

Lake Resources LKE.AX, OTC: LLKKF

Ready to charge



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Executive summary

Lake Resources is developing five lithium projects in Argentina. The company has the largest lithium lease holding in the country, amounting to more than 2,200 km², all of which it owns 100%. The most advanced project is Kachi, where the company announced a maiden resource of 4.4 million tonnes lithium carbonate equivalent (LCE) in November 2018, and a refreshed pre-feasibility study (PFS) in March 2021.

Lake looks incredibly cheap: A valuation framework is established that values Lake based on a percentage of NPV prior to production, and at a multiple of earnings once production commences. Assuming that Lake's four other projects are being valued at say US\$50m, **the market is valuing Kachi at just 10% of its post-tax NPV₈ of US\$1.6bn (A\$2.0bn).** **This is incredibly cheap.** Lake's most obvious peer, Standard Lithium, another direct lithium extraction (DLE) based company is currently trading at 107% of its adjusted attributable post-tax NPV₈. On this basis, the market is valuing Lake at a 90% discount to Standard Lithium.

Over the next year, Lake is expected to complete a number of tests and developments that will significantly advance the Kachi project. This includes expanding and upgrading the resource; completing a Definitive Feasibility Study (DFS) (expected 1Q22); completing an Environmental and Social Impact Assessment (2Q22); and undertaking brine extraction and reinjection tests. Discussions with potential off-takers are ongoing. Once these tests are completed, and given Kachi's compelling environmental, social, and corporate governance (ESG) credentials and financial robustness, it seems reasonable to expect Lake to trade at a similar valuation as Standard Lithium. **Valuing Kachi at 100% of NPV and other projects at US\$100m, suggests a valuation of A\$1.89/share. This is 7x the current share price.**

The Kachi project is expected to commence production in 2H24, and to generate annual EBITDA of US\$261m. Assuming financing of 70% debt and 30% new equity issued at A\$1.50/share, and an EV/EBITDA multiple range of 15x to 25x, **Lake could be valued at A\$3.63/share to A\$6.24/share. This represents 13x to 23x the current share price.** If this is achieved by mid-2025, it would represent an annual return of 91% to 119% over the next four years. While these valuations may seem high in the context of Lake's current (undervalued) share price, the multiples on which they are based are low compared to current lithium sector multiples. Livent is trading at ~65x 2021 EV/EBITDA. Albemarle is trading at ~26x, and the market seems to be valuing its lithium business at ~37x.

One factor expected to set Lake apart from current lithium producers is that **all of Lake's product is expected to be high-purity, 'battery grade' product.** This is not the case for current producers who sell a mix of different grades as evidenced by the average selling prices and operating margins achieved. An argument could well be made that the superior margins anticipated at Kachi justify a premium multiple.

Expanding Kachi could make it best in class globally: Whilst Kachi already boasts compelling financial metrics, management is examining the potential to double capacity. The large scale of the resource, the robust outlook for demand, the strong ESG credentials of the project, and the fact that battery makers will require large volumes of consistently high-purity product over a period of decades, would all seem to justify expansion. Assuming 'Phase 2' comes on stream in 2028, lifting total capacity to 51,200 tpa LCE, and based on standardized cost estimates, and selling prices of US\$15,500/t LCE, **an expanded Kachi could boast a post-tax NPV₈ of US\$3.8bn and an IRR of 53%.** In full

production, the project could generate annual EBITDA of US\$571m. These would be incredibly robust metrics; it is unusual, in any sector, for a project of this scale to feature such a high IRR. Furthermore, operating costs could decline to US\$3,200/t LCE, **making Lake one of the lowest cost producers globally.**

Lithium demand set to soar: Lithium demand is expected to rise ten-fold over the next decade to more than 3.0m tpa LCE by 2030. This incredible outlook is underpinned by government policies aimed at encouraging the adoption of electric vehicles, an acceleration in production commitments from global automakers, pledges from private sector vehicle fleet users, and falling battery costs. US president Joe Biden's American Jobs Plan includes US\$174bn in spending aimed at building domestic supply chains for electric vehicles. Albemarle is now forecasting demand of 1.14m tonnes LCE by 2025. Over the past two and a half years, Albemarle has raised its forecast for demand in 2025 by the equivalent of about one lithium project per quarter.

Automakers at full throttle: According to the International Energy Agency (IEA), global EV sales reached 3.2m units in 2020, representing 4.6% of total vehicle sales. Under the IEA's Sustainable Development Scenario, this is expected to rise to more than 46m units in 2030, representing 35% of total sales, and growth of 31% pa over the next decade. In January 2021, General Motors said it planned to offer only electric light-duty vehicles by 2035. Ford announced, May 2021, a new goal of 40% of global sales being electric by 2030. Over the past couple of years, planned sales by global automakers have shifted from tracking the IEA's Stated Policies Scenario to be more in line with the Sustainable Development Scenario, based on meeting global climate goals in line with the Paris Agreement, by 2025.

The supply-side will struggle to keep pace: Meeting this demand will require some 2.6m tpa in new capacity over the next decade. This equates to 37x SQM's production of lithium products in 2020, or 52 expanded Kachi projects. It represents a capital requirement of more than US\$30bn, into an industry that today generates about US\$3bn pa. **There are legitimate concerns as to whether lithium supply will be able to meet demand.**

Direct lithium extraction is the future: As project financing becomes increasingly tied to ESG credentials, new lithium projects will need to adhere to strict environmental standards. DLE offers substantial benefits in terms of environmental footprint, water use, and carbon emissions. These advantages are being increasingly recognised as evidenced by BMW's lithium chemicals purchase agreement with Livent, and Schlumberger's and Panasonic's new project in Nevada. **Over the next few years, DLE is expected to become the primary method of lithium extraction;** in fact, it represents the only realistic way to achieve both the growth in supply required, and sustainability.

Share price catalysts: A number of factors are expected to drive the stock over the few months including a resource upgrade and expansion (3Q21), a DFS (1Q22), an environmental assessment (2Q22), potential offtake agreements, further news flow regarding battery tests with Novonix, a decision as to expanding Kachi, and further discussions potentially leading to debt financing with export credit agencies.

Lake Resources provides investors with one of the very few ways to gain exposure to direct extraction, the technology that represents the future for lithium. There is huge upside potential as Kachi and other projects get developed. The company looks incredibly cheap. That presents an opportunity.

Simon Francis

June 2021

Key financial data

Figure 1: Shareholding structure

ASX code		LKE
Share price, 11 June, 2021	A\$/share	0.27
Shares on issue	Millions	1,026.5
Options	Millions	122.5
Fully diluted shares	Millions	1,149.0
Market capitalisation	A\$ millions	277.1
Cash on hand, 31 March, 2021	A\$ millions	24.0
Top 20 shareholders:		36.6%

Source: Lake Resources

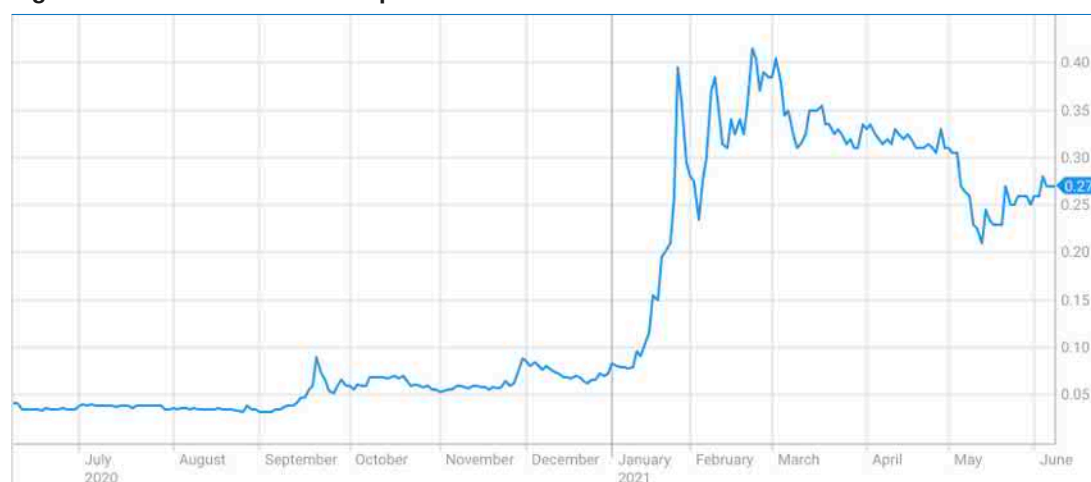
Key Management:

Mr Stephen Promnitz, Managing Director: Stephen Promnitz joined Lake as Managing Director in November 2016. Prior to Lake Resources, Stephen was 2IC of Kingsgate Consolidated, a listed Pacific Rim gold producer with assets in Chile. Before this time, he held senior corporate finance roles with Westpac and Citigroup. He started his career as a geologist with Rio Tinto before managing Western Mining Corp's mining operations in Argentina. He holds a Bachelor of Science Honours (Natural Resources) from Monash University and is fluent in Spanish.

Mr Stuart Crow, Chairman and Non-Executive Director: Stuart has global experience in financial services, corporate finance, investor relations, international markets, salary packaging and stock broking. Stuart is passionate about assisting emerging listed companies to attract investors and capital and has owned and operated his own businesses.

Dr Nick Lindsay, Non-Executive Director: Dr Lindsay is Technical Director, in charge of delivering the Kachi Project to FID. He has over 30 years' experience in Argentina, Chile and Peru in technical and commercial roles in the resources sector with major and mid-tier companies, as well as start-ups. A fluent Spanish speaker, Dr Lindsay has successfully taken companies in South America, such as Laguna Resources which he led as Managing Director, from inception to listing, development and acquisition. He is a member of the AusIMM and the AIG and holds a Bachelor of Science (Honours) in Geology, a PhD in Metallurgy and Materials Engineering and an MBA.

Figure 2: Lake Resources share price chart



Source: ASX

Valuations: phenomenal upside potential

- Valuing the Kachi project in line with Lake's nearest peer could support a valuation a year from now of A\$1.89/share, 7x the current share price
- As Kachi starts production valuations could reach A\$3.63/share to A\$6.24/share based on multiples that are more conservative than current sector valuations
- Share price catalysts include resource upgrades, a DFS, potential offtakes, further results from battery tests at Novonix, and project financing

The valuation framework is based on valuing Kachi at a percentage of NPV prior to production, and at a multiple of earnings once production commences.

One year valuation of A\$1.89/share

Assuming a valuation of US\$50m for Lake's other projects, **the market is valuing Kachi at just 10% of its post-tax NPV₈ of US\$1.6bn. This looks unjustifiably cheap.** Over the next year or so, Lake is expected to complete a number of tests and developments that will significantly advance the Kachi project. This includes completing the current drilling aimed at expanding and upgrading the resource; a Definitive Feasibility Study (1Q22); an Environmental and Social Impact Assessment (2Q22); undertaking brine extraction and reinjection tests; further discussions with Export Credit Agencies; further discussions regarding offtake agreements; results from further battery tests at Novonix; a decision on expanding the project to an assumed capacity of 51,200 tpa (probably later this year); and a potential listing in the US (targeted for 4Q21).

With these developments completed, and given the project's financial robustness, it seems reasonable to expect Lake to trade at a similar valuation as Standard Lithium, its nearest peer.

Standard Lithium is currently trading at 107% of adjusted, attributable NPV. **Based on a capacity of 25,500 tpa LCE, valuing Kachi at 100% of its NPV of US\$1.6bn and other projects at US\$100m in aggregate, suggests a valuation A\$1.89/share. This is 7x the current share price.**

Figure 3: Valuation framework and potential outcomes

Timeframe	Valuation A\$/share	Methodology	Comments
One year	1.89	100% of NPV	EV/NPV multiple in line with Standard Lithium (currently 107%) Valuation reflects tight lithium market, environmental advantages of DLE, project scalability Other projects valued at US\$100m
2025	3.63 to 6.24	15x to 25x EV/EBITDA	Phase 1 coming on stream in 2H24 Valuation multiple: top end in line with ALB and SQM valuations Lithium market expected to be in deficit Technology switch from ponds to DLE in full swing Other projects still valued at US\$100m
Potential Phase 2 2028	7.83	15x EV/EBITDA	Potential Phase 2 in production, annual EBITDA US\$571m More normalised multiple after rapid growth phase Assumes resource is expanded and upgraded Other projects still valued at US\$100m

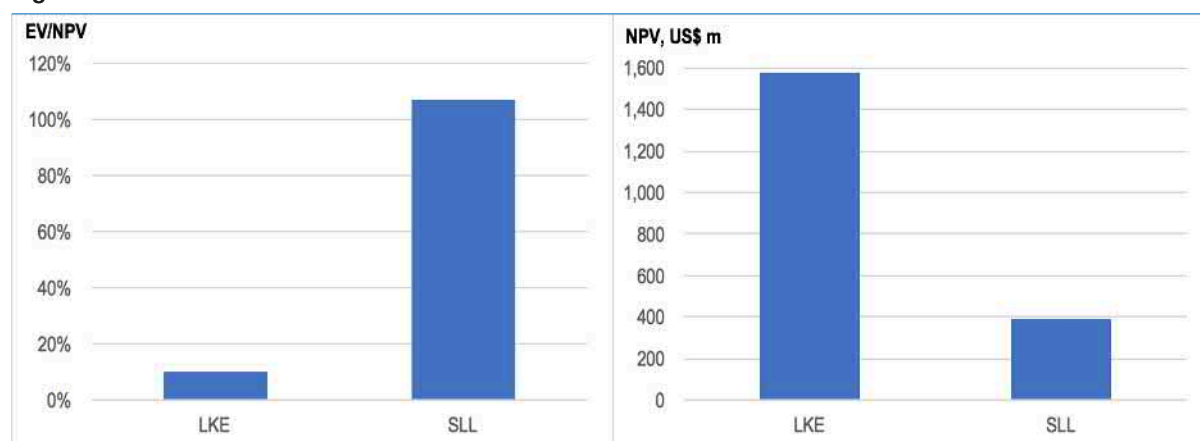
Source: Orior Capital

Figure 4: Lake Resources valuation model

Shares on issue, current	millions	1,026	
Options and rights	millions	123	
Fully diluted shares	millions	1,149	
Phase 1 development			
NPV ₈ , post-tax	US\$ m	1,580	Revised PFS, March 2021
NPV ₈ , post-tax	A\$ m	2,038	
A\$:US\$ fx rate		1.29	
1-year valuation based on % of NPV			
30%	A\$/share	0.57	All per share figures include a valuation of US\$100m for Lake's other projects
50%	A\$/share	0.94	
75%	A\$/share	1.41	
100%	A\$/share	1.89	
Phase 2 development			
NPV ₈ , post-tax	US\$ m	3,768	Orior Capital estimate
NPV ₈ , post-tax	A\$ m	4,861	
1-year valuation based on % of NPV			
30%	A\$/share	1.30	
50%	A\$/share	2.17	
75%	A\$/share	3.26	
100%	A\$/share	4.34	
Phase 1			
Capex	US\$ m	544	Projected start-up 2H24 Revised PFS, March 2021
Capex	A\$ m	702	
Debt	A\$ m	492	Assume 70% debt
Equity	A\$ m	211	Assume 30% equity...
New shares	millions	140	...Issued at A\$1.50/share
Fully diluted shares	millions	1,289	
Annual EBITDA	US\$ m	261	Revised PFS, March 2021
Annual EBITDA	A\$ m	337	
Phase 1 EV/EBITDA valuations			
10x	A\$/share	2.33	
15x	A\$/share	3.63	
20x	A\$/share	4.94	Implies a market cap. of A\$6.4bn
25x	A\$/share	6.24	
30x	A\$/share	7.55	
Phase 2			
Capex	US\$ m	312	
Capex	A\$ m	403	
New debt	A\$ m	282	Assume 70% debt
New equity	A\$ m	121	Assume 30% equity...
New shares	millions	40	...Issued at A\$3.00/share
Fully diluted shares	millions	1,330	
Annual EBITDA	US\$ m	571	Orior Capital estimate
Annual EBITDA	A\$ m	737	
Phase 2 EV/EBITDA valuations			
10x	A\$/share	5.06	Implies a market cap. of A\$6.7bn
15x	A\$/share	7.83	
20x	A\$/share	10.60	
25x	A\$/share	13.37	

Note: all per share valuations include a valuation of US\$100m for Lake's other projects

Source: Orior Capital

Figure 5: Lake Resources and Standard Lithium EV/NPV and attributable NPV

Source: Orior Capital

Phase 1 valuation of A\$3.63/share to A\$6.24/share as production commences

As Lake enters production the market is likely to value the company on its earnings. The project is expected to generate EBITDA of US\$261m pa based on US\$15,500/t LCE. Assuming it is financed 70% debt and 30% equity with new shares issued at A\$1.50/share (a 21% discount to A\$1.89/share), and applying an EV/EBITDA multiple range of 15x to 25x, **Lake could be valued at A\$3.63/share to A\$6.24/share. This represents 13x to 23x the current share price.** Assuming the market starts to value Lake on earnings in mid-2025, **it would represent an annual return of 91% to 119% over the next four years.**

