



## Lithium reality check

*April 2011*

**As the era of electric vehicles draws closer, the lithium supply industry is positioning itself for an anticipated boom in demand. But disparities in the various market forecasts mean the future is anything but certain for the growing number of emerging suppliers**



The site of Chemetall's lithium project in Silver Peak, Nevada

As the global lithium industry met in Toronto for **IM's** Lithium Supply and Markets conference (LSM'11) in January, it was clear that some delegates wanted to inject a dose of reality to an industry characterised by optimism.

The anticipated boom in electric vehicle production has seen a wave of junior lithium companies emerge over recent years; potential suppliers for what could become the combustion engine of the 21st century - the lithium-ion battery.

The bone of contention rests on the supply and demand outlook over the next decade, and whether these dynamics leave room for new players in the market.

Supply forecasts are subject to the capacity of new start-ups and expansions from both established producers and emerging companies, but the demand side is much more speculative.

Analysts estimate that demand in 2011 will be in the region of 105-115,000 tpa of lithium carbonate equivalent (LCE) - carbonate being the main form in which lithium is sold to battery makers. But demand forecasts for 2020 vary widely.

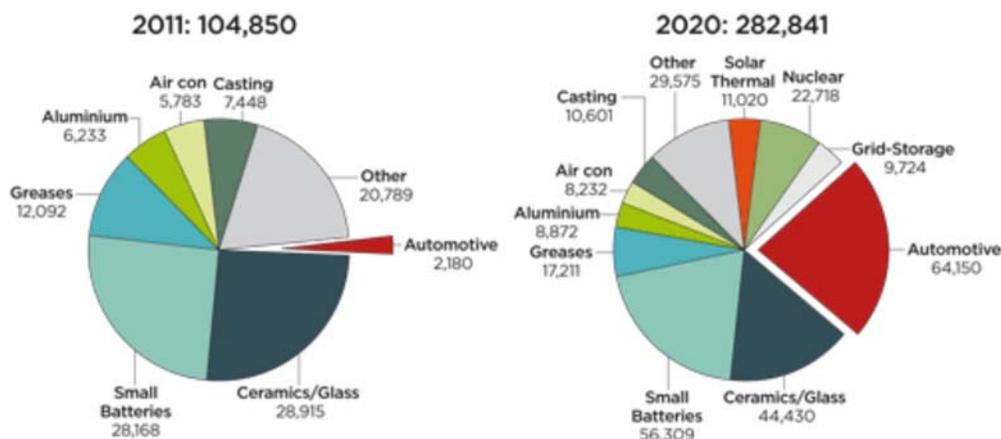
On the conservative side, Chile-based consultancy signumBOX estimates 187,000 tonnes, while US consultancy TRU Group puts the figure at about 249,000 tonnes and Canada's Byron Capital Markets forecasts 282,842 tonnes.

In one of the more bullish estimates, Metal Bulletin Research/Industrial Minerals predict in their forthcoming Global Lithium Market Outlook that the world will require between 290,000 and 380,000 tpa of LCE by 2020.

