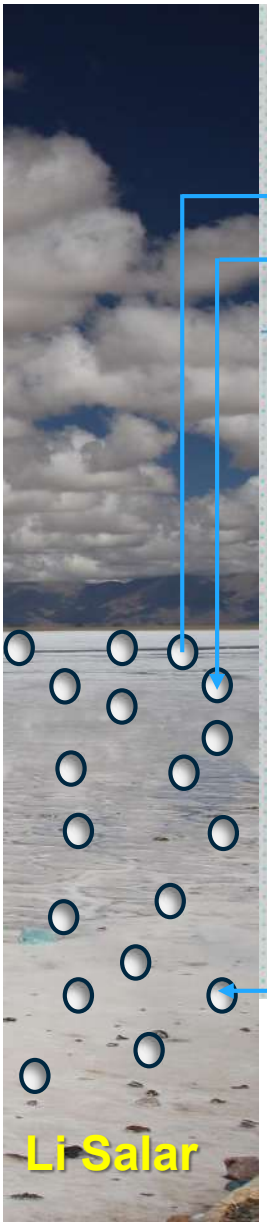


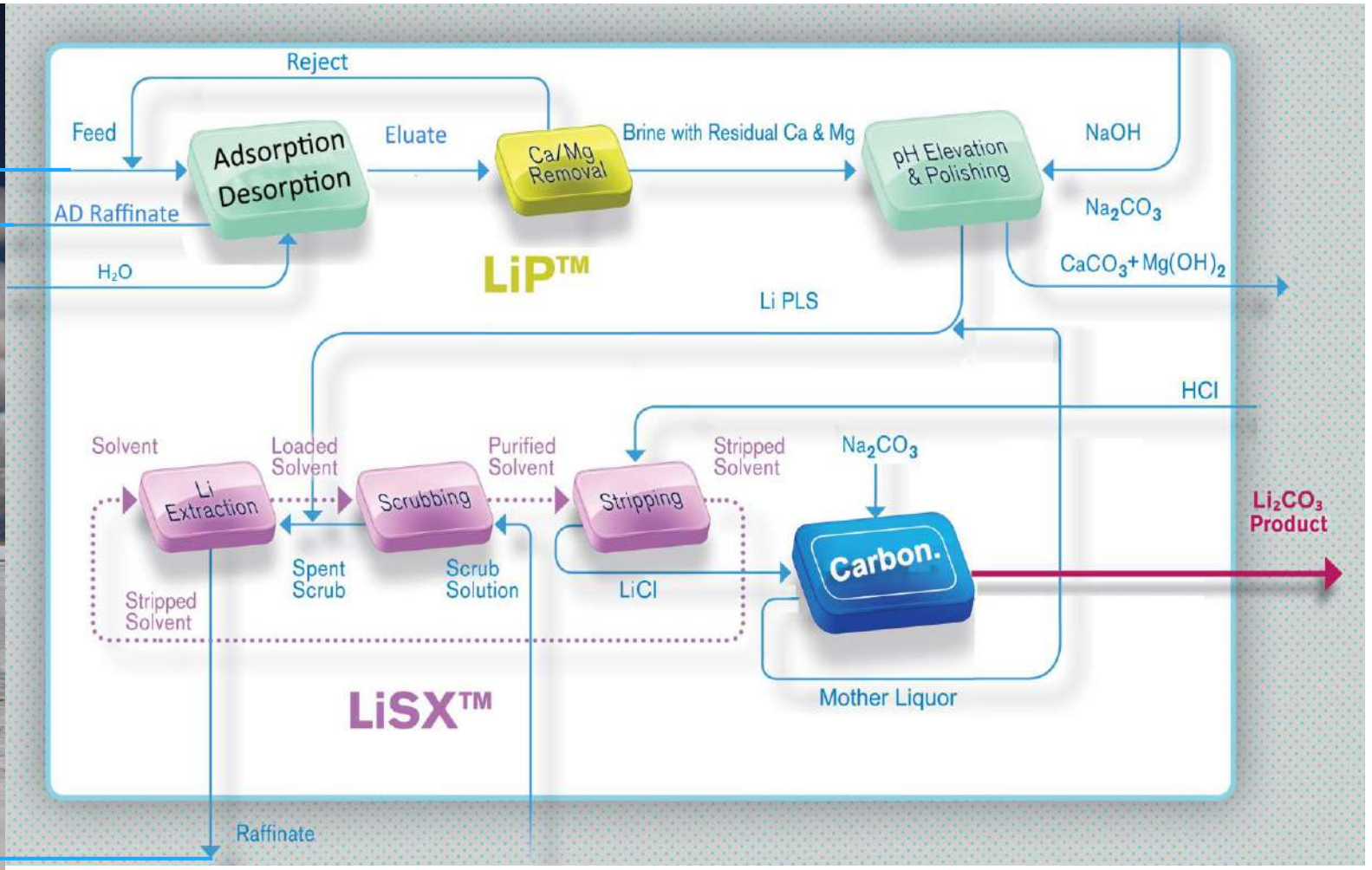
Tenova's Alternative – $LiOH \cdot H_2O$