Although these valuations look high in the context of the current share price, they are based on earnings multiples that are lower than current market valuations of (profitable) lithium producers. Further, Kachi compares favourably in terms of profitability, growth potential and ESG credentials:

- Albemarle, a diversified lithium producer, is current trading at 26x 2021 EV/EBITDA and the market appears to be paying 37x for its lithium business; Livent is trading at 65x 2021 EV/EBITDA
- By virtue of the DLE process, Lake is expected to sell all of its output into the battery market, where high purities attract premium prices, and thus higher margins
- Lake is expected to achieve an EBITDA margin of 66% from Phase 1 of the project; Albemarle and SQM achieved EBITDA margins of 26% and 35% in 2020
- Kachi boasts comparatively strong ESG credentials in that virtually all of the brine is returned to the aquifer, the project uses significantly less land, and it has a smaller carbon footprint
- Assuming resources can be upgraded, Kachi is readily scalable

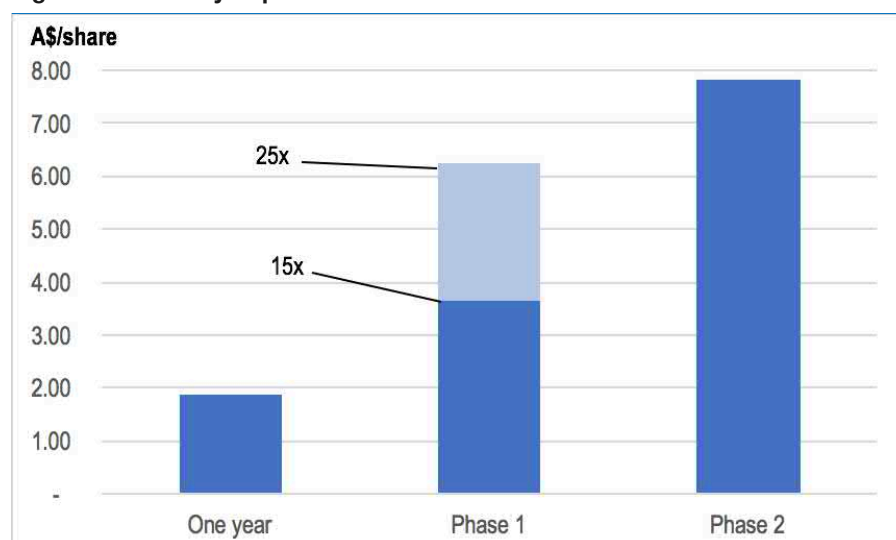
Phase 2 valuation of A\$7.83/share

Lake's Kachi development is at something of an inflection point. The Revised PFS, March 2021, is based on capacity of 25,500 tpa LCE. It boasts a post-tax NPV₈ of US\$1.6bn. While the project already has impressive financial metrics, management is now examining the potential to double capacity. Financial modelling suggests this would have a hugely positive impact on earnings and valuations. **Based on adding a 'Phase 2' that doubles capacity to 51,200 tpa in 2028, the post-tax NPV₈ could reach US\$3.8bn, and annual EBITDA US\$571m.**

Assuming a similar 70:30 debt-to-equity financing (even though Phase 2 could probably be financed out of cash flows from Phase 1) with equity issued at A\$3.00/share, and an EV/EBITDA multiple of 15x, **Lake could be valued at A\$7.83/share.**

Tests over the next year should determine the feasibility of expanding Kachi. This includes the resource upgrade and expansion, environmental assessments and brine extraction and reinjection tests. Assuming these tests are successful, given the outlook for demand and the environmental advantages of direct lithium extraction, a doubling of capacity could well become 'base case'.

Figure 6: Summary of potential Lake Resources valuations



Source: Orior Capital estimates

Obviously, these valuations reflect the successful development and expansion of Kachi, and will only come to fruition over a number of years. Even so, they are remarkable. They are born out of:

- A phenomenal outlook for demand, driven partly by global governments aiming to tackle climate change and adopting policies to accelerate the uptake of EVs
- Major industrial groups in the automotive and transportation sectors supporting the switch to EVs
- Supply-side issues, especially the inability to rapidly expand evaporation ponds and the need for higher quality and environmentally cleaner and sustainable western world sources of supply
- Lake's high purity product, and thus its high selling prices, and high margins

Other projects

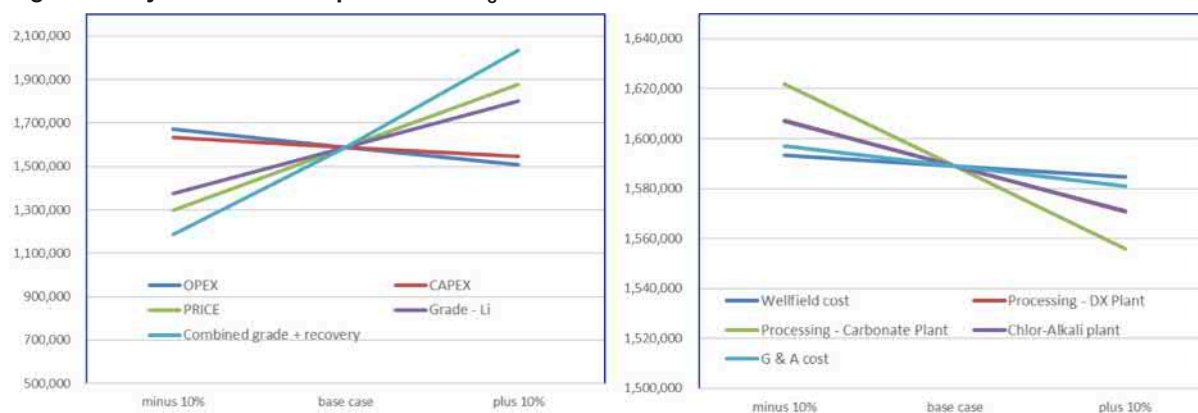
In addition to Kachi, Lake owns four other projects in Argentina. These projects are at earlier stages. They are included in the valuations herein at a broad-brush aggregate valuation of US\$100m. Once Lake commences development of these projects, valuations would be expected to increase substantially. See Appendix 1 for descriptions of these assets.

Sensitivity

The project NPV is sensitive to a number of key inputs including selling prices, capital costs and operating expenses. Reducing the assumed selling price by 10% from US\$15,500/t to US\$13,950/t would reduce the post-tax NPV₈ of the (25,500 tpa) project by 18% from US\$1,580m to US\$1,291m.

Increasing the operating costs of the project by 10% throughout the project lifetime would reduce the project NPV by ~5% to US\$1,498m. Increasing the capital costs of the project by 10% would reduce the project NPV by about 3% to US\$1,527m.

Figure 7: Key sensitivities to post-tax NPV₈ in the March 2021 PFS



Source: Lake Resources

Peer valuations driven by looming supply deficit

As a general rule of thumb, companies at the DFS stage and near to financing and cash flows, can typically trade at 30-50% of NPV. Current valuations, though, are higher than this. They reflect the unusually strong prospects for growth in lithium demand, and a sense that supply will struggle to keep up with demand. Governments around the world are increasingly adopting policies aimed at electrifying transportation, including future bans on internal combustion engine vehicles and the provision of financial incentives aimed at accelerating the adoption of EVs. Investors are looking to gain exposure to these 'green recovery' themes. Lithium companies will continue to be major beneficiaries of these trends.

Standard Lithium

The most obvious comparable company is Standard Lithium, listed on the TSX.V. Standard Lithium is developing the South Arkansas Lithium Project, a joint venture with leading speciality chemicals producer Lanxess AG. The project utilises direct extraction. Standard Lithium has a 30% stake in the venture, with Lanxess holding the remaining 70%. In May 2020, Standard Lithium announced the successful start-up of its demonstration plant. In March 2021, the company announced that Veolia Water Technologies (Veolia) had successfully converted lithium chloride produced at the Arkansas plant into high purity 99.985% lithium carbonate. The work was completed at Veolia's facility in Plainfield, Illinois.

In August 2019, Standard Lithium released a PEA targeting production capacity of 20,900 tpa LCE, and boasting a post-tax NPV₈ of US\$989m and an IRR of 36% at a lithium carbonate price of US\$13,550/t. Based on the sensitivity analysis in the PEA (post-tax NPV₈ of US\$1,415m at a lithium carbonate price of US\$16,260/t), the NPV would be ~US\$1,303m at a selling price of US\$15,500/t, the price adopted by Lake in its refreshed PFS. This represents an attributable NPV to Standard Lithium of US\$391m. **On this basis, Standard Lithium is currently trading at an EV of 107% of NPV₈.**

Lithium Americas

Lithium Americas has not announced plans to employ direct lithium extraction, and thus, is not regarded as a direct peer for Lake Resources. That said, Lithium Americas is also trading at a valuation of around 100% of NPV, lending further weight to Lake being able to achieve this valuation as the Kachi project advances. Lithium Americas (49%) and Ganfeng Lithium (51%) own a JV that is developing the Cauchari-Olaroz lithium project in Argentina. The JV owns 91.5% of the project with the Government of Jujuy Province of Argentina owning the remaining 8.5%. Lithium Americas owns an effective 44.8% stake. The first stage of the project has a slated capacity of 40,000 tpa. According to Lithium Americas' June 2021 presentation, the project is expected to start production in mid-2022. Development of a Phase 2 expansion of 20,000 tpa LCE has already commenced.

Lithium Americas also owns (100%) the Thacker Pass project in Nevada. A feasibility study is underway targeting an initial 30,000 to 35,000 tpa LCE. Management is also reviewing the potential for a 20,000 tpa lithium hydroxide conversion plant. More than US\$100m has been spent on the project to date.

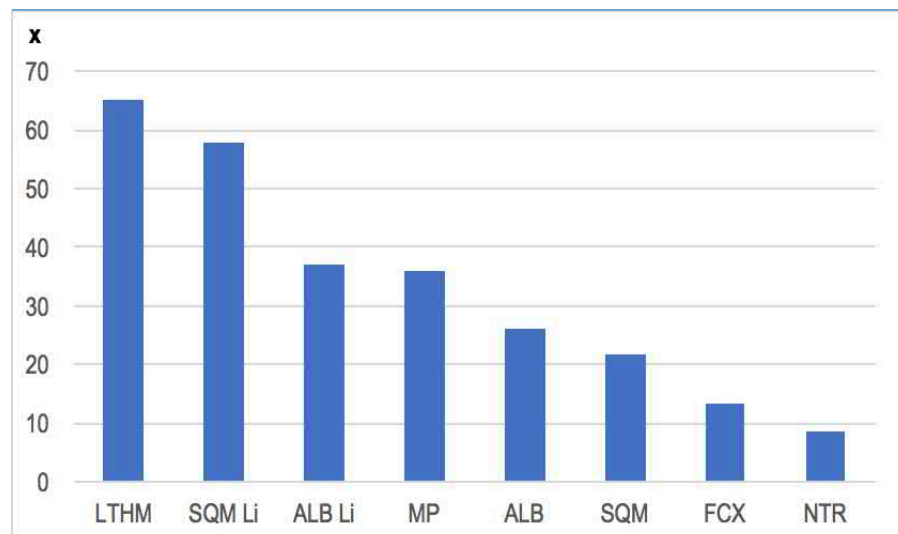
In terms of valuations, the Cauchari-Olaroz project has a post-tax NPV₈ of US\$1,957m (US\$877m attributable to Lithium Americas) at a selling price of US\$12,000/t, which is the mid-point given in the September 2019 feasibility study. Taking this figure, and assuming the market is valuing the Thacker Pass project at US\$200m to US\$300m (roughly 2-3 times development costs to date), **the market is valuing Lithium Americas' stake in the Cauchari-Olaroz project at 102% to 113% of NPV.**

Producers

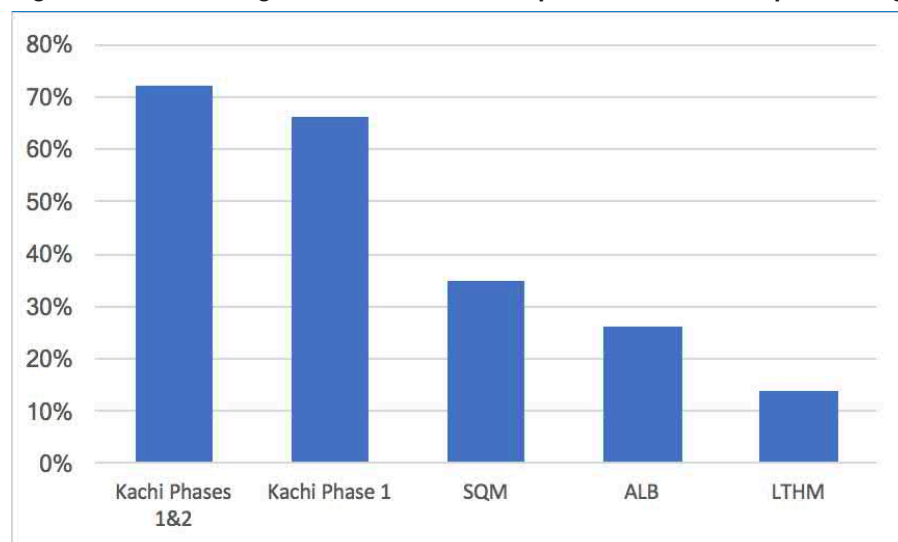
The few lithium companies currently in production (and profitable) are also trading on high multiples. Livent is currently the only listed pure lithium company that uses a hybrid direct extraction type of process. It is trading at an estimated 65x 2021 EV/EBITDA. Albemarle and SQM are both diversified companies with lithium interests. Albemarle is also active in bromine and catalysts. It is trading at an estimated 26x 2021 EV/EBITDA. Based on the 2020 segment information, assuming the market is valuing Albemarle's bromines and catalysts businesses at a typical speciality chemicals multiple of say 14x, the implied valuation of the lithium business would be 37x EV/EBITDA.

SQM is trading at an estimated 22x EV/EBITDA. It has interests in speciality plants nutrition, iodine and derivatives, potassium and industrial chemicals. Plants nutrition generates greater revenues and profitability than lithium. In 2020, lithium accounted for just 18% of gross profit. Assuming the market is valuing the non-lithium businesses at an average 14x, the implied multiple for the lithium business would be 58x.

Typically, US industrials can trade at around 10-12x EV/EBITDA. Freeport-McRohan is currently trading at 13x, and Nutrien at 9x. The multiples being paid for lithium stocks reflect the strong prospects for growth and the fact there are limited ways to gain exposure to profitable lithium producers. Similarly, in rare earths, MP Materials is trading at about 36x 2021 EV/EBITDA.

Figure 8: EV/EBITDA multiples for selected companies and implied valuations of lithium segments

Source: Company data, Orior Capital

Figure 9: EBITDA margins for selected lithium producers and anticipated margins for Kachi

Source: Company data, Orior Capital

Kachi expansion would be world leading

- The current drill program, aimed at upgrading resources could underpin a doubling in capacity at Kachi to 51,200 tpa
- Assuming 'Phase 2' comes on stream by 2028, standardised cost estimates, and selling prices of US\$15,500/t LCE, post-tax NPV₈ could reach US\$3.8bn
- An expanded Kachi would be regarded as 'best in class' globally in terms of environmental credentials, low production costs and profitability

This section examines the potential financial impact of expanding Kachi. Based on the current planned capacity of 25,500 tpa LCE, Kachi boasts low C1 cash costs of US\$4,200/t, a high anticipated margin over C1 costs of 73%, annual EBITDA of US\$261m and an IRR of 35%. Whilst these are already compelling financial metrics, management is examining the potential to double capacity. Assuming 'Phase 2' comes on stream in 2028, lifting total capacity to 51,200 tpa LCE, and based on standardized cost estimates, and selling prices of US\$15,500/t LCE, **an expanded Kachi could boast a post-tax NPV₈ of US\$3.8bn**. Once 'Phase 2' is fully up and running, the project could generate annual EBITDA of US\$571m. The project IRR could reach 53%. These would be incredibly robust metrics; **it is unusual, in any sector, for a project of this scale to boast such a high IRR**. Management also anticipates being able to lower energy costs from the level assumed in the PFS (which is based on trucked gas), suggesting these figures could be improved further.

A number of things will need to be accomplished to demonstrate the feasibility of an expansion including upgrading resources, completing brine extraction and reinjection tests, and environmental assessments. Assuming these things can be successfully completed, a number of important factors would seem to justify a Phase 2:

- The substantial scale of the resource
- The robust outlook for demand
- The substantial environmental advantages of the project compared to evaporation ponds including significantly reduced water usage, land use, and carbon footprint
- The fact that battery makers and automotive OEMs will require substantial volumes of consistently high-purity product over a period of decades
- Compelling financial metrics

The financial modelling herein suggests that an expanded Kachi would be the, or one of the, lowest cost projects supplying high quality lithium products to the battery sector, with very high margins, and world leading ESG credentials.

In short, an expanded Kachi project could be best in class globally.

