Lithium Mining to Manufacturing Electric Cars: Moving from Climate Change to Climate Solutions

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Introduction

Ms. Robyn Denholm, is the Australian-born chair of Tesla – a company best known for both having a celebrity founder, Mr. Elon Musk, and for being the world's biggest electric vehicle (EV) manufacturer. On June 2, 2021, Ms. Denholm delivered a keynote address on the company's environmental, social and governance credentials to the *Minerals Council of Australia*.

A key aspect of her talk was her belief that Australia can be a big winner in the global transformation to renewables and sustainable energy. All up, she said that there were about $5,000 worth of minerals and metals in every Tesla EV. Altogether, Tesla was on track to spend more than $1 billion a year on Australian-mined lithium, nickel and other metals needed to make batteries for its vehicles.[2]

Such numbers indicates that if Australia embraces the world's accelerating transition to clean energy it could become a renewable energy superpower. But first, it must turn its focus from exporting planet-warming fossil fuels (e.g. coal and gas) to exporting the minerals required for EV and other battery technologies. But this alone is not enough. This article will analyse the steps Australia must take to transition from being just a miner of lithium-ore; to becoming an onshore processor of lithium into higher-value products such as battery cells; and ultimately making the EVs that need these lithium batteries. The obstacles that the country will face in this transformative process will also be explored.

The Great Lithium Boom of 2020

The markets for battery ingredients such as lithium and cobalt have, in the recent past, been very volatile. Prices soared from 2016-18, but then came under pressure in 2019 from a sudden influx of new supply that outpaced demand. In that year, there was a rush of new mining projects that tipped the industry into oversupply, and this was compounded by reductions in Chinese subsidy programs that put a pause on the EV revolution in that country. The price of hard-rock lithium concentrate, known as *spodumene*, then crashed by nearly 50% during 2019 and continued downwards in the first half of 2020 with the COVID-19 pandemic threatening to drive car sales even lower.

Australia is the world's top exporter of lithium, accounting for 55 per cent of global supply, which it ships mainly to China for processing. Prices collapsed from a 2017 peak of $US 25,000 per tonne of lithium carbonate equivalent (LCE) to a low of $US 5,000 in 2019. This market downturn pushed some Western Australian operators to breaking point that year.[3]

[1] First published: Janek Ratnatunga (2021) "Australia: Changing Focus from Climate Change to Climate Solutions, *On Target*, ICMA Australia Newsletter, 25(3), May-June, pp.4-10.

[2] Nick Toscano (2021), "Australia told to 'seize' clean energy boom", *The Age*, June 3, p22.

[3] Colin Kruger (2021) "Electric car battery demand puts lithium in pole position, April 24, 2021, *Saturday Age*, Business, p.3

But as it turned out, 2020 was a 'tale of two halves'. In the second half of the year, there was a post-pandemic recovery push with world governments starting to unleash 'green' stimulus programs. With car makers coming on-board and ramping up plans to electrify their vehicle fleets, investors and analysts started showing renewed optimism about battery demand and bet billions on a major comeback in critical minerals including lithium.

Post the initial few months of the pandemic, after the initial shock freezing of the global manufacturing and supply lines, global battery demand increased significantly. Lithium batteries were not only required for EVs, but also for storage of solar power generated both commercially and domestically. After China brought covid-19 under some control, the demand for EVs increased in China resulting in an uptake of lithium-ion batteries to store renewable energy. Britain said it would ban new petrol and diesel car sales from 2030. Europe rose to become the world's largest EV market. And new US President Joe Biden laid out plans to boost the sector with a roll-out of 500,000 EV charging stations and vowed he would make all federal fleets fully electric. EVs finally look poised to take the ascendancy over their petrol-powered rivals.

This renewed optimism about the EV revolution and signs of strengthening sales in China and Europe has not gone unnoticed by investors. As key ingredients in the batteries for EVs, lithium and other mineral prices showed a significant turnaround. Interest in the lithium mining sector has soared with each new announcement of a major car maker's plans to go fully electric or major economies announcing multibillion-dollar investments to push the electrification and decarbonisation of their transport infrastructure. UBS is projecting EVs to comprise 40 per cent of new vehicle sales by 2030, fuelling an increase in lithium demand.[4]

Demand for lithium is now more solid and it is across three major fronts, not just one. Previously, China was carrying pretty much the entire growth – as most lithium processing and battery manufacturing was done in that country – but now Europe and latterly the US are also demanding the minerals. As a result, the share prices of Australian lithium producers have been soaring since October. Analysts are expecting 2021 price rises for lithium products including spodumene, carbonate and hydroxide of 10 per cent on average.