### **Selected emerging lithium suppliers**

Company	Main project	Development stage	LCE capacity (tpa)	Date	Notes
<b>Brine</b>					
Rincon Lithium	Salar del Rincon, Salta, Argentina	Small-scale production. Started first shipments	1,500	Online	Plans to increase capacity in line with market demand
Orocobre	Olaroz, Jujuy, Argentina	Feasibility	15,000	2012	Potash by-product, offtake deal with Toyota Tsusho
Lithium Americas	Cauchari/Olaroz, Jujuy, Argentina	Pre-feasibility	-	2013	Pilot production in Q4 2011
Lithium One	Sal de Vida, Salta, Argentina	Pilot production, pre-feasibility	-	2013-14	Offtake deal with Korea Resources Group
Comibol	Salar de Uyuni, Bolivia	Pilot production	500	Online	Plans for 30,000 tpa carbonate plant
<b>Geothermal brine</b>					
Simbol Materials	Salton Sea, California, USA	Construction/start-up	500 → 1,500	Online in March/April	Targeting expansion to 16,000 tpa
<b>Spodumene</b>					
Galaxy Resources	Mt Cattlin, Australia / Jiangsu, China	Mine started, plant under construction	17,000	Q2 2011	Targeting Li-ion battery production
Reed Resources	Mt Marion, Western Australia	Construction of concentrate plant	35,600 (concentrate)	Q3 2011	Pre-feasibility stage on carbonate plant
Nemaska Exploration	Whabouchi, James Bay, Quebec, Canada	Pre-feasibility	30,000 (concentrate)	Q4 2012	Offtake deal with Chinese carbonate producer
Canada Lithium	Val d'Or, Quebec, Canada	Pre-feasibility	20,000	2013	Delayed: reviewing resource estimate
<b>Hectorite</b>					
Western Lithium	Kings Valley, Nevada, USA	Pre-feasibility	27,000	2014	Potassium sulphate by-product

### Lithium demand by market (tonnes, LCE)



Source: Byron Capital Markets

### Auto outlook

One thing most analysts agree on is that the market will grow - by at least 7% a year for the next decade - and that growth will be underpinned by the adoption of hybrid (HEV) and electric vehicles (EV).

Lithium demand from these fledgling motor markets will be negligible in 2011, with Nissan's *Leaf* EV the first mass-produced EV to hit the market in North America.

But the next two years are set to be the turning point. Nissan has indicated that 20,000 *Leaf* models have already been

reserved for 2011 and has set a target of 150,000 models in the next five years.

Meanwhile, car giants like Toyota, GM and Ford all plan to launch EV models in 2011 or 2012. German car maker Volkswagen has set the ambitious target of producing 10m. EVs worldwide by 2018, while India's Tata Motors is aiming for 4m. in the next ten years.

Daniela Desormeaux, general manager of signumBOX, has estimated the growth of lithium demand for EV and HEV by projecting the amount of vehicles produced by major car manufacturers.

By 2025, Desormeaux expects Nissan to be consuming 10,480 tpa LCE, with Toyota at 11,453 tpa, GM at 12,077 tpa and Chinese group BYD at 14,207 tpa.

Based on projections for all manufacturers, the automotive industry is expected to require almost 100,000 tpa LCE by 2025. But depending on the rate of EV adoption, a possible range of 69,400-155,500 tpa is predicted.

Analysts at Canada-based Byron Capital Markets have forecast that batteries will drive about two thirds of lithium demand growth to 2015, adding 41,000 tpa LCE to the market.

Of this, about 28,000 tpa is expected come from the automotive industry and 13,000 tpa would be bound for smaller cells used in portable electronics.

The adoption of EV and HEV by consumers will be influenced by the rising price of crude oil, which reached a long-term high of about \$110/bbl (Brent) in March.

Higher fuel costs, which have been exacerbated by political unrest in the Middle East and North Africa, have served to underline the volatility and risk that comes with oil dependence. Further hikes will narrow the gap in operating costs between the two vehicle types.

"There is a correlation between the price of oil and the sale of hybrid vehicles - they tend to move in tandem in that as the price of oil declines, it presents a disincentive to purchase hybrid vehicles," said Lara Smith in MBR's upcoming report.

"We have reached peak oil and therefore expect future higher prices of oil. Further, the recent unrest in the Middle East and ensuing higher oil prices may accelerate development of the electric vehicle markets," she added.



Lithium concentrate plant at Talison's Greenbushes operation in Western Australia

## Alternative applications

Speaking at LSM'11 in Toronto, Byron analyst John Hykawy highlighted the strong growth potential in non-battery markets.

While the lion's share of attention goes to growth in EV, traditional end uses such as glass and ceramics and emerging energy applications will also boost demand significantly.

"While the lithium industry is dominated by talk about the advent of automotive batteries, we believe there are several other potential growth areas that could drive substantial demand growth through 2020," said Byron Capital analyst John Hykawy.