Figure 10: Key parameters of the Kachi PFS

Production parameters	Units	PFS April	PFS March	Phases 1&2
Annual production	Tonnes LCE	25,500	25,500	51,200
Annual production	Tonnes contained lithium	4,801	4,801	9,619
Life of project production	Tonnes LCE	638,000	638,000	1,250,000
Project life	Years	25	25	25
Brines extracted and treated	Million m ³ per annum	23	23	46
Lithium grade to DLE plant	Mg/litre	250	250	250
Average recovery rate	%	83.2	83.2	83.2
Lithium carbonate grade	%	99.9	99.9	99.9
Indicated mineral resource	Million tonnes LCE	1.01	1.01	2.00*
Financial parameters				
Initial capital costs	US\$ millions	544	544	856
Operating costs	US\$/t	4,178	4,178	3,198
All-in sustaining costs	US\$/t	5,100	5,100	4,570
Lithium carbonate price (99.9%)	US\$/t	11,000	15,500	15,500
Margin over C1 cash costs	US\$/t	6,822	11,322	12,302
Revenues, at full production	US\$ millions per annum	280	395	794
Revenues, life of project	US\$ millions	7,030	9,845	18,648
EBITDA, cumulative first 3 years	US\$ millions	442	743	743
EBITDA at full production	US\$ millions per annum	155	261	571
EBITDA, life of project	US\$ millions	3,890	6,402	12,510
NPV ₈ , pre-tax	US\$ millions	1,050	2,170	4,940
NPV ₈ , post-tax	US\$ millions	748	1,580	3,768
IRR, pre-tax	%	25	42	60
IRR, post-tax	%	22	35	53
Payback period from first production	Years	5	3	1-2

Note * = anticipated end-2021

Source: Lake Resources

Modelling expansion

The financial impact of expanding Kachi is examined based on Phase 2 coming on stream in 2028, selling prices of US\$15,500/t LCE as per the revised PFS, and standardized estimates for capital and operating costs. This exercise reveals a number of significant potential outcomes:

- Post-tax NPV₈ of US\$3.8bn
- IRR of 53%
- Annual EBITDA of US\$571m from 2028
- Capex for phase 2 of just US\$312m, representing US\$12,200 per tonne of additional capacity
- Operating costs of US\$3,200/t for the two phases combined, down from US\$4,200/t for Phase 1, and putting Kachi amongst the lowest cost producers globally

Key assumptions

Capacity of 51,200 tpa

The assumed capacity of 51,200 tpa is derived from scaling the brine flow rate in the PFS (2,927 m³/h), and assumptions for plant availability (90%) and recovery rates (83.2%). The brine is assumed to contain 250 mg/L lithium, as per the current resource.

Timing

The Kachi project is expected to start-up in 2H24, reaching 85% capacity utilisation in 2025, and full production of 25,557 tpa in 2026. Phase 2, comprising an additional 25,600 tpa is assumed to come on stream in 2028.

Figure 11: Estimated production profile with Phase 2 coming on stream in 2028

		2024	2025	2026	2027	2028	2029	2030
Production	Tonnes LCE	3,834	21,724	25,557	25,557	51,200	51,200	51,200

Source: Orior Capital

Companies developing capital intensive projects often aim to reduce upfront capital costs by phasing development. Sometimes, this is to appease existing shareholders who may not welcome a large capital raising. Strategic partners often want the opposite. Usually well-funded, they aim to complete projects in short order. The assumption is that construction of Phase 2 commences in 2026, after 'Phase 1' has been in operation for more than a year. In practice, this timetable may be accelerated. Lithium Americas is developing the Cauchari-Olaroz project in Argentina with Ganfeng Lithium. In May 2021, Lithium Americas and Ganfeng Lithium announced the start of development of Phase 2 of the project, about one year before Phase 1 is scheduled to come on stream.

Project life time

Cash flows are modelled up to 2050, after which it is assumed the operation terminates. Phase 1 is assumed to operate from 2024 to 2050, and Phase 2 from 2028 to 2050. This is conservative. Given the substantial inferred resource and the resource target, management will hope to extend the project well beyond 2050.

Resources

Based on these assumptions the project would utilise ~1.5Mt LCE of resource. This is about one-third of the current inferred resource of 4.4Mt contained LCE, but greater than the current indicated resource of 1.1Mt contained LCE. In May 2021, Lake announced, under JORC guidelines 2018, a new drill program aimed at upgrading resources, partly to generate a JORC compliant reserve for the ongoing DFS, and partly to allow for potential capacity expansion. **Assuming resources can be upgraded, there is plenty of scope for Kachi to become a significant scale, multi-decade project.** There could also be potential for further expansion.

The current resource comprises an indicated resource of 1.1Mt LCE located in the central area of the project, and an inferred resource of 3.4Mt LCE in the surrounding area. Brine bearing sediments remain open at depth and laterally. Management has an exploration target of 8Mt to 17Mt LCE.

Capital costs

Companies often derive substantial unit cost savings from capacity expansion, both in terms of capex costs and operating costs. Capex estimates for the expansion are based on the PFS capital costs being scaled using the 'six-tenths rule', as explained in AusIMM Monograph 27 – The Cost Estimation Handbook (2nd Edition, 2012). According to the rule, the cost of expansion may be estimated by the following: Phase 1 cost x [(Total capacity / Phase 1 capacity) ^0.6].

Applying this to the expected cost breakdown from the Kachi PFS, and assuming the engineering and construction costs (EPCM) are the same as for Phase 1, suggests an incremental capital cost for Phase 2 of US\$312m. Total capital for the project, Phases 1 and 2 combined, would be US\$856m.

Unit capital costs for Phase 2 would be US\$12,200/t, down from ~US\$21,000/t for Phase 1.

Figure 12: Capital cost estimates based on the Six-Tenths rule

US\$ m	Phase 1	Phases 1 and 2	Incremental
Direct costs	331.0	501.7	170.7
Wellfield	25.3	38.4	13.1
DX processing	67.3	102.0	34.7
Carbonate processing plant	24.2	36.6	12.5
Regeneration plant	69.7	105.7	36.0
Earthworks & services	126.6	191.8	65.3
Infrastructure & support	17.9	27.1	9.2
Indirect Costs	122.3	211.6	89.3
Construction indirect	68.3	103.5	35.2
EPCM allocation	54.1	108.1	54.1
Total direct & indirect costs	453.4	713.4	260.0
Contingency	90.9	143.1	52.2
Total capital cost	544.3	856.5	312.2

Source: Lake Resources, Orior Capital

Operating costs

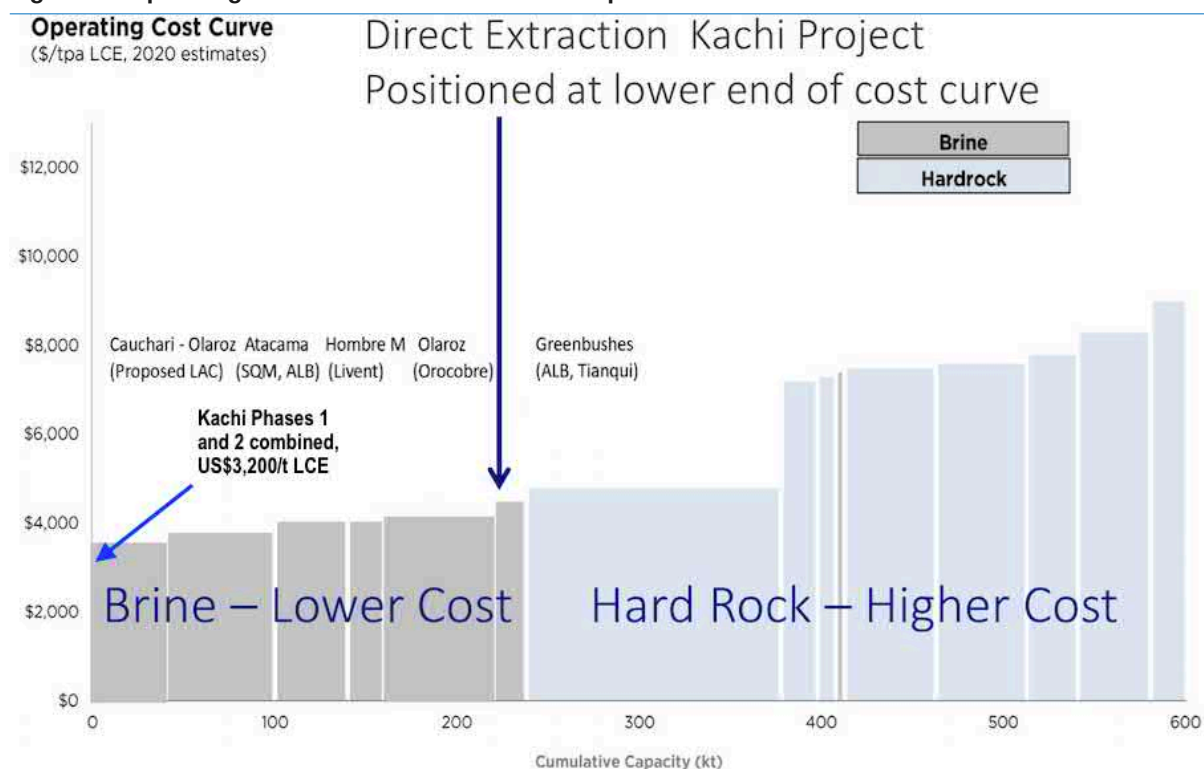
The six-tenths rule can also be applied to operating costs. Applying the rule to all costs except for transportation costs, which would be expected to double, suggests unit operating costs could decline from US\$4,200/t during Phase 1 to US\$3,200/t when both phases are up and running. This approximate US\$1,000/t saving in operating costs is significant. Based on an expanded capacity of 51,200 tpa, this operating cost saving alone represents an increase in EBITDA of US\$51m pa.

Figure 13: Operating cost estimates based on the Six-Tenths rule

	Phase 1 US\$ m	Phases 1 & 2 US\$ m	Change %	Phase 1 US\$/t LCE	Phases 1 & 2 US\$/t LCE	Change %
Operating costs	96.2	145.9	52%	3,763	2,850	-24%
General, admin	7.2	10.9	52%	281	213	-24%
Transportation	3.5	6.9	100%	135	135	0%
Total	106.8	163.7	53%	4,179	3,198	-23%

Source: Lake Resources, Orior Capital

This would make Kachi one of the lowest cost producers globally, especially of high quality lithium products.

Figure 14: Operating cost curve with estimated cost position for Kachi Phases 1 and 2 combined

Source: Lake Resources, Orior Capital

For both capital and operating costs, detailed expansion studies may reveal cost savings that are better than these broad-brush estimates. For example, Lake is currently assessing the use of solar hybrid power. This could lower both operating costs, and the total carbon footprint.

Lithium prices

Prices for lithium carbonate are assumed to be US\$15,500/t, the same price that management adopted in the refreshed PFS, which is based on Lake producing 99.9% lithium carbonate. Subsequently, Lake has demonstrated the capability to produce as high as 99.97%, a substantially purer product that is expected to command a premium price.

Margins

The net impact of doubling production volumes and lower operating costs could be that annual EBITDA rises from US\$261m during Phase 1 to US\$571m once Phase 2 comes on stream, based on US\$15,500/t lithium carbonate.

One of the factors expected to set Lake Resources apart from current lithium producers is that **all of Lake's product is expected to be high-purity, 'battery grade' product**. This is not the case for current producers who tend to produce a mix of different grades. This is evidenced in the average selling prices achieved, and in the operating margins. The superior margins expected to be achieved by Lake compared to existing producers is one factor likely to drive higher valuations.

Taxes and royalties

A 3% royalty is paid to the Province of Catamarca. Argentinian export taxes are 12%, but a cap on the Peso:USD exchange rate makes the effective rate about 5%. A change in the exchange rate cap could impact the effective export tax rate. Corporation tax is 25%.

Sensitivity

The expansion modelling is sensitive to a number of key inputs.

Reducing selling prices by 10% to US\$13,950/t LCE would reduce the post-tax NPV₈ by 14% to US\$3.3bn.

Increasing the capex for Phase 2 by US\$100m would lower the post-tax NPV₈ by 3% to US\$3.7bn.

Increasing operating expenses for Phase 2 by 10% (US\$320/t LCE) would lower the post-tax NPV₈ by 3% to US\$3.7bn.

Figure 15: Kachi EBITDA estimate

		2024	2025	2026	2027	2028	2029	2030 to 2050
Production								
Production ramp up		15%	85%	100%	100%	100%	100%	100%
Brine extracted	million m ³	3.5	19.6	23.1	23.1	46.2	46.2	46.2
Brine treated	million m ³	3.5	19.6	23.1	23.1	46.2	46.2	46.2
Concentration	mg/L	250	250	250	250	250	250	250
Contained lithium in brine treated	Tonnes Li Tonnes Li ₂ CO ₃	865 4,607	4,904 26,106	5,770 30,712	5,770 30,712	11,559 61,527	11,559 61,527	11,559 61,527
Recovery		83%	83%	83%	83%	83%	83%	83%
Recovered lithium	Tonnes Li	720	4,081	4,801	4,801	9,619	9,619	9,619
Recovered lithium	Tonnes Li ₂ CO ₃	3,834	21,724	25,557	25,557	51,200	51,200	51,200
Lithium product sold	Tonnes Li	720	4,081	4,801	4,801	9,619	9,619	9,619
Lithium product sold	Tonnes Li ₂ CO ₃	3,834	21,724	25,557	25,557	51,200	51,200	51,200
Profit and loss								
Selling price	US\$/t LCE	15,500	15,500	15,500	15,500	15,500	15,500	15,500
Revenues	US\$ m	59.4	336.7	396.1	396.1	793.6	793.6	793.6
COGS	US\$ m		90.8	106.8	106.8	163.7	163.7	163.7
Unit COGS	US\$/t LCE		4,179	4,179	4,179	3,198	3,198	3,198
Royalties, export tax	US\$ m	4.8	24.2	28.5	28.5	58.6	58.6	58.6
Royalty to Catamarca	US\$ m	1.8	7.4	8.7	8.7	18.9	18.9	18.9
Royalty to Catamarca		3%	3%	3%	3%	3%	3%	3%
Argentine export tax	US\$ m	3.0	16.8	19.8	19.8	39.7	39.7	39.7
Argentine export tax		5%	5%	5%	5%	5%	5%	5%
EBITDA	US\$ m	54.7	221.7	260.9	260.9	571.3	571.3	571.3

Source: Orior Capital

Bring on the lithium decade

- Lithium demand is set to rise ~10x over the next decade driven by increasing EV penetration and developments in energy storage
- Meeting this demand will require 52 'expanded Kachi projects' and more than US\$30bn in new investment
- There are legitimate concerns as to whether supply will be able to keep pace

The lithium sector is on the cusp of a period of embryonic demand growth which could see demand rise ten-fold over the next decade. Government policy incentives, a new determination among the global automakers to invest in EVs, falling battery costs, and private sector commitments from vehicle fleet users will all contribute to a step change in the industry. The International Energy Agency's (IEA) Sustainable Development Scenario is based on EV sales reaching more than 46m units in 2030. Assuming average battery sizes continue to grow to say 70 kWh by 2030, the EV battery market could reach 3.2 TWh by 2030, requiring some 2.7m tpa LCE. Adding in demand from energy storage systems and traditional sectors, **lithium demand could exceed 3.0m tpa LCE by 2030. This is ~10x the size of the current market.**

Assuming current lithium capacity is 400,000 tpa LCE, this will mean adding more than 2.6m tpa LCE over the rest of this decade. This represents 37x SQM's production of lithium products in 2020. **It represents 52 expanded Kachi projects.** Realistically the only viable way to achieve this is by the rapid deployment of DLE type projects. In terms of investment, assuming that average capex costs can be brought down to say US\$12,000/t, total investment of more than US\$30bn will be needed, into an industry that today generates about US\$3bn pa. **There are legitimate concerns as to whether the supply side will be able to keep up.**

Even these figures could turn out to be conservative. Over the past year, commitments from global automakers have shifted from tracking the IEA's Stated Policies Scenario, to be in line with the more optimistic Sustainable Development Scenario by 2025. The US is committing substantial funds to electrifying transportation.