Globally, demand sits at about 300,000 tonnes of lithium-carbonate equivalent, and this is expected to triple by 2025 and then likely double again through to 2050, as the change of pace sweeping the EV industry accelerates.[5]

Clearly Australia mining industry is on to a winner. Here is a pathway to reduce its dependence on exporting fossil fuels. However, to completely eliminate its dependence on fossil fuels (e.g. coal) in a politically feasible manner, more steps will need to be taken.

The Next Step: Processor of Lithium Cells

In her talk to the *Minerals Council of Australia*, Ms. Denholm, the chair of Tesla, emphasized her company's immensely important contribution to the decarbonisation of the planet by its pioneering push to replace combustion engine cars with EVs.

However, she said that although Australia is capable of supplying almost all of the lithium-ore and other minerals required by Tesla's global production needs, the country was missing out on a far

[4] Céline Fornaro and Patrick Hummel (2021) "Electric transport: Adoption sooner than expected", UBS Global Research, https://www.ubs.com/global/en/collections/sustainable-investing/latest/2021/trends-electric-transport.html

[5] Nick Toscano (2021), "Lithium miner back in the driving seat on electric vehicle rebound", *Sydney Morning Herald*, January 25, https://www.smh.com.au/business/companies/lithium-miner-back-in-the-driving-seat-on-ev-rebound-20210124-p56wfi.html

more valuable role in the global supply chain – that of refining the lithium and processing the battery cells. Ms. Denholm said that while Australia is rich in reserves of battery raw materials, large amounts are typically shipped thousands of kilometres away to be processed and turned into higher-value products such as battery cells in China and other Asian countries due to an absence of a strong local refining sector. She said that Australia should be prioritising developing and expanding its onshore refining capabilities, which would drive down costs and eliminate carbon emissions.[6]

"Australian mining is in the middle of a rapid and important transition: from exporting climate change to exporting climate solutions. *The opportunity for Australia is extraordinary, and now is the time to seize it.*"

An estimated three quarters of Tesla's lithium needs and more than one third of its nickel is sourced from Australia. Globally, even though Australia supplied nearly 50 per cent of the world's lithium ore last year at a value of about $US100 million ($130 million), it supplied none of the refined product suitable for battery cells.

"If it were processed onshore in Australia, the value would have been more like $US1.7 billion. So that's a $US1.6 billion annual opportunity and growing."

"Australia has the minerals to power the renewable energy age throughout the world in the coming years. It will require massive innovation: we need to scale up at an extremely fast pace and mining needs the same kind of innovation as the industries it supplies."

The Australian government has taken notice of this. It has made a top priority of supporting the Australian resources industry to develop downstream, value-adding processes for critical minerals. Construction of a new refinery to produce lithium hydroxide in Perth appears on track to begin later this year after conglomerate Wesfarmers received approval for the project from the State's environmental regulator.

Manufacturers around the world are increasingly concerned about meeting growing environmental and social demands of their customers and emerging market requirements anticipated in future European Union battery regulations. As mining processes account for half of a battery cell's carbon footprint, low-carbon minerals will be at an increasingly strong advantage in the future. Ms Denholm said the best way to reduce the carbon footprint of minerals was to stop shipping them *"across 9000 kilometres of ocean"* before refining them. [See Appendix 1 on the flip-side of lithium batteries, i.e. can it lead to a CSR nightmare?].

However, why stop at refining? Why not produce the battery cells? And what is the impediment to Australia manufacturing the finished product, i.e. the EV itself?

Why Cannot Australia Manufacture EVs?

