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Queensland energy storage manufacturing plan 2020

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Executive summary

Australia's energy strategy appears to be concentrated on hydrogen. Research suggests that resilience and adaptive capacity are dependent on both a diversity of options and the capacity to respond to change. It is therefore important to develop an energy strategy that includes more than just hydrogen. Europe's Green Deal includes a commitment to carbon neutrality by 2050, the shift of electricity supply to renewable energy and the electrification of mobility (European Commission, 2019e). South Korea too has announced plans to become carbon neutral by 2050 (Board, 2020) and its car manufacturing industry is investing heavily in its 'eco-friendly vehicles' as sales of EV exports increase (Choo, 2020). While China has not committed to carbon neutrality, since its 9th Five Year Plan (1995-2000) battery electric vehicles have been a key Science and Technology Industrialisation Project (Gong et al., 2012). As a result of significant industry support and EV subsidies, since 2018 more than 1 million EVs have been sold annually in China.

There is a large shift to electric mobility in Europe and Asia.

The IEA predicts that EV sales in China and Europe will grow by 43-55% annually to 2030

Both Europe and China have introduced ambitious vehicle tailpipe emissions standards by 2025, effectively 3 litres per 100km in Europe and 4 litres per 100km in China. Carmakers plan to invest heavily in electric vehicles by 2025 (Todts, 2019). The IEA estimates that under current policy settings global annual EV sales will reach 22.5 million in 2030 but potentially up to 43 million if there is a strong push by EV manufacturers (International Energy Agency, 2019). Current and planned EV passenger models in Europe and China are, and will be, predominantly powered by lithium-ion batteries (LiB).

Europe and China's mobility strategies are heavily reliant on Li-ion Battery manufacturing capacity.

Global Li-Ion Battery manufacturing capacity is projected to grow by 27% pa to 2030.

The IEA's New Policy Scenario finds that global LiB capacity will increase to 1300GWh in 2030 but could reach 2800GWh per year in some scenarios (International Energy Agency, 2019). Australia has significant competitive advantage to supply to European and Asian electric mobility plans. It has:

- good deposits of lithium, nickel, cobalt, graphite and rare earth elements for LiB manufacturing;
- world's best solar and wind resources in Queensland and West Australia to power manufacturing with energy generated from wind power and solar PV currently predicted to be $30/MWh in 2030 (Blakers and Stocks, 2020) and lower according to others (Bellini, 2020);
- existing primary metal resources and manufacturing, and the potential to produce green aluminium through access to low cost renewable electricity;
- existing rail infrastructure to transport resources to regional centres for manufacturing and port facilities for export of manufactured product to Europe and Asia.

Australia can benefit from this global trend to electric vehicles because it has all the natural resources and infrastructure to secure competitive advantage to manufacture energy storage.

There is significant interest from the Queensland energy storage sector, engineering consultancies and CSIRO to develop a Queensland Energy Storage Manufacturing Strategy. The combined view of this group is that globally competitive manufacturing is no longer premised on low cost labour, but rather on the cost of capital and entrepreneurial spirit. Queenslanders have enough entrepreneurial spirit and technical expertise to be as competitive as any nation. This plan outlines the rationale for this strategy and the next steps that need to be taken to develop a Queensland Energy Storage Manufacturing Strategy.

Develop new employment opportunities for regional Queensland communities

Australia has recently announced a national hydrogen strategy (Finkel, 2019) to facilitate investment in a low-carbon energy fuel that will encourage the development of a new export-focussed industry. While this is an excellent strategy for Australia to pursue, there is an additional, complementary, global opportunity that could deliver significant benefits for Queensland in terms of industry development, potential for export and creation of employment opportunities in regional Queensland. This opportunity is driven by a global transition to low-carbon transport and variable renewable energy with a need for a combination of storage types to stabilise the grid, shift energy from times of surplus supply to times of low supply, facilitate 'baseload' supply for industrial consumers, create reserves for extended periods of low supply and facilitate electric mobility. All of these technologies are currently deployable although not yet at volume, due to higher prices compared to internal combustion engine vehicles and coal- and gas-fired power generation. Queensland, with its mineral, solar, wind and labour resources in regional centres, and proximity to Asian markets, is well-placed to develop a manufacturing industry that will underpin the deployment of energy storage technologies in Queensland, facilitate the export of energy storage products and create new employment opportunities.