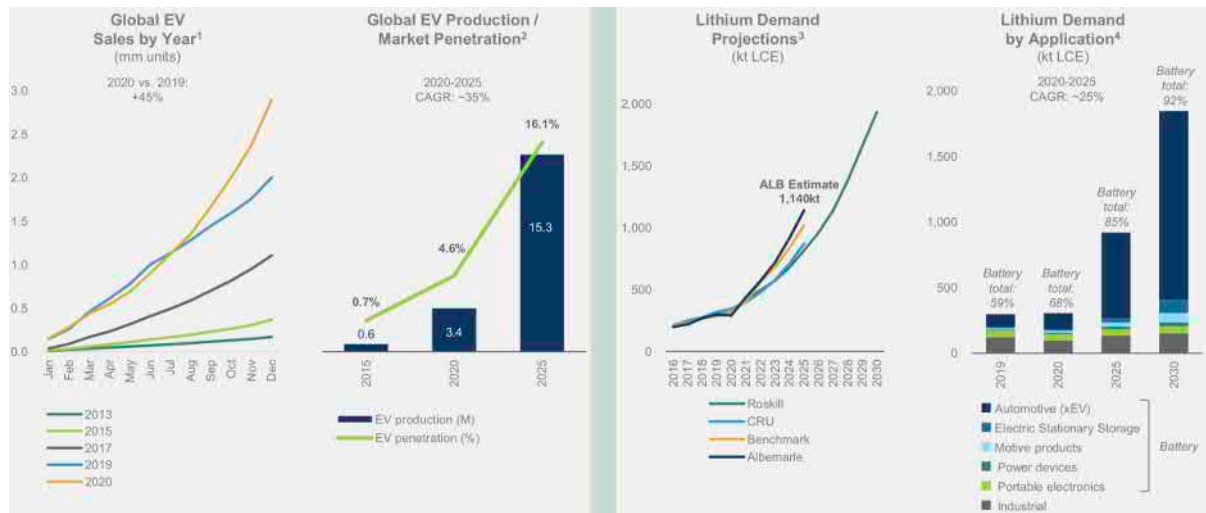
Albemarle raises demand forecasts

Albemarle set out its forecasts for lithium demand in its March 2021 Investor Presentation. The company now expects demand to reach 1.14m tonnes LCE by 2025, up from estimated demand of 292,000 tonnes in 2020, and representing **demand growth of 31% pa over the next five years.** These forecasts are built off the assumptions that global EV penetration will rise from an estimated 4.6% of global new car sales in 2020, to 19% by 2025, and that battery sizes will increase from an average of 40 kWh per EV in 2020 to 55 kWh per EV in 2025.

Over the past two and a half years, Albemarle has raised its forecast of 2025 demand by 340,000 tonnes LCE. This represents the need for roughly one additional lithium project every 3 months.

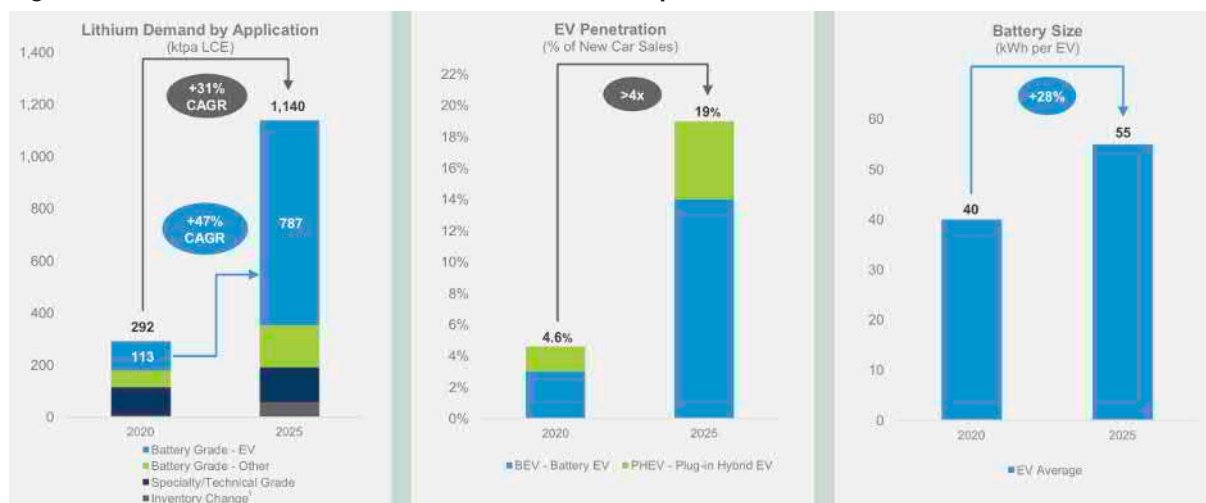
In Albemarle’s February 2021 results call, the company’s CEO Kent Masters, said he recognised that Albemarle’s demand forecasts were higher than those of most independent industry analysts, noting that Albemarle uses “external estimates, internal forecasts and discussions with our strategic customers and suppliers to generate a detailed demand forecast”. He also observed that Albemarle’s forecasts are lower than “some of the more ambitious targets from auto OEMs”.

Figure 16: Strong lithium demand driven by EV’s



Source: Albemarle Corp, March 2021

Figure 17: Albemarle’s lithium demand forecast revised upwards



Source: Albemarle Corp, March 2021

Despite this apparent bullishness, Albemarle’s forecasts do not include two factors that could drive demand further. One is regulation. Mr Masters noted that if the US were to adopt European style incentives to drive EV adoption it would be incremental to these forecasts. Now it appears the US government is doing just that. Another factor is that Albemarle’s forecasts do not assume major changes in battery technology. Mr Masters noted that “advanced battery technologies such as solid state batteries could potentially increase lithium intensity later this decade”.

<https://investors.albemarle.com/events/event-details/q4-2020-albemarle-corporation-earnings-conference-call>

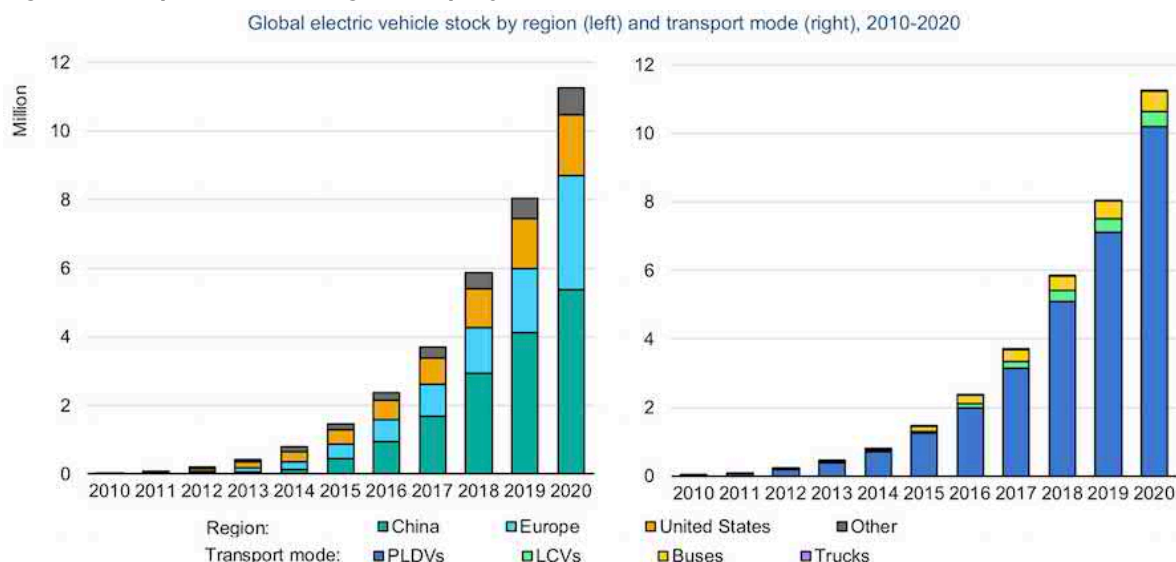
<https://investors.albemarle.com/static-files/68a11b21-735f-416f-b8bd-35e516fd30f9>

US President Joe Biden’s American Jobs Plan calls for some US\$2.3 trillion to be invested in multiple sectors including US\$174bn to build out domestic supply chains for electric vehicles. The plans include raising the limit of 200,000 vehicles per automaker on which incentives apply (which has put early movers Tesla and GM at a disadvantage), raising incentives to as much as US\$12,500/vehicle, building a national network of 500,000 charging stations by 2030, and replacing 50,000 diesel transit vehicles and 20% of US school buses. The bill includes a 30% tax credit for manufacturers to retool. The plans need to be approved by Congress before becoming law.

IEA’s Sustainable Development Scenario looks likely

According to the International Energy Agency (IEA), the global stock of passenger vehicles reached 11.3m at the end of 2020, including 10.2m electric cars. Registrations of electric cars rose by 41% last year. This is despite a pandemic-impacted decline in overall car sales of 6%. About 44% of this stock of cars is in China, though Europe overtook China last year as the largest EV market.

Figure 18: EV penetration has grown rapidly



IEA. All rights reserved.

Notes: PLDVs = passenger light-duty vehicles, LCVs = light-commercial vehicles. Electric vehicles include battery electric and plug-in hybrid electric vehicles. Europe includes EU27, Norway, Iceland, Switzerland and United Kingdom. Other includes Australia, Brazil, Canada, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand.

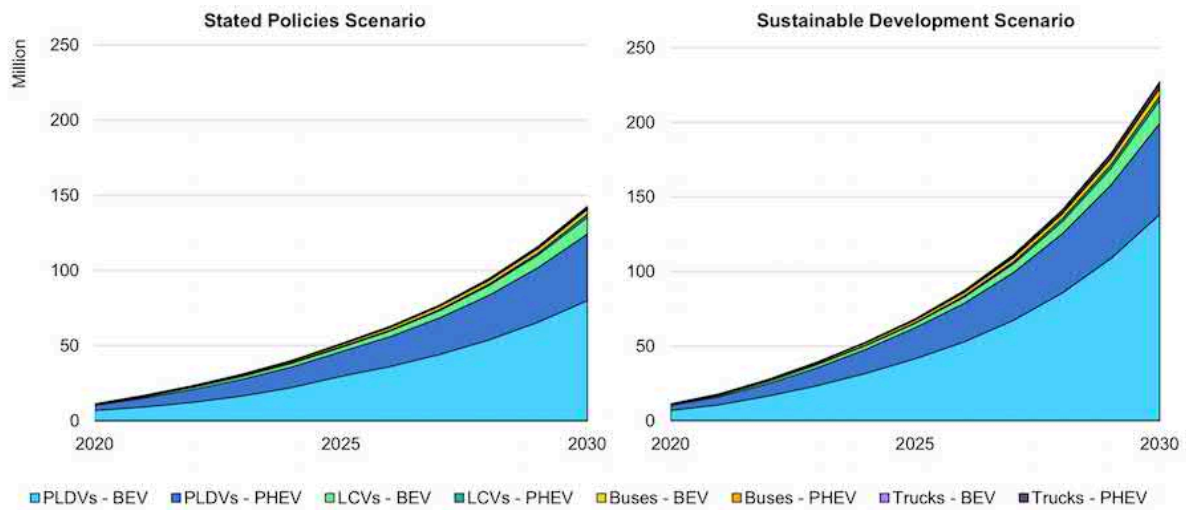
Source: IEA, Global EV Outlook, 2021

In its Global EV Outlook, 2021, the IEA presents two scenarios for future EV demand, based on different policy outcomes. In the Stated Policies Scenario, which takes into account existing policy announcements by various governments, the IEA expects the global stock of electric vehicles to expand from 11.3m units in 2020 to 51m vehicles in 2025, and almost 145m vehicles in 2030. This represents an average annual growth rate of ~29% pa this decade. By 2030, EVs are expected to account for ~7% of the global vehicle fleet with EV sales reaching nearly 15m units in 2025 (10% of all road vehicle sales) and more than 25m vehicles in 2030 (15%), according to the IEA.

The Sustainable Development Scenario is more ambitious. It is based on meeting the global climate goals in line with the Paris Agreement. In this scenario, the collective pledges of the Electric Vehicle Initiative’s EV30@30 Campaign to reach a 30% market share for EVs in all modes except two-wheelers by 2030 is surpassed, reaching almost 35%, and reflecting increasing ambitions for

widespread EV adoption. In this scenario, the global stock of electric vehicles reaches almost 75m vehicles in 2025, and 230m in 2030. By 2030, EV sales are expected to surpass 46m units pa.

Figure 19: Global EV stock by scenario

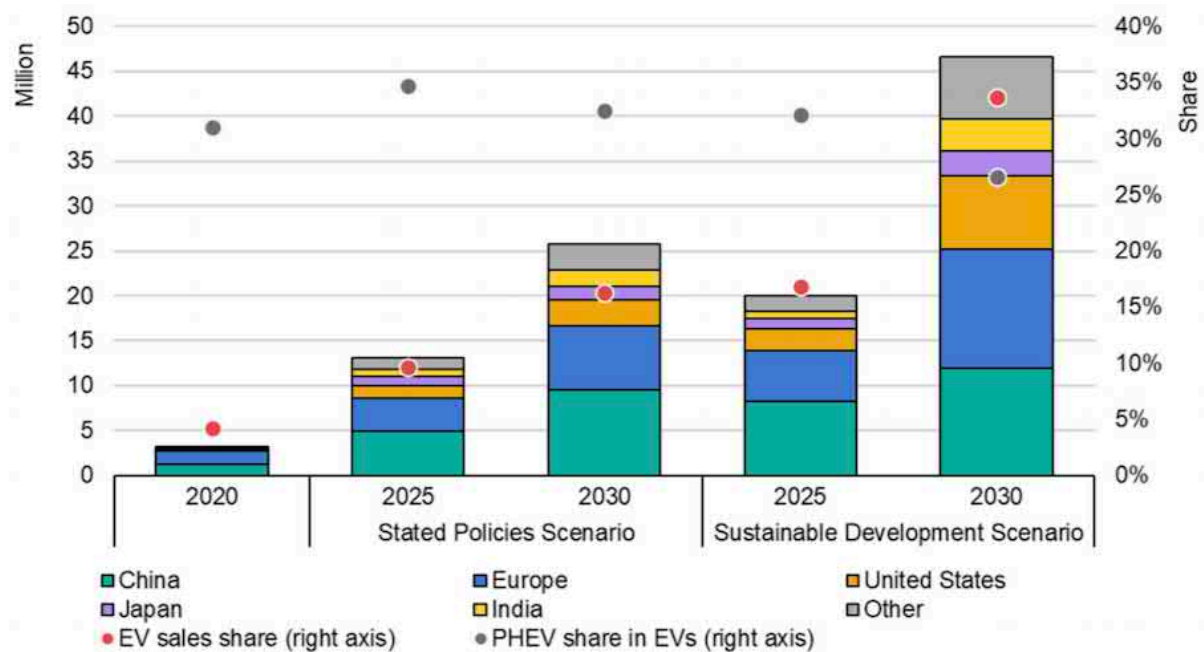


IEA, All rights reserved.

Notes: PLDVs = passenger light-duty vehicles; BEV = battery electric vehicle; LCVs = light-commercial vehicles; PHEV = plug-in hybrid electric vehicle. The figure does not include electric two/three-wheelers. For reference, total road EV stock (excluding two/three-wheelers) in 2030 is 2 billion in the Stated Policies Scenario and 1.9 billion in the Sustainable Development Scenario. Projected EV stock data by region can be interactively explored via the [Global EV Data Explorer](#).

Source: IEA, Global EV Outlook, 2021

Figure 20: Global EV sales by scenario and market



Source: IEA, Global EV Outlook, 2021

Automakers making big commitments

Over the past year, global automakers have made notable commitments to increase the range of EVs available and for EVs to represent a higher portion of sales. In 2020, there were 370 EV models available, up 40% from 2019. Although China has the largest range, the number of models available in Europe doubled last year. According to the IEA, 18 of the 20 top automotive manufacturers, accounting for nearly 90% of 2020 vehicle sales, plan to increase the number of available models and to boost EV production. Some OEMs are planning to reconfigure their product offerings to eliminate internal combustion engine models altogether and to sell only EVs. Key announcements include:

- General Motors said, January 2021, it planned to offer only electric light-duty vehicles by 2035. GM plans to offer 30 all-electric models globally by mid-decade, with 40% of the company's U.S. models offered being battery EVs by the end of 2025. GM is investing US\$27bn in electric and autonomous vehicles in the next five years, up from US\$20bn planned before COVID-19.
- BMW revealed, March 2021, that it expects fully electric vehicles to account for at least 50% of global deliveries by 2030.
- Volvo stated, March 2021, that it plans to become electric by 2030, and will phase out any car in its global portfolio with an internal combustion engine, including hybrids. By 2025, Volvo aims for 50% of its global sales to be fully electric, with the rest hybrids.
- Stellantis was formed in 2021 from the merger of Fiat Chrysler Automobiles and French Group PSA (Peugeot). The group has 14 vehicle brands including Alfa Romeo, Chrysler, Citroën, Dodge, Fiat, Jeep, Maserati, Peugeot, Ram and Vauxhall. In April 2021, Stellantis said it aims to increase EV sales to as much as 70% of total sales in Europe, and to 35% of sales in the US, by 2030.
- Ford announced, May 2021, a new goal of 40% of global sales being electric by 2030.
- Volkswagen stated, May 2021, that it expects all-electric vehicles to exceed 70% of European and 50% of Chinese and US sales volumes by 2030.