"Continued penetration of the use of lithium in the manufacture of glass and ceramics, solar energy and nuclear may well lead burgeoning demand through the course of the next decade," he added.

The Japanese Rapid nuclear reactor utilises reserves of  $^6\text{Li}$  metal as a way to self-moderate the temperature of the reactor, allowing it to run without operator intervention.

It is estimated that about 1,000 small reactors containing lithium may come into service by 2040, with an associated 1,900 tonnes LCE used in them.

"The same control system is completely adoptable by larger reactors. A typical 1.2GW reactor size of today is 6,000 times larger than a Rapid, and would use 11,400 tonnes of LCE," said Hykawy.

"We believe that we may see testing of such systems before 2020," he added. Byron forecasted that nuclear applications could consume 22,718 tpa LCE by in 2020.

Solar thermal power could also make a significant impact on lithium demand by 2020.

A mixture of salts such as lithium nitrate can be used to increase the temperature at which a solar thermal plant can operate, according to research at Sandia National Laboratory.

A 200MW plant would require 2,000 tonnes of salt-based working fluid, of which 25% is lithium nitrate, according to Sandia.

Byron Capital has forecast solar thermal power could account for 11,000 tpa LCE demand in 2020 - higher than demand for established applications such as aluminium production and air conditioning.

Significant growth between 2011 and 2020 is also expected in glass and ceramics (54%), grease and lubricants (42%) and the small batteries market, which is expected to double in the next ten years (see chart).

## Serious lithium oversupply?

With the increasing use of EV and portable electronics, growing demand from traditional applications and the more unpredictable growth in nuclear and renewable energy, the lithium market has plenty of room for expansion.

The big question in the lithium industry is over how much room this demand growth is going to leave for new entrants to the supply side.

The presentation that provoked the strongest reaction from the floor at LSM'11 was by Edward Anderson, the CEO of US consultancy TRU Group, who put a negative spin on the prospects for emerging lithium producers.

Anderson said the lithium industry could reach "serious peak oversupply" by 2017 as capacity added by new projects outpaces anticipated demand.

"There will be no cataclysmic supply shortage within the foreseeable future... supply could theoretically be much, much, higher [than demand]," said Anderson, who forecasted global lithium demand to grow annually by an average of

8% to 2020.

According to TRU, lithium demand is expected to just exceed 45,000 tpa Li-contained (249,000 tpa LCE) in 2020, but supply will have risen towards 70,000 tpa (373,000 tpa LCE) based on new project start-ups and capacity expansions by existing producers.

Established producers such as SQM, FMC, Chemetall and Talison are undergoing expansions or have new capacity in the pipeline, while over a dozen projects claim they have plans to start up within the next decade.

Anderson believes that the market - even with an anticipated boom in electric vehicles using Li-ion batteries - will not provide opportunities for many new suppliers to enter production.

“New developments do turn the supply curb noticeably north by the middle of the decade. Existing producers will maintain a dominant position even as new producers start up,” he said.

“The supply-demand outlook suggests projects that have technical issues may be abandoned even if already constructed. Many might go into production and fail due to strong competition, especially mineral-based projects,” said Anderson.

This year the world’s first mass-produced electric vehicle using lithium batteries, the Nissan *Leaf*, will be available to consumers in the USA and Canada.

TRU expects the market for primary and secondary batteries to represent 45% of global lithium demand compared with 18% in 2008, but said the technology must be improved if it is to be accepted by consumers.

“Lithium battery technology still needs development, with the main issues being safety and durability,” said Anderson.

“The Nissan *Leaf* is arriving well before it is due... a premature baby, so to speak,” he added.

Anderson’s predictions on the prospects for junior lithium groups, and especially hard rock miners outside the ‘lithium triangle’ in South America, did not settle well with some delegates at the conference.

The managing director of emerging Australia-based producer Galaxy Resources, Iggy Tan, has been a strong advocate of the opportunities for new entrants in the lithium market.