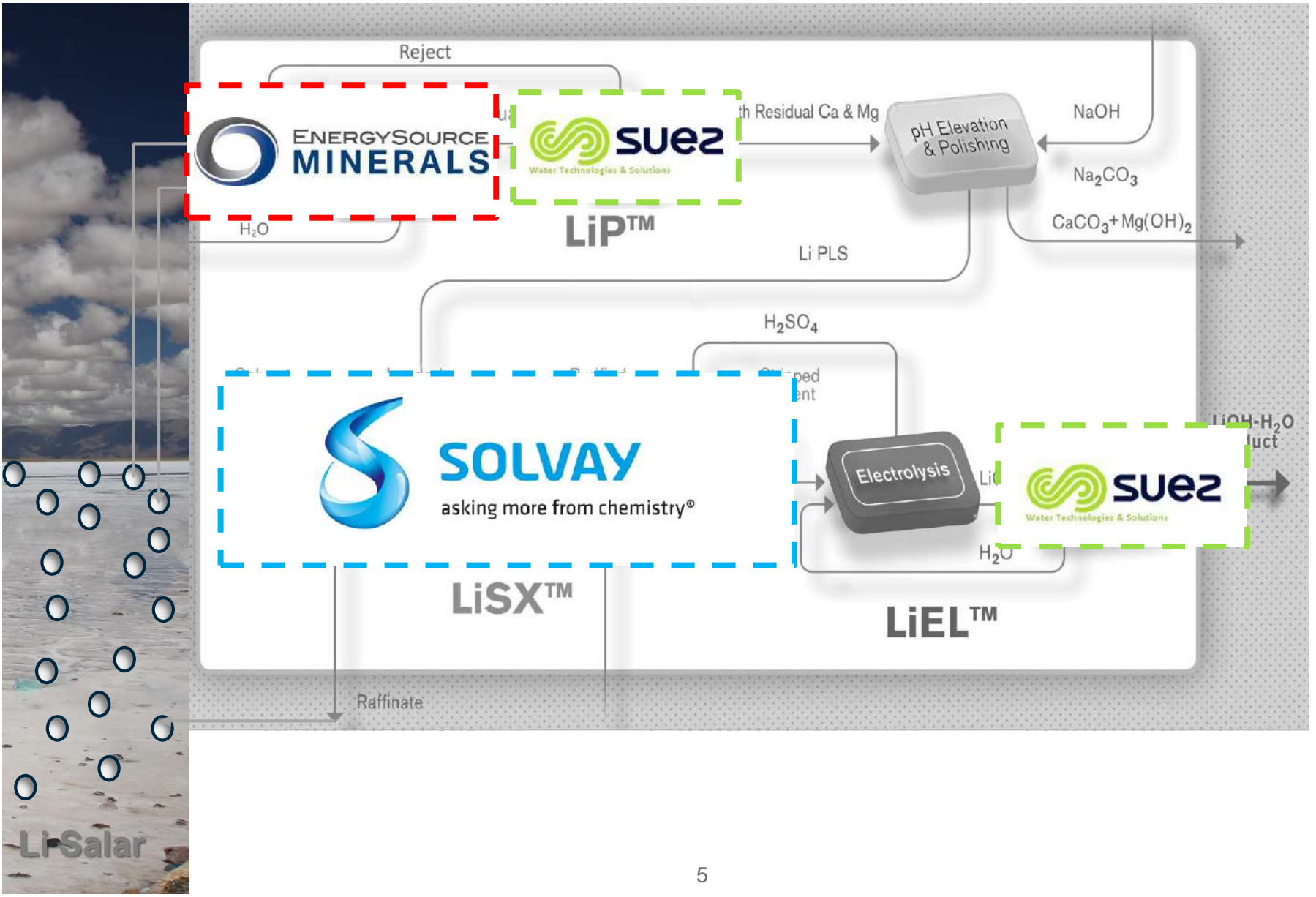


Tenova's Alternative – Li_2CO_3



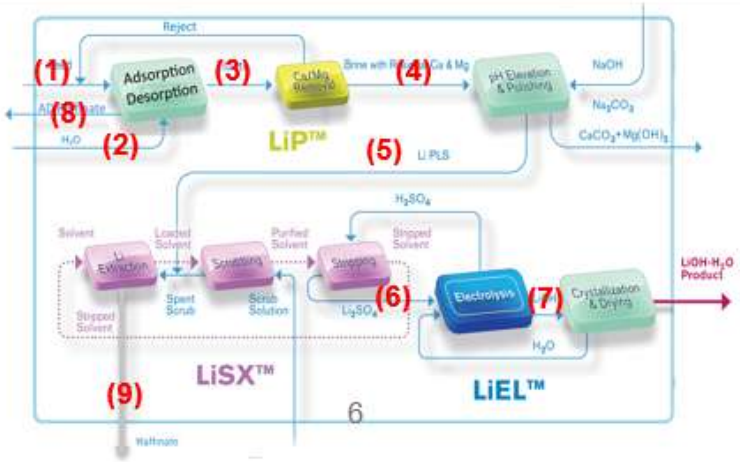


The Partners



Conceptual Mass Balance

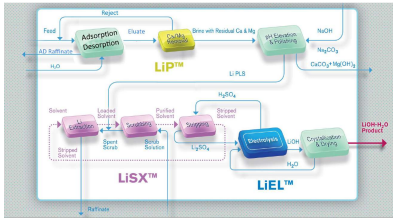
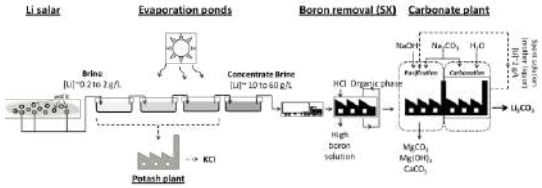
stream		Li	Na	K	B	Ca	Mg	SO_4	Cl
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Feed	(1)	720	95,000	8,400	500	10,000	10,000	7,500	200,000
Elution	(2)	<1	10,000	100	25	500	250	50	15,000
Eluate	(3)	3,000	10,500	250	200	500	250	50	35,000
Permeate	(4)	2,900	10,000	200	200	90	15	<1	30,000
Li PLS	(5)	2,900	20,000	200	200	<1	<1	<1	30,000
Li_2SO_4	(6)	37,100	50	25	<1	<1	<1	254500	<1
LiOH	(7)	21,000	30	15	<1	<1	<1	<1	<1
AD Raffinate	(8)	<10	95,000	8,400	450	10,000	10,000	7,500	200,000
SX Raffinate	(9)	<1	20,000	200	50	<1	<1	<1	30,000