General Motors:

<https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jan/0128-carbon.html>

BMW: <https://www.press.bmwgroup.com/global/article/detail/T0327929EN/a-new-era-a-new-class-bmw-group-steps-up-technology-offensive-with-comprehensive-realignment-e2-80-93>

Volvo: <https://www.media.volvocars.com/global/en-gb/media/pressreleases/277409/volvo-cars-to-be-fully-electric-by-2030>

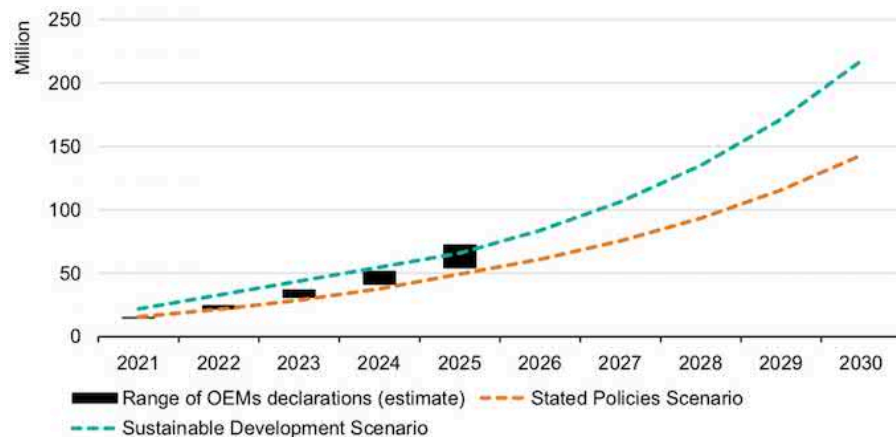
Stellantis: <https://www.electrive.com/2021/04/18/stellantis-reveals-key-details-of-electrification-plans/>

Ford: <https://media.ford.com/content/fordmedia/feu/en/news/2021/02/17/ford-europe-goes-all-in-on-evs-on-road-to-sustainable-profitabil.html>

Volkswagen: <https://www.volkswagen-newsroom.com/en/press-releases/volkswagen-is-accelerating-transformation-into-software-driven-mobility-provider-6878>

The IEA estimates that combined, the announcements by the various OEMs suggest EV sales of 55m to 73m units by 2025. While in the immediate term, planned sales are in line with the Stated Policies Scenario, by 2025, sales are expected to be more in line with the Sustainable Development Scenario.

Figure 21: OEM announcements compared to EV stock projections in two IEA scenarios, 2021-2025



Source: IEA, Global EV Outlook, 2021

Vehicle fleet operators buying in

There has also been strong buy-in from international commercial vehicle fleet users, with companies committing to switch to electric vehicles. Amazon has ordered 100,000 light-commercial EVs from Rivian, and aims to be net-zero emissions by 2040. Walmart plans to electrify its entire vehicle fleet by 2040.

Figure 22: Private sector declarations related to electric commercial vehicles

Company	Operating area	Announced	Target / actions
Amazon	Global	2020	Orders 100 000 BEV light-commercial vehicles from start-up company Rivian. Amazon aims to be net-zero emissions by 2040.
Anheuser-Busch	United States	2019	Orders up to 800 hydrogen fuel cell Nikola heavy-duty trucks.
DHL Group	Global	2019	Delivery of mail and parcels by EVs in the medium term and net-zero emissions logistics by 2050.
FedEx	Global	2018	Transition to an all zero-emission vehicle fleet and carbon neutral operations by 2040.
H ₂ Mobility Association	Switzerland	2019	19 of Switzerland's largest retailers invest in Hyundai hydrogen trucking services that will deploy up to 1 600 heavy-duty zero-emission trucks.
Ingka Group (IKEA)	Global	2018	Zero-emission deliveries in leading cities by 2020 and in all cities by 2025.
Japan Post	Japan	2019	Electrify 1 200 mail and parcel delivery vans by 2021 and net-zero emissions logistics by 2050.
JD	China	2017	Replace entire vehicle fleet (> 10 000) with New Energy Vehicles by 2022.
SF Express	China	2018	Launch nearly 10 000 BEV logistics vehicles.
Suning	China	2018	Independent retailer's Qingcheng Plan will deploy 5 000 new energy logistics vehicles.
UPS	North America	2019	Order 10 000 BEV light-commercial vehicles with potential for a second order.
Various companies	Multinational	2018	Walmart, Pepsi, Anheuser-Busch, FedEx, Sysco and other large multinational corporations pre-order 2 000 Tesla Semi models within six months of truck's debut.
Walmart	United States	2020	Electrify the whole vehicle fleet by 2040.

Source: IEA, Global EV Outlook, 2021

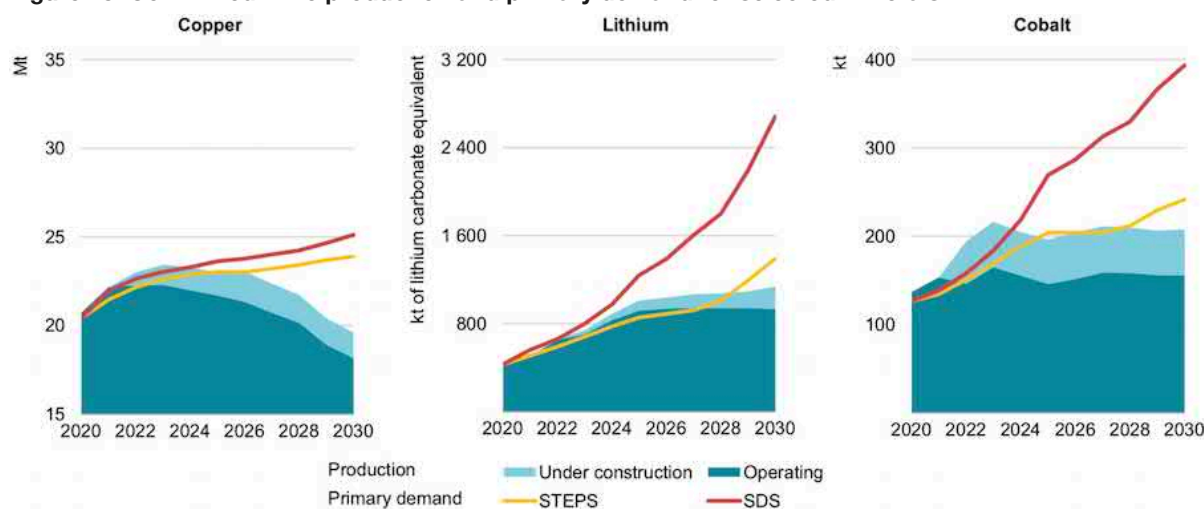
Supply-side issues need to be addressed

There are number of supply-side issues that will need to be addressed if global climate goals and these EV demand forecasts are to be met.

Funding

Meeting demand will require funding of tens of billions of dollars. Export credit agencies and other government related financing groups are likely to play a lead role. In the IEA's Sustainable Development Scenario there will be severe shortages of lithium by the mid-2020s unless new projects, not currently under construction, are brought on stream.

Figure 23: Committed mine production and primary demand for selected minerals



Source: The Role of Critical Minerals in Clean Energy Transitions, IEA, 2021

A shift away from evaporation ponds to DLE

Evaporation ponds are essentially a 1st Century technology that was used by the Romans to produce salt. They are slow to establish, and to expand, have low recoveries, and have come under environmental scrutiny, especially in Chile. The lithium industry is now at the forefront of a 'technology-upgrading' that will see far greater use of DLE. Surely, the best way for companies operating on the Salar de Atacama to improve lithium recoveries and address environmental concerns would be to invest in DLE processes.

A need to diversify supply

Today, lithium is mainly produced either via inefficient evaporation ponds in South America or from Australian hard rock sources that are processed in China. Neither is ideal from the perspective of a western world automaker. Developing DLE projects in South America, as well as in the US and Europe, will create more diversified supply chains.

Direct lithium extraction coming of age

- A rapid deployment of lithium capacity over the next few years will lead to greater environmental scrutiny of extraction processes; direct lithium extraction offers significant environmental and other benefits
- BMW has signed an offtake agreement with Livent; Schlumberger, Panasonic and Mitsui have announced DLE related projects
- DLE is expected to become the primary lithium extraction technology this decade

Need for a better solution

A combination of factors including lithium being a critical mineral in the bid to decarbonize; production capacity needing to increase eight-fold over the next decade to meet current demand estimates; and the growing relationship between sustainability and financing, all suggest the ESG credentials of lithium extraction methods will be subjected to closer scrutiny in the coming years by customers, regulators, and local communities. Only projects that adhere to strict environmental standards are likely to proceed.

Lithium extraction from salt brines is already facing opposition in Chile. According to Fitch Solutions, extraction from the lithium triangle salt flats has been highly water-intensive, requiring about 2m litres of water per tonne of lithium extracted. Fitch believes this presents a risk of water shortages for future agricultural needs in an area already regarded as one of the driest on Earth. Further, the risk of pollution of local water supplies may result in rising opposition to new lithium operations. Indigenous communities in the lithium triangle have voiced opposition to lithium extraction.

The only realistic option to achieve both the growth in supply required, and sustainability, is to use direct lithium extraction. **DLE is expected to become the primary method of lithium extraction over the next few years.** At some stage, lithium producers currently using evaporation ponds are likely to come under pressure to upgrade facilities and use some form of DLE.

It's already happening

In March 2021, BMW secured a €285m lithium chemicals purchase agreement with Livent, with BMW citing Livent's "unique technology" for producing lithium. Livent operates what is currently the only commercial hybrid direct extraction operation in the western hemisphere.

Also in March 2021, Schlumberger announced the development of a lithium extraction pilot plant in Clayton Valley, Nevada, USA through a new venture called NeoLith Energy. NeoLith uses a DLE process. Last week, Schlumberger said it would collaborate with Panasonic Energy of North America, with Panasonic providing guidance to validate and optimize material for battery-grade consumption. The NeoLith pilot plant is located some 200 miles from Panasonic's battery manufacturing operation, Panasonic Energy of North America, in Sparks, Nevada.

In May 2021, Mitsui announced an MOU with Lithium Power International that will include collaboration on future DLE based projects.

Also in May 2021, Eramet and Électricité de Strasbourg announced they had successfully extracted lithium from geothermal brine during pilot-scale tests in early-2021 at the Rittershoffen geothermal power plant in northern Alsace, France. Eramet used a DLE process developed as part of its Centenario Lithium project in Argentina.

Last week, Albemarle was reported to be introducing a way of extracting more lithium from its brine resources, lifting yields from 50-55% to 80-85%. The project has a budget of under US\$200m, and is expected to take 18 months to implement. Although details are scant at this stage, this is expected to be another DLE based process.

Jade Cove Partners, a superb resource for direct extraction technologies in lithium, is now tracking 70 DLE technology solutions in development and operation around the world.

DLE offers substantial and sustainable advantages

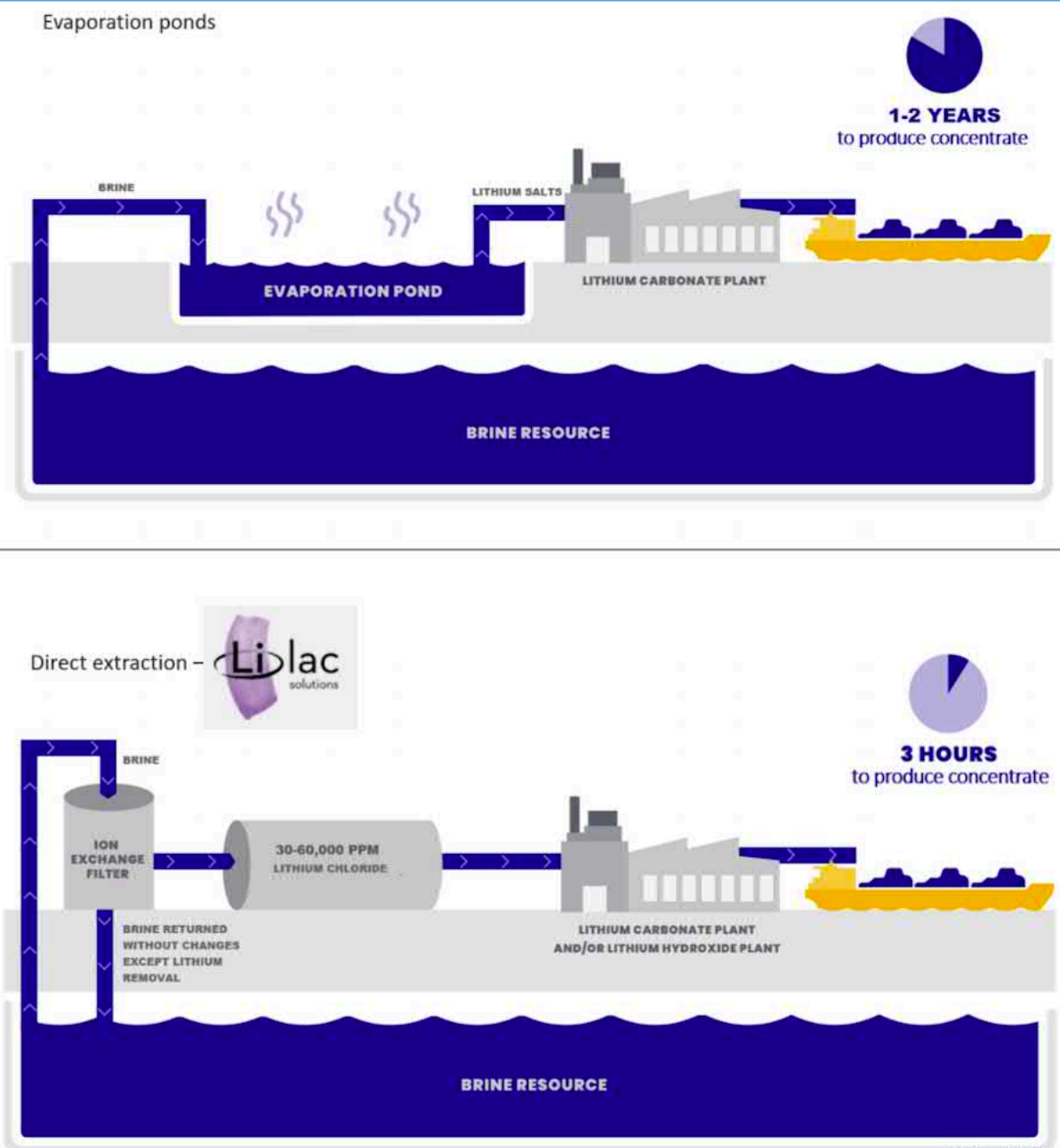
In an evaporation pond operation, brine is pumped to the surface, left to sit in giant ponds for months (or years) while the water evaporates, and then chemical reagents are used to remove the impurities. Start-up times are slow. It is difficult to expand capacity. Companies adopting this model often focus on lithium grades, and magnesium to lithium (Mg/Li) and sulphates to lithium (SO₄/Li) ratios because these determine how much chemistry is needed. Every brine is different, meaning that a new flowsheet has to be developed for each project.

Direct extraction largely negates these issues. It allows lithium to be removed from brine without first being concentrated. The numerous steps involved in impurity removal in evaporation based processes are not required in DLE. Further, Mg/Li and SO₄/Li ratios are far less relevant. In the Lilac Solutions process, only the lithium is removed; the brine is returned to the ground without chemical interference. All this has obvious advantages. Although many of the recent developments in direct extraction as applied to lithium are new, direct extraction itself, especially ion-exchange, is well established in the water treatment industry for more than 50 years.