Reacting to TRU’s forecasts, he said: “This sort of thing is sensational, unrealistic and scaremongering.”

“What good [are substantial oversupply forecasts] to the industry? These sort of predictions go out to the mass media and it hurts the industry. We have issue with that,” he added.

Tan used the example of electric bicycles (e-bikes) to illustrate the untapped potential of lithium-ion batteries in the market. Galaxy aims to be the largest e-bike battery producer in the world.

“We focus on electric vehicles but there are a lot of low-hanging fruit like e-bikes and starter batteries... there are 27m. e-bikes produced in China each year,” said Tan, who predicts e-bike producers will adopt lithium technology over the predominant lead-acid batteries.

Galaxy plans to commission a 17,000 tpa lithium carbonate plant in Jiangsu, China, by the end of the second quarter of 2011.

The plant will process spodumene concentrate from the group’s Mt Cattlin mine in Western Australia, where Galaxy started production in 2010.

The successful start up at Jiangsu would see Galaxy emerge as the world’s first integrated producer of hard-rock lithium concentrate and battery-grade lithium carbonate.



FMC's operations at Salar del Hombre Muerto, Argentina

### Decision time for the 'big three'

While Galaxy's planned production capacity is relatively small compared with global supply (105-115,000 tonnes), the group leads a pack of emerging lithium players looking to carve out a space for themselves in the market.

A key factor in the success of emerging suppliers will be the actions of the larger established names in the industry: SQM and Chemetall in Chile; and FMC in Argentina.

Talison in Western Australia is also a large lithium producer, but sells lithium in the form of concentrate to chemical converters, largely in China.

The director of Lithium Business Solutions at Chemetall, Rainer Aul, explained at LSM'11 that the group plans to expand production at its operations at Salar de Atacama, Chile, Silver Peak, USA, and the Langelsheim plant in Germany.

"Chemetall has steadily increased production in the past and expects to continue to do so in the future to meet market needs," said Aul.

The Germany-based group has capacities of about 33,000 tpa lithium carbonate and 5,000 tpa lithium hydroxide, which by 2020 it expects to expand to a respective 50,000 tpa and 15,000 tpa.

The ability of established producers in South America to quickly expand capacity to meet demand leads some to speculate that there is little room for new producers - especially those with higher production overheads than the brine operations in Chile and Argentina.

The decisions of the 'big three' producers in South America will also affect the pricing outlook for lithium.

Daniela Desormeaux, who gave a detailed outlook on the lithium industry in her presentation in Toronto, said these producers have two options.

In the first scenario, new producers are allowed to enter the market, and prices would be in theory driven by the marginal cost of the last operation entering the market.

The big three would lose market share, but prices should remain at existing levels of about \$4,500-5,000/tonne LCE.

Alternatively, the established industry could try to nip emerging competitors in the bud by pricing them out of the market.

The financial weight of these companies, which all have larger operations in other chemical industries, would allow them to somewhat offset the lower prices.

"The only way to maintain market share is with an aggressive price strategy in order to get the new projects out of the market - at least the projects with higher costs," said Desormeaux.

## Provincial powers

Out of the three countries that make up the 'lithium triangle' in South America, Argentina is seen as the most accessible for outside investors.

Bolivia, which is said to have the largest reserves, is cut off to overseas mining companies, with the country's socialist government taking a state-led approach to developing its resources (*IM March 2010: Doubts surround Bolivia lithium development*).

Chile, the world's largest lithium-producing country, categorises its reserves as strategic because of nuclear applications, which has created barriers to development.

As a consequence, only four companies have announced their intention to develop lithium projects in Chile, while Argentina has been a focal point for junior exploration companies in recent years.

According to the US Geological Survey (USGS), Argentina has the world's fifth largest known lithium resources, with an identified 2.6m. tonnes contained in salt brines.

In March, Jujuy province, one of Argentina's three lithium-rich states, declared it had also made lithium a strategic mineral, bringing some uncertainty to projects receiving future mining permits.