Tesla is putting up what Elon Musk calls 'giga factories' in Berlin, Shanghai and Austin, Texas – ahead of an unfolding boom in electric vehicles (EVs) and will come online in the next 12 to 36 months. Tesla is expanding fast and could potentially be producing as many as 2.1 million cars by 2025, giving it a growth rate of about 35 per cent per year.[7]

[6] Nick Toscano (2021), "Australia told to 'seize' clean energy boom", *The Age*, June 3, p22.

[7] Robin Pagnamenta *(2020), "Elon Musk's dreams could yet come crashing back to earth", Sydney Morning Herald, December 3.* https://amp.smh.com.au/business/companies/elon-musk-s-dreams-could-yet-come-crashing-back-to-earth-20201203-p56k4w.html

Why are none of these car manufacturing factories in Australia? Why are the European and Japanese car manufacturers not interested? The answer is tragic. Australia has lost its car manufacturing expertise due to its high labour costs and outdated factories.

Australia, like the USA, became a manufacturing powerhouse after World War II. However, manufacturing expertise and ingenuity was slowly eroded when cheap labour overseas – coupled with efficient global supply-chains – moved Australia's manufacturing capability offshore to Asia in the 1980s and 1990s. Because of its high labour costs, Australia's manufacturing businesses assumed they could not be competitive in manufacturing; but instead could just live off its service, education, and financial sectors, cushioned by the worldwide demand for its staples in agriculture and mining. Slowly, Australia's car industry that was once the backbone of manufacturing in Australia since 1925 was lost (along with its related know-how).

Australian manufacturing has had many challenges over the past decade including: the Global Financial Crisis; an extended period of relatively high exchange rates (which reduced from a high of 0.79 vis-à-vis the USD only from January 2018); the rapid rise of China as 'the world's factory' and Australia's largest trading partner; the end of local automotive assembly operations in 2017; the onset of digitalisation and 'the fourth industrial revolution'; and large increases in local energy and other input costs.[8]

Today, the 'lucky' country has become the 'lazy' country, with Australia's minerals being exported to other countries, especially China, to manufacture products and sell them back to it. Australia's wool is imported by China, not for its own consumption, but to value-add and export to the world. The list goes on. Australia's supply chains are dominated by very few countries; whose interests vary from its own. Of recent times, Australia has been subjected to 'bullying' by being over-dependent on some countries that import large quantities from its agriculture and mining sectors.

Clearly, there is an urgent need in the longer term for Australia to expand from an economy that extracts and farms to one that adds value and manufactures complex things in a sustainable way. Setting up car factories again to manufacture EVs are a start, but in the long-run, Australia needs to support advanced manufacturing, not just primary production. This means that Australian companies must manufacture complex products such as drones and robotics, renewable energy, processed food for export and the like, so they can scale up to become global powerhouses that can compete on quality, not on price.[9]

Lessons From Europe

Where did Australia go wrong? Let us learn from what is happening in Europe. An excellent essay in the *Economist* magazine, analyses the reason why European companies have fallen behind their American competitors.[10]

The first reason is that European firms seem to have been *outmanaged*. The authors analysed firms competing in the same sector over the past 20 years and found that incumbent American companies mostly focused on to churning out bigger profits and were better positioned for *future success* than

[8] The Australian Industry Group Australian (2019) "Manufacturing in 2019 Local and Global Opportunities" *AI Group Report,* May, p.47. https://cdn.aigroup.com.au/Economic_Indicators/Economic_Outlook/Australian_Manufacturing_in_2019.pdf

[9] Janek Ratnatunga (2020), "Funding Manufacturing Post COVID-19: A National Security Issue", *Journal of Applied Management Accounting Research*, Winter, 18 (1), pp. 27-32.

[10] The Economist (2021), "The land that ambition forgot" Briefing, June 5. https://www.economist.com/briefing/2021/06/05/once-a-corporate-heavyweight-europe-is-now-an-also-ran-can-it-recover-its-footing

their European counterparts. This forward-looking approach is the domain of management accounting.

A second reason Europe fell behind in recent decades is that its biggest firms are in the *wrong industries.* The sectors European firms dominated 20 years ago, such as insurance or telecoms, have grown at a glacial pace. America, by contrast, had 20 years ago already made significant inroads into software and e-commerce – industries that would soon redefine the global economy and generate trillion-dollar valuations. The political protection afforded in Europe to businesses – e.g. from hostile takeovers (rare in mainland Europe) — is one reason their financial results are underwhelming.