The advantages of DLE include:

- Lithium recoveries are as high as 80-90%, compared to 50-60% for evaporation ponds
- This means lower grade brines can be used and still produce high-grade eluate feedstock grading 50,000 to 60,000 mg/L lithium
- The processing time is 2-3 hours, not 9-18 months
- The process is repeatable; it is essential for battery makers to have consistent product
- It is not subject to the vagaries of the weather such as rain which can dilute ponds, or prolonged cloudy periods which can impact the rate of evaporation
- The environmental footprint is substantially smaller
- The brine is returned to the aquifer, after the lithium is removed, without being chemically modified
- The technology can be scaled easily and quickly

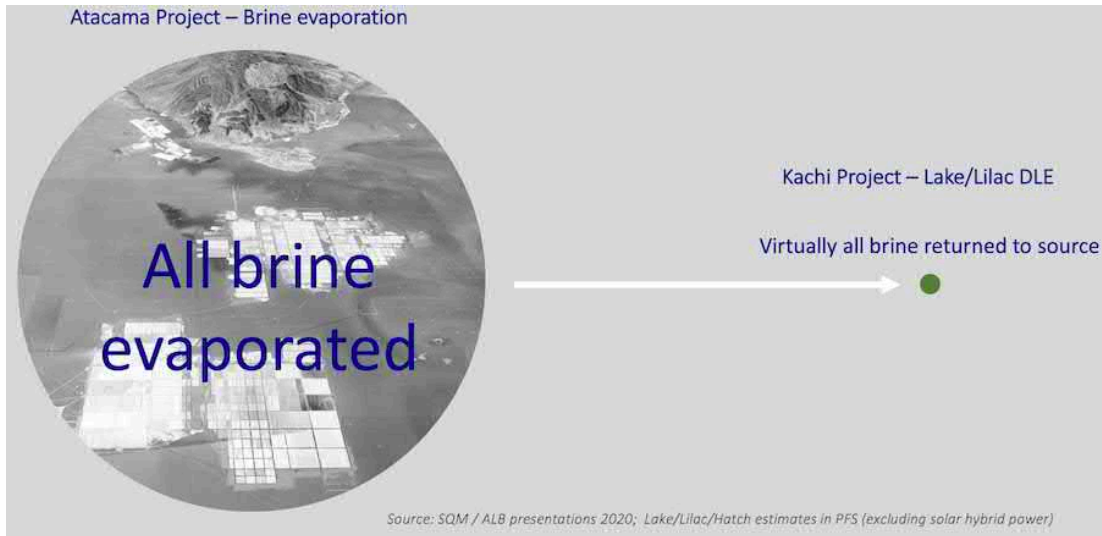
Figure 24: First century technology versus 21- century technology



Source: Lake Resources

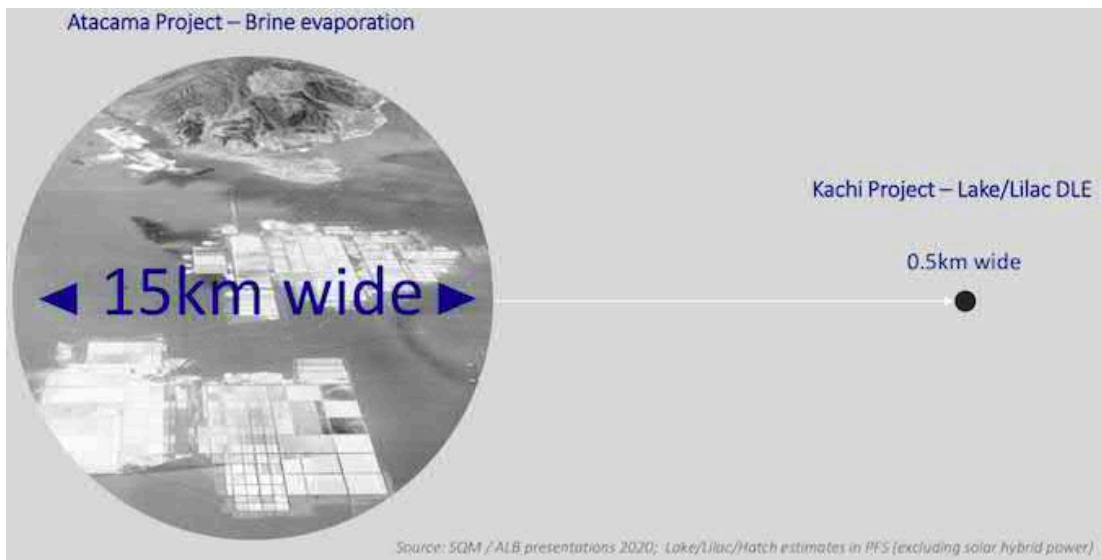
<https://www.mining.com/esg-to-assume-center-stage-in-lithium-extraction-report/>
<https://www.press.bmwgroup.com/global/article/detail/T0328669EN/bmw-group-steps-up-sustainable-sourcing-of-lithium-for-battery-cell-production-to-ensure-rapid-e-mobility-expansion?language=en>
<https://www.slb.com/newsroom/press-release/2021/pr-2021-0610-sne-panasonic>
<https://www.aramet.com/sites/default/files/2021-05/Eramet-ES-PR-EuGeLi-11052021.pdf>
 Jade Cove Partners, a valuable resource in DLE <https://www.jadecove.com>
<https://www.mining.com/web/albemarle-to-boost-extraction-in-search-for-green-growth/>

Figure 25: With DLE, virtually all brine is returned to the aquifer



Source: Lake Resources

Figure 26: Kachi benefits from significantly less land use



Source: Lake Resources

Figure 27: DLE has a smaller carbon footprint, Kg CO₂e/kg product



Source: Lake Resources

Appendix 1: Lake Resources' assets

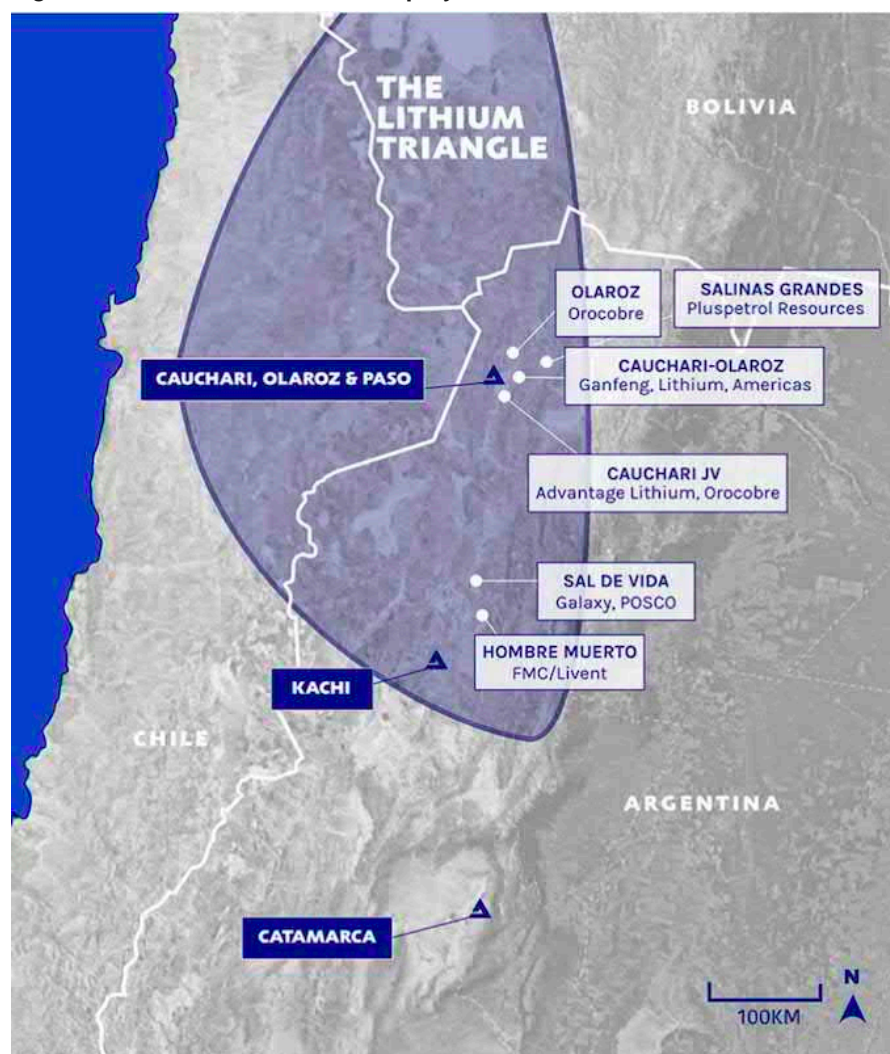
Lake Resources is developing five lithium projects in Argentina. Four of these are lithium brines projects, and one is a pegmatite project. The company has the largest lithium lease holding in Argentina, amounting to more than 2,200 km², all of which it owns 100%.

Figure 28: Lake Resources lithium projects, Argentina

Project	Area, km ²	Province
Brine		
Kachi	744	Catamarca
Cauchari	37	Jujuy
Olaroz	142	Jujuy
Paso	296	Jujuy
Other areas	98	Catamarca
Pegmatite		
Catamarca	904	Catamarca
Total	2,221	

Source: Lake Resources

Figure 29: Lake Resources lithium projects



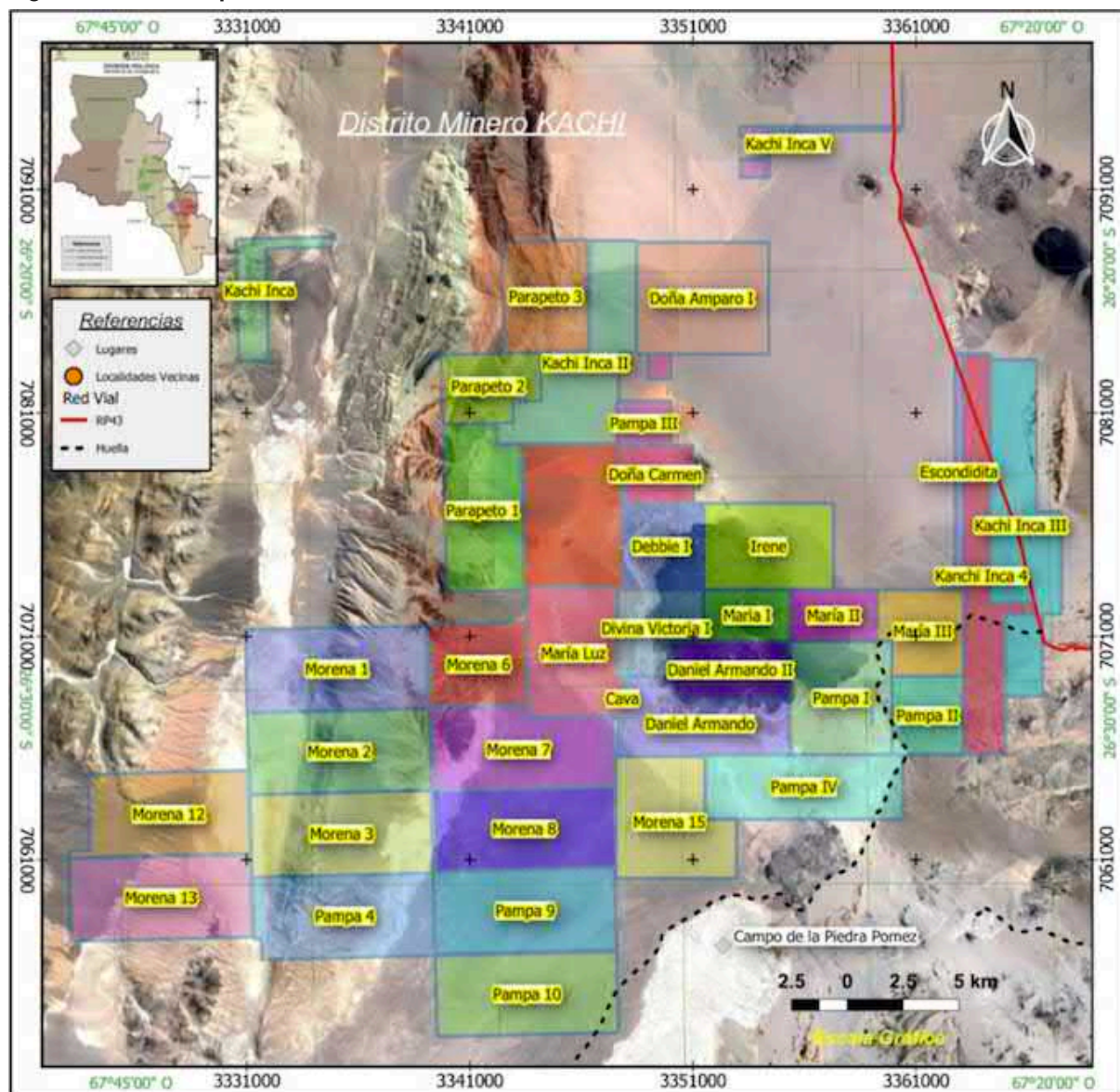
Source: Lake Resources

Kachi

Kachi is most advanced of Lake Resources' projects. The company released a maiden resource at Kachi of 4.4 million tonnes lithium carbonate equivalent (LCE) in November 2018. The PFS was released in April 2020 and refreshed in March 2021.

The project is held under 39 mineral concessions covering 74,382 hectares that are 100% owned by Lake Resources through its wholly owned Argentine subsidiary, Morena del Valle Minerals S.A. In Argentina, mineral rights are awarded by provincial governments as either exploration or mining licenses. All tenements at Kachi are held under mining licenses. The mineral licenses have no expiry date provided (small) annual fees are paid, and all obligations are met under the national mining code.

Figure 30: Kachi map of mineral licences



Source: Lake Resources

Figure 31: Kachi mining concessions

Name	Role No.	Area, Ha	Status
Kachi Inca	13-M-2016	858	Granted
Kachi Inca I	16-M-2016	2,881	Granted
Kachi Inca II	17-M-2016	2,823	Granted
Kachi Inca III	47-M-2016	3,354	Granted
Kachi Inca V	45-M-2016	305	Granted
Kachi Inca VI	44-M-2016	110	Granted
Dona Amparo I	22-M-2016	3,000	Granted
Dona Carmen	24-M-2016	874	Granted
Debbie I	21-M-2016	1,501	Granted
Divina Victoria I	25-M-2016	1,266	Granted
Daniel Armando	23-M-2016	2,116	Granted
Daniel Armando II	97-M-2016	1,388	Granted
Escondita	131-M-2018	373	Granted
Irene	28-M-2018	2,250	Granted
Maria Luz	34-M-2017	2,425	Granted
Maria I	140-M-2018	889	Granted
Maria II	14-M-2016	888	Granted
Maria III	15-M-2016	1,396	Granted
Morena 1	72-M-2016	3,025	Granted
Morena 2	73-M-2016	2,989	Granted
Morena 3	74-M-2016	3,007	Granted
Morena 4	29-M-2019	2,968	Granted
Morena 5	97-M-2017	1,415	Granted
Morena 6	75-M-2016	1,606	Granted
Morena 7	76-M-2016	2,805	Granted
Morena 8	77-M-2016	2,961	Granted
Morena 9	30-M-2016	2,822	Granted
Morena 12	78-M-2016	2,704	Granted
Morena 13	79-M-2016	3,024	Granted
Morena 15	162-M-2017	2,559	Granted
Pampa I	129-S-2013	2,312	Granted
Pampa II	128-M-2013	1,119	Granted
Pampa III	130-M-2013	477	Granted
Pampa IV	78-M-2017	2,569	Granted
Morena 11	201-M-2018	815	Granted
Parapeto 1	133-M-2018	2,504	Granted
Parapeto 2	134-M-2018	1,259	Granted
Parapeto 3	132-M-2018	1,892	Granted
Gold Sand 1	238-M-2018	853	Granted
39 Mining leases	Total	74,382	

Source: Lake Resources

The resource at Kachi is based on 15 drill holes totalling 3,150m, with depths of up to ~400m. Drilling revealed thick permeable sand dominated sediments that are believed to continue below the drilled levels, and beyond the surface dimensions of the salt lake.

The brine resource, begins at a depth of 50m from the surface and continues to 400m depth; it is assumed to be a constant 350m thick throughout the resource area. The seismic geophysical survey shows the host sediments extend well beyond 400m depth in the west of the basin.

The total Mineral Resource comprises a brine volume of 3.8 km³, with an average drainable porosity of 8% and mean lithium grade of 211 mg/L, for a total lithium content of 826,000 tonnes, or 4.4m tonnes LCE. Of this, the Indicated Resource comprises 1.01m tonnes LCE at an average grade of 289 mg/L lithium. A diluted head grade of 250 mg/L is used in the PFS.