A new act, named *Decreto 7592/II*, states that all present and future lithium projects must be studied by a special expert commission before being approved by local and national authorities.

The decision is aimed at preserving resources in Jujuy - one of three Argentinean provinces with significant lithium reserves - to create value-added industries in the region and jobs for local people.

The commission will be coordinated by the Argentinean Production Ministry and be composed of experts from the Argentinean National Council of Scientific and Technical Research, the University of Jujuy and the Environmental Department of Jujuy.

Following the commission's valuation, the project can then be approved or rejected by the Argentinean Production Ministry and the Provincial Secretary of Jujuy.

"This new regulation will have an impact on the projects that are currently under evaluation in the province, since it brings new steps and new procedures," Desormeaux told **IM**.

"This situation brings uncertainty to the other projects that are currently being developed in Salta and Catamarca provinces, since current local legislation does not classify lithium as a strategic mineral, but this situation can change in the future," she added.

Companies developing lithium projects in Jujuy province include Lithium Americas (Cauchari-Olaroz), Orocobre (Olaroz), Dajin Resources (Salinas Grandes) and Rodinia Lithium (Salinas Grandes).

Lithium Americas told **IM** that the company did not expect any delays to its Cauchari-Olaroz project - one of the most advanced lithium projects under development in the region.

"In Argentina, the mining law is a federal law and the provinces cannot change it. The provinces only legislate on the environmental approval process," said the group's CEO Waldo Perez.

"There were concerns in some portions of the Jujuy society that the current system to provide environmental approval needed to incorporate more actors in [local] society, and that is what they did," he added.

Lithium Americas said the decree would not affect its environmental baseline report for Cauchari-Olaroz. However, Perez said there would be increased requirements for the project's final exploitation permit.

Rodinia, which said it was still assessing the impact of the developments, pointed out that its flagship project in Argentina - Diablillos - was located in neighbouring Salta province.

## Technology brings new era

The next decade will be a period of huge transition for the lithium industry, with both supply and demand set to rise faster than ever before.

By 2010 EVs will be a noticeable presence in cities from New York to Beijing, and changing lifestyles in developing countries will substantially increase demand for consumer electronics.

Alternative applications for lithium could be found in new energy technologies, such as next-generation nuclear power, solar thermal plants and grid storage systems, and battery recycling is expected to become more widespread.

Demand growth, both projected and real, is already driving the diversification of world supply. This year could see three emerging companies, Galaxy, Rincon Lithium and Simbol, with fresh supplies of lithium carbonate on the market.

Time will tell if lithium supply will become a truly diverse, global industry, or whether many of its young entrants will fall by the wayside when the competition gets tougher.

## Geothermal lithium nears market entry

California-based Simbol Materials is set to become the world's newest entrant to the lithium carbonate market as it plans to start a 500 tpa high-purity plant within the next month.

The group has developed technology to extract lithium from geothermal effluent brines to produce lithium and other compounds and will process 99.999% purity lithium carbonate as a derivative product.

Simbol will process lithium extracted from a geothermal power plant at the Salton Sea, southern California, in a process that eliminates the solar evaporation stage critical to the world's leading brine producers. A three-fold capacity expansion is expected to be announced soon.

The initial production will utilise a lithium carbonate plant acquired from Limtech Lithium Industries, which has been relocated from Shawinigan in Quebec, Canada. Simbol also plans to produce zinc and manganese from plants connected to the geothermal plant in the future.

"We are adamant on retaking the market share Limtech had and expanding. We've already done the designs and engineering to expand the facility to multiples of its existing capacity," Simbol's CEO Luka Erceg told **IM**.

"As we move forward, we expect to connect to geothermal plants that give us 16,000 tpa of capacity for lithium carbonate equivalent (LCE). Our existing resource relationships will provide us, currently, with the ability to build four such plants," he added.