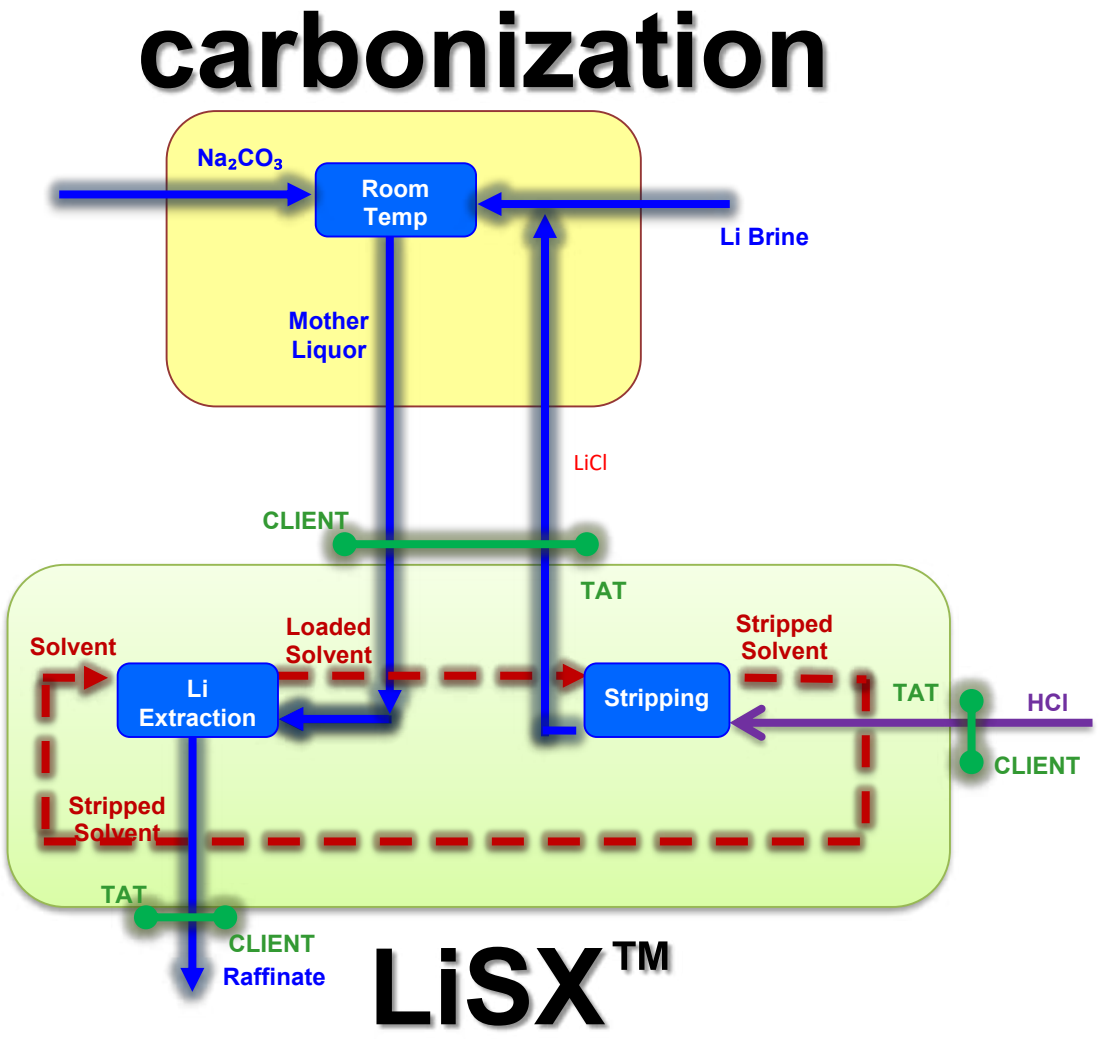
Process Advantages

• Residence time from brine to end-product in hours (not months)	**Fast**
• Li-depleted brine can be re-injected into the salar	**Sustainable**
• Weather independent	**Reliable**
• Process independence in brine chemistry • No by product production required	**Simple**
• Suitable even for dilute Li feed solution <100 ppm • Ability to produce multiple salts directly: Li_2CO_3, LiCl, LiOH – and much more	**Versatile**
• Overall Lithium recovery >95% • Lithium purity obtained > 99.9%	**Efficient**
• No complex solid/liquid separation and no solid waste handling • Precipitation/Evaporation stages not required	**Cheap**

In a nutshell

For average 20 ktpy LCE operation	Tenova Li process	Ponds process
		
Total Solution CAPEX	$250M ~$300M	$350M~$450M
Total Solution OPEX	$2.5-3.5/kg Li_2CO_3	$2.5-4.5/kg Li_2CO_3
Processing Time (from wells to final product)	Hours	18 Months
Recovery	>95%	Between 30% - 60%
End product	Either Lithium Carbonate or Direct production of Lithium Hydroxide	Lithium Carbonate production or Lithium Hydroxide from the Lithium carbonate (at additional cost)

Mother Liquor Processing



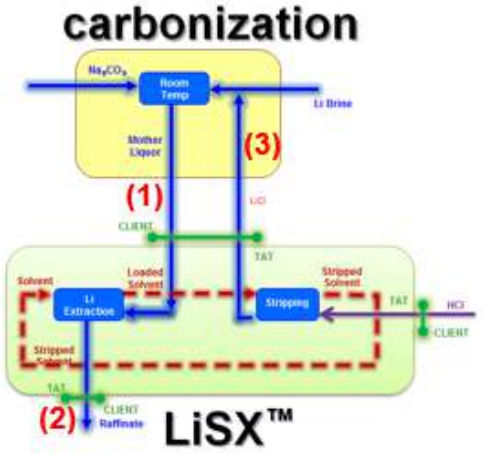
Advantages

- 100% lithium recovery
- Additional 3 – 5 ktpa
- ROI< 6 month

ML – Conceptual Mass Balance

stream	Li	Na	K	B	Ca	Mg	CO_3	SO_4	Cl
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Feed (1)	1,300	100,000	4,000	10	<1	<1	8,500	500	150,000
Raffinate (2)	<1	100,000	4,000	10	<1	<1	8,500	500	150,000
LiCl (3)	11,000	500	5	<1	<1	<1	50	10	55,000

For 4,000 tpa LCE additional production	
CAPEX	~$25M



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