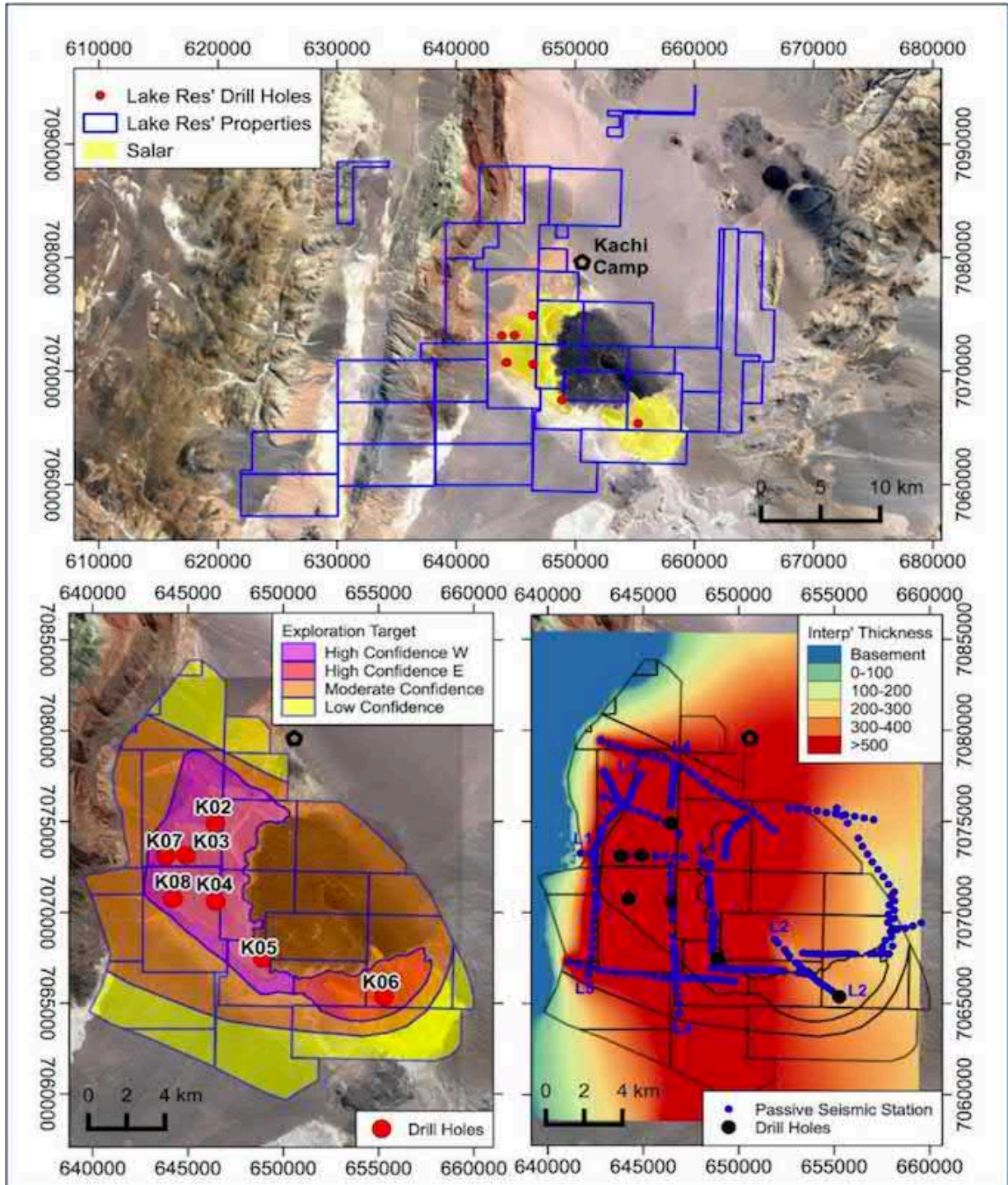
Figure 32: Kachi drilling results

Drill hole	Type	Total Depth m	Interval From To m m		Lithium mg/L	Magnesium mg/L	Potassium mg/L
Northern Area							
K07D01	Diamond	76	10	34	157	-	3,330
K03D02	Diamond	151	74	92	180	1,740	4,435
K03R03	Rotary	242	213	237	306	1,307	5,998
K03R12	Rotary	400	358	400	267	1,180	5,180
K02D13	Diamond	404	60	60	217	3,557	4,438
			64	108	182	2,884	3,620
			269	298	204	2,163	4,100
			313	343	252	1,411	4,987
Southern Area							
K06D04	Diamond	168	95	113	203	766	3,321
K06R05	Rotary	87	68	85	167	1,000	3,160
K06R06	Rotary	180	not sampled				
K06R07	Rotary	189	159	179	191	1,009	961
K06D08	Diamond	405	69	70	194	958	3,171
			120	121	191	873	3,199
			165	166	170	880	3,650
			206	206	164	894	3,590
			258	259	164	888	3,560
			354	405	170	877	3,670
K05D09	Diamond	139	62	62	83	1,229	965
			108	108	222	1,325	4,360
K05D11	Diamond	391	157	157	95	1,460	1,926
			188	188	215	919	3,596
			224	248	175	876	3,065
			289	289	143	1,088	2,251
			301	301	116	1,035	1,782
			291	334	234	3,199	4,980
K08R14	Rotary	364	301	361	326	1,232	6,038
			349	391	185	1,955	3,892
K04R15	Rotary	350	290	350	265	1,154	4,993

Note: Intervals shown as being 1m are point samples at that depth, taken with a downhole spear

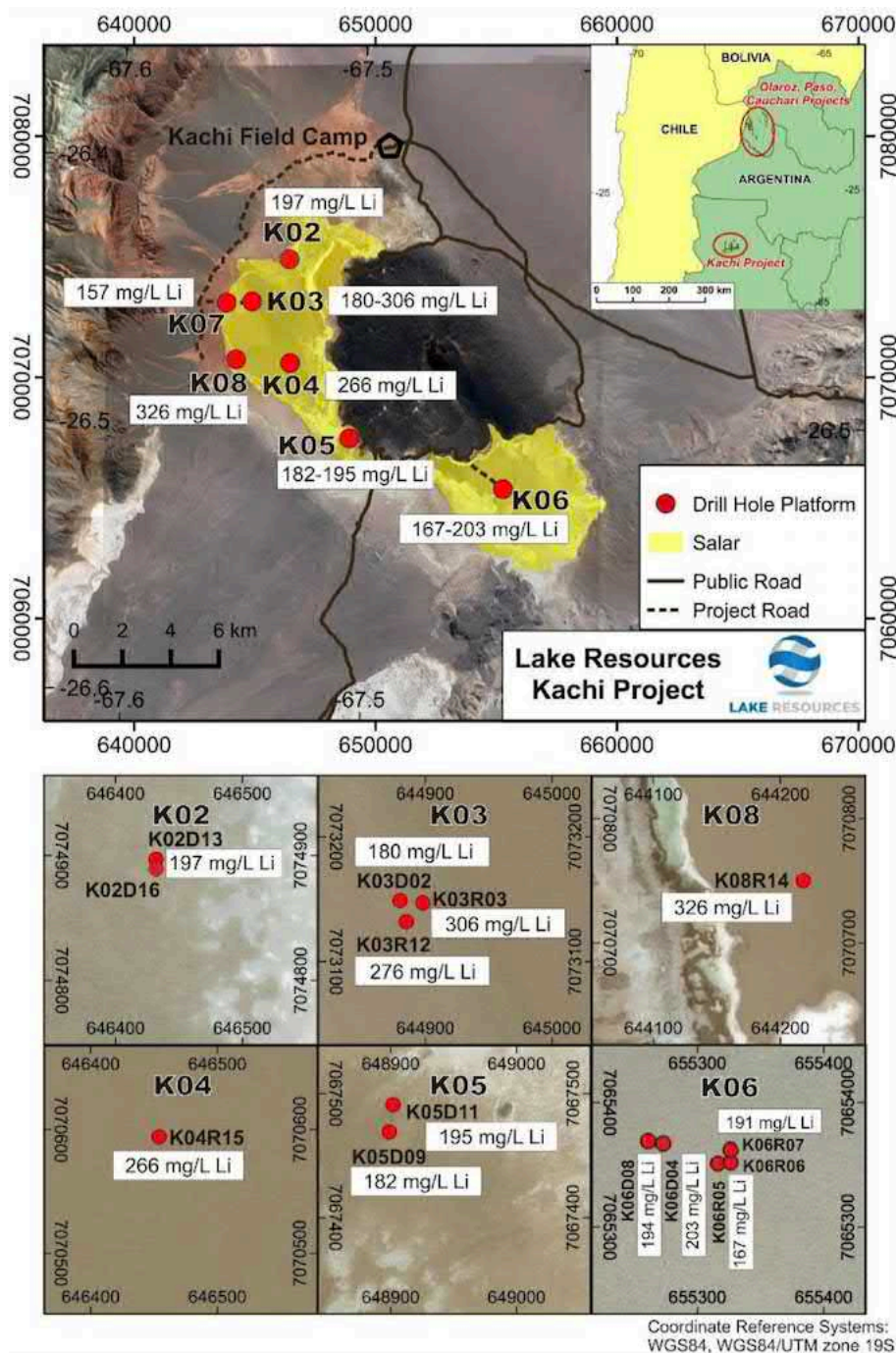
Source: Lake Resources

Figure 33: Kachi: drill holes and seismic lines used in exploration



Source: Lake Resources

Figure 34: Drilling locations and average lithium concentrations

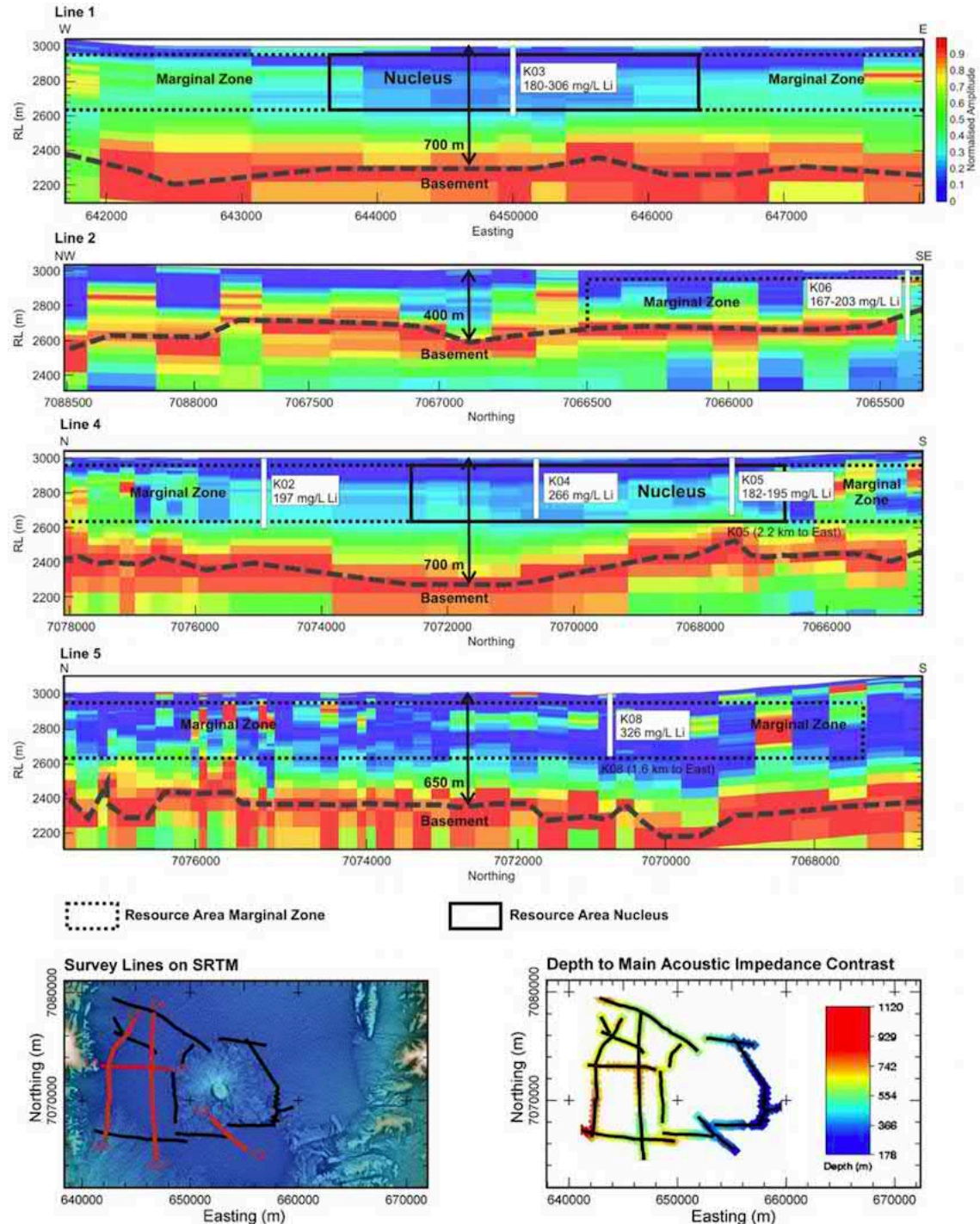


Source: Lake Resources

A passive seismic survey of the basin was undertaken to better understand the basin stratigraphy, geometry, and thickness of the sediments hosting the brine. This helped identify drill hole sites. The seismic information suggests the basin is 700-800 m deep in the western area. Interpretation of the seismic survey indicates that much of the basaltic volcanic material visible at surface forms a thin veneer overlying lake sediments, extending the bounds of the salar beyond the visible salt crust. This has led to the initial brine target area being expanded to the north, west and south of the observed salar with lake sediments evident in seismic lines to significant depths below alluvial fans and relatively thin ignimbrites. Based on this geological and geophysical interpretation the area of 295 km² has been applied to the exploration target. There is a significant volume of lake sediments below

the 400m depth of drilling, which is used as a cut off depth for the exploration target estimate and the base of the sedimentary basin over a large proportion of the project area.

Figure 35: Seismic Profiles showing location and depth to basement together with the depths used in the mineral resource estimate and exploration target calculation (thick dashed black line is the basement reflector)



Source: Lake Resources

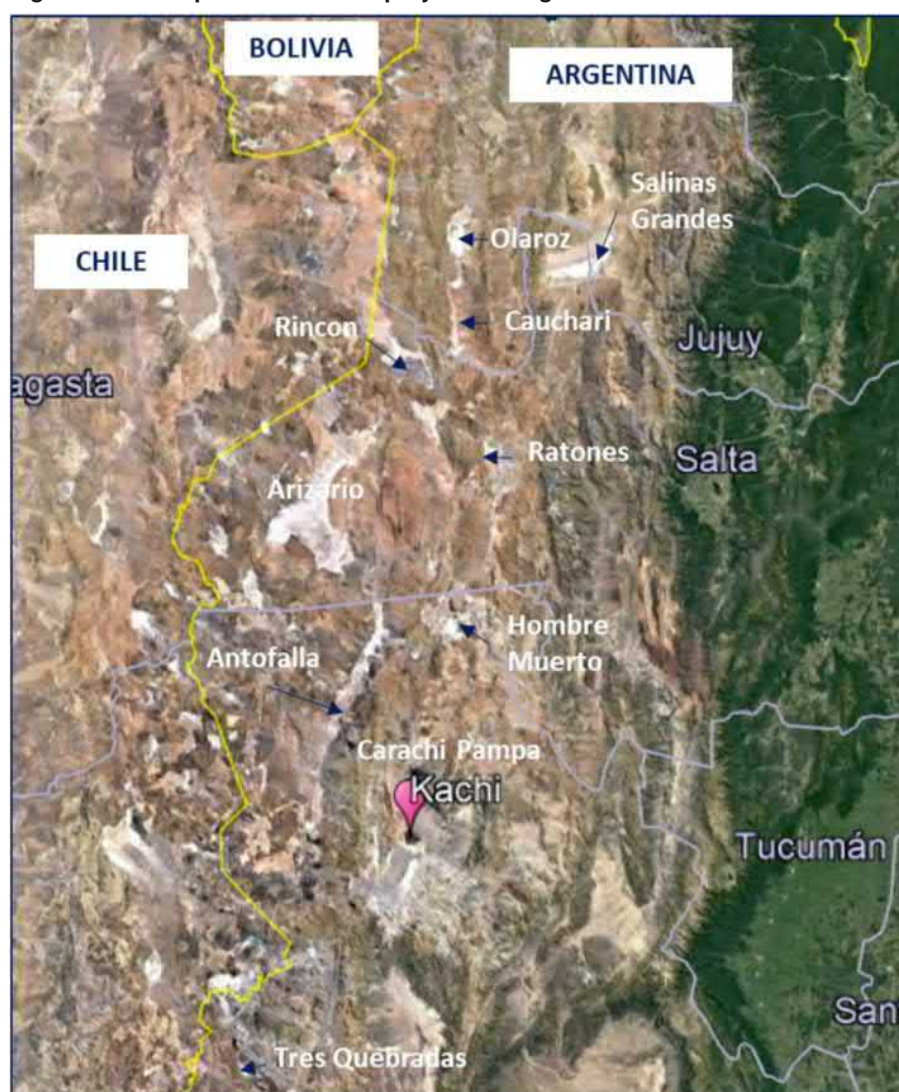
Adjacent properties

There a number of other lithium producers and developers in northwest Argentina. Two of these projects are in production. In 2020, Livent produced some 16,000 tonnes of lithium carbonate at its Salar de Hombre Muerto, and Orocobre and Toyota Tsushu produced 11,300 tonnes of lithium carbonate at Salar de Olaroz.

Ganfeng and Lithium Americas' Cauchari-Olaroz project is currently under construction. The project is expected to commence production in mid-2022. Eramet's Centenario project is on hold.

In addition to these projects, management has identified a further 12 projects at the feasibility stage (PEA, PFS, DFS) that combined would have a capacity of 386,000 tpa LCE by 2025 if they all come to fruition. Of these only four plan to use direct extraction. That is Lake Resources, Livent, Eramet (project on hold), and Rincon.

Figure 36: Principal lithium brine projects in Argentina



Source: Lake Resources

Cauchari

The Cauchari project covers some 37 km² in Jujuy province. The licences are contiguous to brine deposits owned by Ganfeng/Lithium Americas, and Orocobre (having acquired Advantage Lithium).

Lake Resources drilled one hole at Cauchari in 2019, which returned compelling results, confirming a major discovery. Lithium brines were intersected over 506m from a depth of 102m to the end of the hole at 608m. The results include 493 mg/L over a wide 343m intersection from 117m depth with a magnesium to lithium ratio of 2.9.

The results are similar to those at the neighbouring Ganfeng/Lithium Americas Cauchari project which has total resources of 24.6m tonnes LCE at 592 mg/L. Management is confident of advancing the project with further drilling.