## Japanese partnership

Based in the San Francisco Bay Area, Simbol is owned by privately held Silicon Valley investors, Mohr Davidow Ventures and Firelake Capital.

Last July the company sold a minority stake to Itochu Corp., giving the Japanese chemical group the sole rights to market Simbol's future products in Asia.

Itochu intends to supply the growing market for lithium-ion batteries - particularly for electric and hybrid vehicles - in Japan, China and South Korea.

"For a small company like ours, entering the Asian markets would be challenging, but Itochu provides us with near-instant access to the relevant markets," said Erceg.

The CEO believes Erceg will be able to compete with the major low-cost brine-based lithium producers present in the market, which include Chile-focused SQM and Chemetall along with FMC's operation in Argentina.

### **Competitive with brine producers**

Demand for lithium carbonate equivalent is expected to rise to over 250,000 tpa by 2020 and Erceg believes the increased market cannot be supplied by the developers of hard rock-based lithium resources.

"We feel there are too many challenges [for hard rock producers] and the costs of production are too high. We feel we can be competitive at whatever price the industry sees... we're not concerned about pricing volatility," he said.

"The world doesn't need a lot of lithium producers. The world needs good quality lithium producers. And there are opportunities in the marketplace to compete with Chemetall, FMC and SQM on quality."

By producing lithium from the waste stream of a geothermal power plant, Simbol will be the first supplier of its kind in the lithium industry, which is undergoing a period of unparalleled expansion driven by anticipated growth in demand for electric vehicle batteries.

"While viewed as just another emerging lithium company, Simbol has a unique position as it is the only company that can produce lithium, manganese zinc and other important battery materials from one brine, one plant, as mixed-metal precursors before they leave our gate," said Erceg.

According to reports by **IM**, Simbol is set to become the second newest lithium carbonate producer in the wave of emerging players due to hit the market, with Rincon Lithium starting up production in Argentina in December.

### **Chinese convertors expect stable prices**

China is the world's largest consumer of lithium, and plays a major role in converting hard-rock lithium concentrate into lithium chemicals for use in industries such as glass and ceramics.

Southern China-based chemicals group, Jiangxi Ganfeng Lithium Co. Ltd, estimated that hard-rock spodumene imports to China accounted for about 18,000 tonnes LCE in 2010

Imports of brine-sourced material were estimated to be about 12,000 tonnes LCE, including lithium carbonate, lithium chloride and concentrated brine.

Chinese brine-based lithium producers only supplied technical grade lithium carbonate and lithium hydroxide at an output of about 8,000-10,000 tonnes LCE last year. Glass grade spodumene (5% L<sub>2</sub>O, CIF Asia) is currently being traded in a \$430-480/tonne range, with lithium carbonate from brine at about \$4,500-5,000/tonne.

Speaking to **IM**, Ganfeng executive vice president, Wang Xiaoshen, said he expected prices for lithium raw materials to remain stable over the next three years.

"We have not worried about supply shortages, but were worried about concentration of supply sources," Wang said.

"But now with the optimistic demand estimation for the new energy industry, there is more investment into lithium resource developments, and the supply concentration will be going down, so we expect prices will be relatively stable until 2014"

"Then we will see how the EV and energy storage industries are going, and how the new lithium resource projects are going. It seems big capacities will be installed in 2014 for lithium carbonate," Wang added.

Ganfeng expects demand for lithium chemicals to grow for most of its main consuming industries, including primary and secondary lithium batteries, pharmaceuticals and polymers.

Demand for some applications, such as flux and lithium bromide for absorption air conditioning, are expected to remain

flat.

China is likely to remain a major target market for hard rock lithium miners, especially those with no plans to convert raw materials into lithium carbonate.

Emerging spodumene miners such as Galaxy Resources, Reed Resources and Canada Lithium will aim to emulate Talison Lithium, which has long been supplying lithium chemical converters from its Greenbushes operation in Western Australia.

However, Galaxy is also planning to supply material from its own 17,000 tpa lithium carbonate plant under construction in Jiangsu, eastern China.