The third, and most striking reason that Europe has fallen behind, according to the *Economist*, is the *lack of newly created firms* in its blue-chip indices. Many of the biggest companies in America, such as Amazon, Netflix, Tesla and Facebook, are young enough to be run by their founders. In Europe, old names prevail. For example, of the world's 142 listed firms worth over $100bn, 43 were set up from scratch in the past half-century, 27 in America and ten in China. Only one was in Europe: '*SAP'*, a German software group founded in 1972. Half of Europe's richest ten billionaires inherited fortunes spawned long ago; in America nine of the top ten are wealthy solely because of companies they founded.

Finally, and this is an important lesson for Australia, is that European companies complain that they face a *less favourable business environment* at home than they encounter elsewhere. Europe's brand of capitalism is often softened by a stronger role for unions. That has its allure, as workers toil shorter hours and enjoy greater job security. It also means higher labour costs. The one major reason that Australia lost its car manufacturing industry was its higher unionised labour costs. This would, however, not be an issue in the highly automated giga-factories like those being constructed by Tesla.

The Role of Management Accountants

If Australia is contemplating boosting its manufacturing capabilities across all types of skills and technologies, this must go hand-in-hand with professionally qualified management accountants to provide reliable information for decision making. All organisations, especially manufacturers, need *reliable cost information* to take strategic decisions that will affect the future of their organisations. Such information is best provided by those who are professionally trained in strategic cost management and business analysis.

A financial audit of past transactions has very little decision information to make strategic decisions, especially if the past is very different to what the environment is going to be in the future. In a world of uncertainty, the one thing we are certain about is that the Post-COVID-19 business environment is going to be very different from anything experienced in the past. Yet, governments have placed statutory obligations on financial statement auditors in auditing the past; but cost auditors have no such statutory backing in auditing numbers that affect future performance.[11]

The implications of getting cost numbers wrong are staggering. Faulty costings result in faulty strategic decision making in pricing, quality, marketing, supply-chain, product mix etc.; which then have a flow on effect in many related industries. Going hand-in-hand with its investment in manufacturing capability, governments must also recognise the need for *statutory strategic cost audits,* to ensure that the resource allocations of government funds are made not only in the most strategic manner but also that value is created in a sustainable manner safeguarding the interests of the future generations.

[11] Only organisations of a certain size in India, Pakistan and Bangladesh are subjected to a statutory cost audit.

Summary

The world is transitioning into to clean energy rapidly. With the significant demand for Australian-mined lithium, nickel and other metals needed to make batteries, its political and business leaders have an opportunity to make Australia a renewable energy superpower by re-focusing from exporting planet-warming fossil fuels to exporting the minerals required for EV and other battery technologies.

After this re-focusing of the mining sector, Australia must then transition from being a lithium-ore exporter; to becoming an onshore refiner and processor of lithium into higher-value products such as battery cells. Ultimately, it must make re-capture its vehicle making expertise – and have an investment environment that is welcoming to both local and overseas car manufacturers that need these lithium batteries.

Australia lost its manufacturing expertise mainly due to unionised higher labour costs, forcing manufacturers to locations with cheap labour. Whilst there were many other factors at play – e.g. the phasing out of government subsidies and the inability to innovate and produce the cars that consumers wanted – high labour costs were the principal reason. But today's factories are different, heavy automated, with robotics and artificial intelligence (AI). Even the energy to run these giga-factories are sourced from renewable solar and wind energy that is stored in lithium batteries on site.

It is vital that Australia transitions from 'exporting climate change' to 'exporting climate solutions'.

Appendix 1

EV Batteries – A CSR Nightmare?

The projected demand for electric vehicles (EVs) means a significant demand for EV batteries, and the mineral raw materials like lithium that they are made of. Despite the largely positive research that have found EVs good for the environment, the growing numbers of EVs present serious problems both at the start of life (mining for raw materials and battery production) and at the end of life (recycling and waste-management).

There two main modes of battery production; *primary production*, using mined raw materials and *secondary production* (i.e., the recycling of the key materials in used batteries).