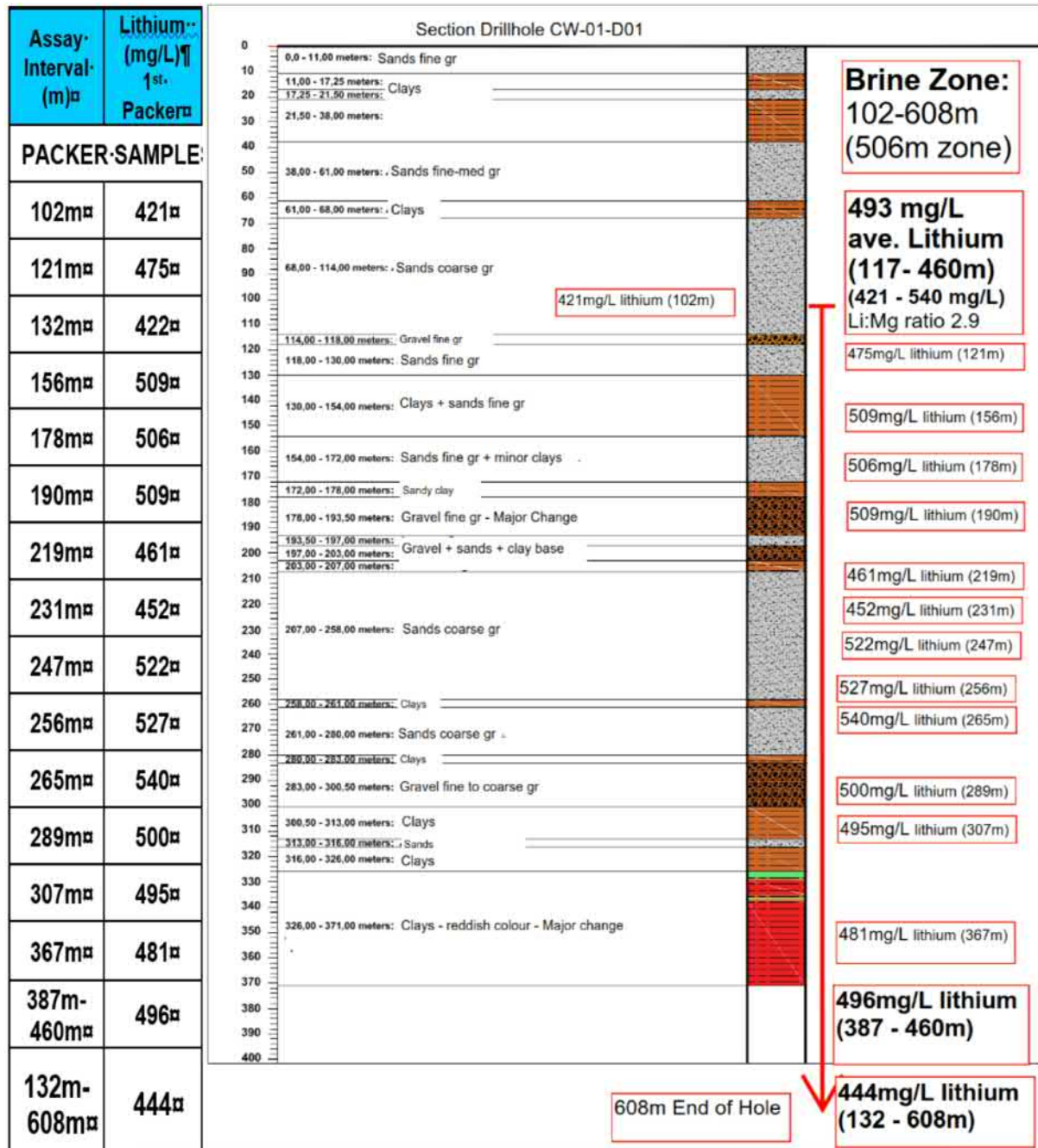
The discovery vindicated a new exploration model designed by Lake Resources in 2016 to explore on the margins of lithium bearing basins under thin alluvial cover to locate similar brines as in the centre of brine bearing basins.

Figure 37: Lake Resources drilling at Cauchari, 2019, indicative boundaries to neighbouring projects



Source: Lake Resources

Figure 38: Results from Cauchari drill hole CW-01-D01



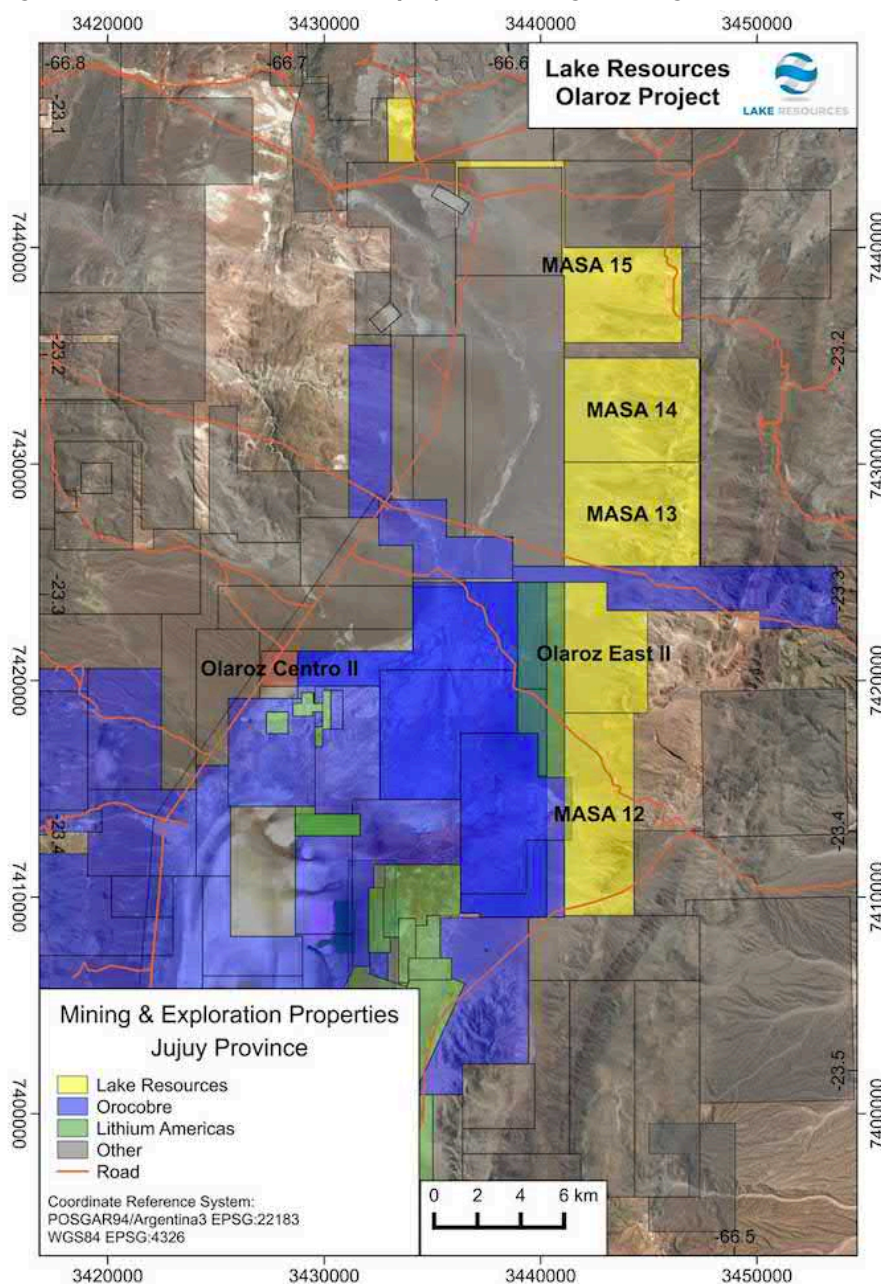
Source: Lake Resources

Other projects

Olaroz

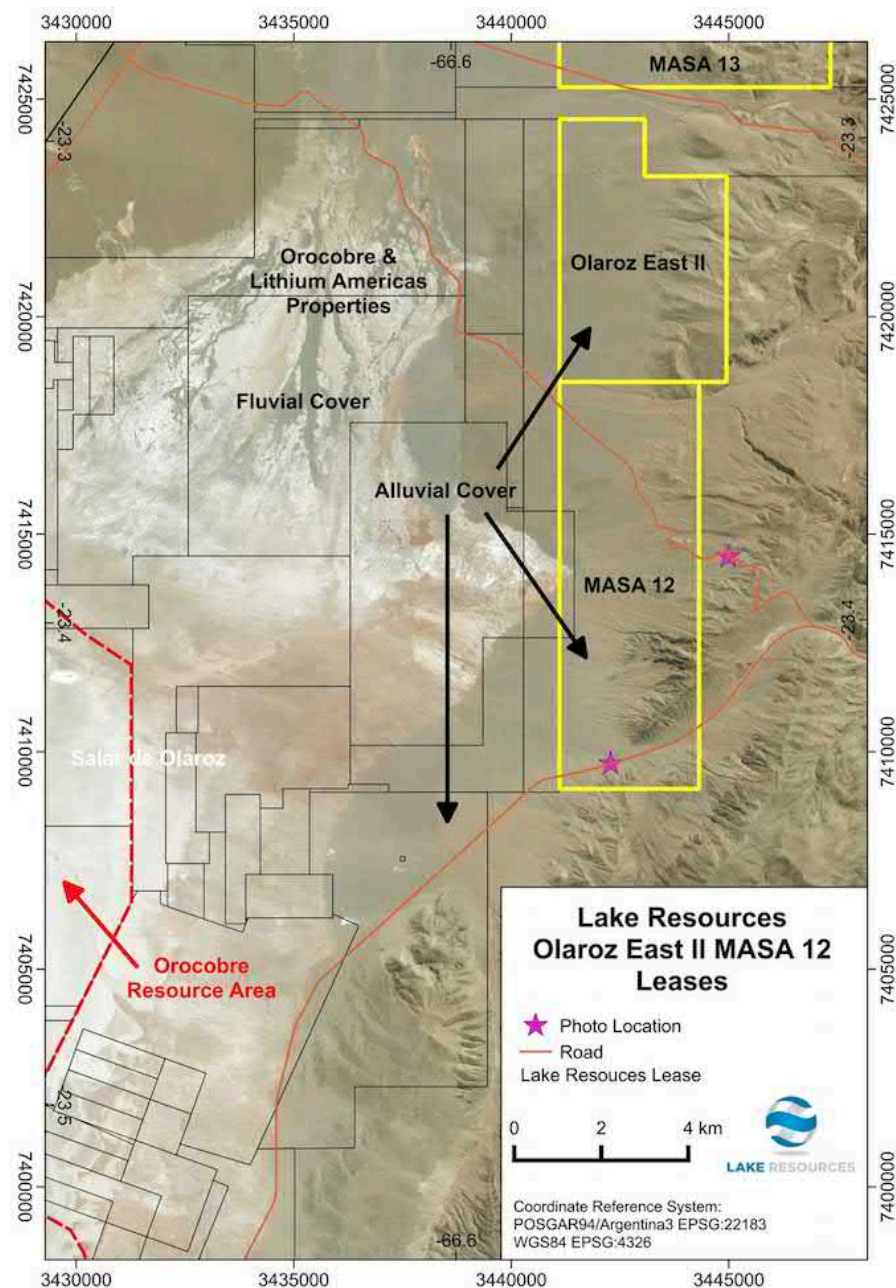
The Olaroz project, covering some 142 km², is also situated in Jujuy province in close proximity to Ganfeng/Lithium Americas’ Cauchari project, and adjoining Orocobre’s Olaroz production area. Lake Resources plans to drill at the project, but it is unclear at this stage when drilling activities will be approved. Management believes, based on the success of drilling on the basin margins under cover at Cauchari and Kachi, that similar brines will extend into Lake’s Olaroz property. The leases extend along the eastern margin of Orocobre’s producing resource, for over 30km north-south, which is a similar length to Ganfeng/Lithium Americas’ resource area.

Figure 39: Lake Resources’ Olaroz project and neighbouring leases



Source: Lake Resources

Figure 40: Lake Resources' Olaroz project showing alluvial cover



Source: Lake Resources

Paso

The Paso project covers some 296 km² in Jujuy province. It lies west of Orocobre’s Cauchari-Olaroz lease area. Salt lakes in the area have shown elevated lithium results at surface. The concession area lies at an elevation of 4,050m. Direct extraction has not been tested at this altitude. Management has been focused on advancing Olaroz and Cauchari before turning its attention to Paso.

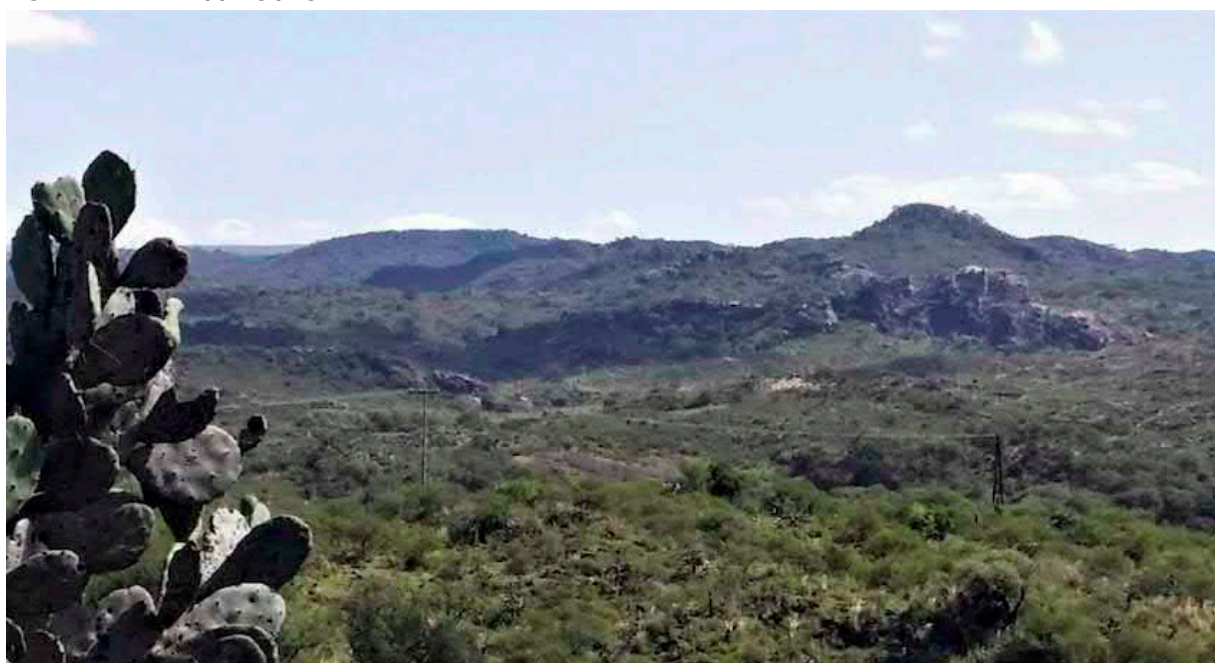
Catamarca

The project is located at the southern end of Catamarca province, south of the ‘lithium triangle’ in the Ancasti Ranges. The project covers some 904 km². The area is known for small-scale production from lithium bearing spodumene pegmatites, mainly from the 1950s to 1990s. Lake Resources exercised its option to acquire the project in September 2018.

According to management, a combination of literature reviews, satellite imagery, and field work helped to identify a series of pegmatite swarms over a belt of 150 km. Outcropping pegmatites with coarse grained spodumene crystals measuring 30cm to 70 cm were identified in a number of locations. **The Catamarca project represents an enormous target, with compelling geology, and historical production in the area.** Opportunities exist to locate new lithium bearing spodumene deposits among pegmatite swarms by using modern exploration technologies.

Latin Resources previously held the adjoining leases (now private). Latin Resources announced, 14 June 2016, the results of 4 samples taken from spodumene exposures in old mine workings, with grades ranging from 4.9% Li_2O to 7.1% Li_2O . In April 2017, the company announced the results of a drill program in which four holes intercepted the down dip extension of outcropping pegmatite that was subject to historical drilling. Results included 3m at 2.98% Li_2O including 1m at 4.61% Li_2O from drill hole LCRC004, 4m at 2.03% Li_2O from drill hole LCRC002, and 6m at 1.62% Li_2O from drill hole LCRC001.

Figure 41: Outcropping pegmatites, Catamarca



Source: Lake Resources, 2018

Latin Resources, ASX announcements June 2016 and April 2017

<https://www.asx.com.au/asxpdf/20160614/pdf/437wn4ljbjvqb.pdf>

<https://www.asx.com.au/asxpdf/20170426/pdf/43hqzwdv84lws4.pdf>

Appendix 2: Companies mentioned

Figure 42: Companies mentioned in this report

Company	Stock code
Lake Resources	LKE.AX
Albemarle	ALB
Amazon	AMZN
BMW	BMW.F
Eramet SA	ERA.PA
Ford	F
Ganfeng Lithium	1772.HK
General Motors	GM
Lanxess AG	LXS.F
Latin Resources	LRS.AX
Lithium Americas	LAC
Lithium Power International	LPI.AX
Livent	LTHM
Mitsui	8031.TT
Novonix	NVX.AX
Schlumberger	SLB
SQM	SQM
Standard Lithium	SLL.V
Tesla	TSLA
Veolia Environnement	VIE.PA
Walmart	WMT

Source: Company data

The author

Simon Francis is a UK qualified chartered accountant with significant experience in the natural resources and minerals sector. Simon led research in the sector in various roles at major financial institutions including Macquarie, Samsung and HSBC, in a career spanning more than 20 years. He has been involved in approximately US\$4bn of capital raising, for a number of natural resources companies. Simon has been engaged in the financing of early stage companies using production agreements, and has privately funded exploration companies in various metals and jurisdictions. Simon seeks to deploy capital in undervalued mining and resources opportunities that have been missed by the market.