In a recent article in *Nature*,[12] the authors estimated that for *primary production*, it takes 250 tons of the mineral ore spodumene when mined, or 750 tons of mineral-rich brine to produce one ton of lithium. The processing of such large amounts of raw materials can result in considerable environmental impacts. Production from brine, for example, entails drilling a hole in the salt flat, and pumping of the mineral-rich solution to the surface. However, this mining activity depletes water tables. In Chile's Salar de Atacama, a major centre of lithium production, 65% of the region's water is consumed by mining activities. This affects farmers in the region who must then import water from other regions. The demands on water from the processing of lithium produced in this way are substantial, with a ton of lithium requiring 1,900 tons of water to extract, which is consumed by evaporation.

[12] Gavin Harper, et.al., (2019), "Recycling lithium-ion batteries from electric vehicles", *Nature*, Vol. 575, pages75–86.

By contrast, the authors calculate that *secondary production* (i.e., recycling) would require only 28 tons of used lithium-ion batteries (LIBs); or around 256 used electric-vehicle LIBs. Obviously, the net impact of LIB production can be greatly reduced if more materials can be recovered from end-of-life LIBs, in as close to usable form as possible. However, in the rapid-growth phase of the EV market, recycling alone cannot come close to replenishing mineral supplies needed.

Using conservative assumptions of an average battery pack weight of 250 kg and volume of half a cubic metre, the authors calculated that the resultant pack wastes would comprise around 250,000 tonnes and half a million cubic metres of unprocessed pack waste when these vehicles reach the end of their lives. Although re-use and current recycling processes can divert some of these wastes from landfill, the cumulative burden of EV waste is substantial given the growth trajectory of the EV market. This waste presents several serious challenges of scale – in terms of storing batteries before repurposing or final disposal; in the manual testing and dismantling processes required for either actions; and in the chemical separation processes that recycling entails.

Initial concerns regarding resource constraints for LIB production scale-up focused on lithium; however, in the near term, reserves of lithium are unlikely to present a constraint. Also, LIBs are anticipated to last 15–20 years based on calendar aging (the aging due to time since manufacture) predictions—three times longer than lead–acid batteries. Of greater immediate concern are cobalt reserves, which are geographically concentrated (mainly in the politically unstable Democratic Republic of the Congo). These have experienced wild short-term price fluctuations and raise multifarious social, ethical, and environmental concerns around their extraction, including artisanal mines employing child labour.

In addition to the environmental imperative for recycling, there are clearly serious ethical concerns with the materials supply chain, and these social burdens are borne by some of the world's most vulnerable people. Given the global nature of the industry, this will require international coordination to support a concerted push towards recycling LIBs and a circular economy in materials.

Another concern is that for repurposing and second-use applications, automotive battery packs are currently dismantled by hand for either the second use of the modules or for recycling. The weights and high voltages of traction batteries mean that qualified employees and specialized tools are required for such dismantling. This is a challenge for an industry in transition with a shortage of skills. An *Institute of the Motor Industry* survey in 2015 found only 1,000 trained technicians in the UK capable of servicing EVs, with another 1,000 in training.[13] Given there are 170,000 motor technicians in the UK, this represented less than 2% of the workforce. There is concern that untrained mechanics may risk their lives repairing EVs, and these concerns logically extend to those handling vehicles at the end-of-life. Additionally, it has been suggested that manual dismantling, in countries with high labour costs, is uneconomic with respect to revenues from extracted materials or components.

Despite these challenges for recyclers at end-of-life; these 'spent batteries' may also present an opportunity as manufacturers scramble for access to strategic elements and critical materials for key components in EV manufacture, i.e., recycled lithium-ion batteries from EVs could provide a valuable secondary source of scarce materials.

Clearly, EV design must strike compromises between crash safety, centre of gravity and space optimization, which must be balanced against serviceability. These conflicting design objectives

[13] IMI (2015), "IMI Raises Skills and Regulation Concerns as Demand for Electric and Hybrid Vehicle Surges", *Institute of the Motor Industry*, https://www.theimi.org.uk/news/imi-raises-skills-and-regulation-concerns-demand-electric-and-hybrid-vehicle-surges

often result in designs that are not optimized for recyclability, and that can be time-consuming to disassemble manually.