1. Global opportunity for new manufacturing capacity

a. Policy supporting global energy transition

Both China and the European Union (EU) have pursued policies to promote the production and sales of electric vehicles to reduce tailgate emissions from personal mobility. A little history and detail follows.

i. China's Five Year Plans

As long ago as the 9th Five Year Plan (FYP) (1995-2000), battery electric vehicles (BEV) were identified as a National Key Science and Technology Industrialisation Project. This was followed by the intention to develop domestic vehicles as a pillar industry of the national economy by 2010 in the 10th FYP (2001-05). The scale of the Chinese market and the investment this attracted, resulted in China becoming the world's largest motor vehicle market in 2009. New Energy Vehicles (NEV) were next identified as a strategic industry in the 11th FYP (2006-10) where funding was made available for moving NEVs from laboratories to the market with annual sales goals (Gong et al., 2012). Initially EV roll-outs were encouraged through government procurement programs of buses, taxis, government vehicles and special purpose vehicles (like garbage trucks, street sweeping vehicles and postal vehicles) but also significant subsidies were made available. Developed alongside energy savings goals, early subsidies for NEVs ranged from RMB 60,000 to 250,000 (US$8,863 – 36,928) per car and from RMB 420,000 to 600,000 (US$ 62,000-89,000) per bus (Gong et al., 2012). Consequently buses were the dominant NEV sale from 2005-8 and China now has the largest EV bus fleet in the world (Eckhouse, 2019). With help from subsidies sales of EV passenger vehicles have also grown sharply with annual sales of more than a 1 million NEVs since 2018 (EV Volumes.com, 2020). From 2019, annual growth in NEV sales has been tempered by declining subsidies with a total phase out scheduled to occur in 2020 (European Chamber, 2017). However, after a decline in sales of NEVs in 2019, the Chinese Government has extended subsidies until 2022 (Tian et al., 2020).

There were many reasons for China courting this new industry. First, the manufacture of EV's is considerably simpler than internal combustion engines (ICE) so China didn't need to compete against the advanced vehicle technologies of the established global ICE auto manufacturers (Barkenbus, 2019). Second, China does not have significant domestic oil reserves to support a large motor vehicle industry, but it does have lithium reserves, required for lithium-ion batteries, the major component of NEVs (Rapier, 2019). Third, Chinese cities have experienced decreasing air quality attributable to vehicle tail-pipe emissions, so avoiding significant pollution from emissions from ICE's was a rational policy measure for increasing personal mobility without experiencing declining city air quality (Gong et al., 2012). (It has been argued that EV's charged from electricity generated from coal does not provide a pollution benefit as emissions-intensity is greater from coal generation than from ICE tail pipes (European Chamber, 2017). Gong (2012) argues that reducing tail pipe emissions improves city air quality as coal generators are located outside of cities such that dispersal over large regional areas reduces concentration of pollution in urban areas). The longer-term benefit of encouraging electric mobility in preference to ICE mobility, is that it is less complicated to transition the stock of power stations than it is to transition the stock of millions of ICE vehicles to low-carbon energy sources.

Sales of new NEVs made up 5% of new vehicle sales in China in 2019. The subsidies and industry support to establish both the EV manufacturing and the domestic auto manufacturing sectors have caused discontent amongst European and US auto manufacturers. The discontent centres on 2 concerns. First, subsidies provided have been available only to domestic Chinese manufacturers, cutting out European auto manufacturers who have sought to gain a foothold in the Chinese NEV market. Second, the cost of access to the Chinese market for European, US, Japanese and South Korean vehicle manufacturers has been the disclosure and transfer of critical know-how to Chinese partners. These discriminatory practices, many claim, are contrary to the principles of the World Trade Organisation (European Chamber, 2017, McBride and Chatzky, 2019), from which China has benefited significantly since 2001.

During 2018-19, investment in new ICE vehicle manufacturing plants was restricted in China and the corporate average fuel consumption limit for cars was decreased to 5 litres per 100km from 2020 and 4 litres per 100 kilometres from 2025 (International Energy Agency, 2019).

China's Ministry of Industry and Information Technology is said to have targets of NEVs making up 25% of all vehicle sales in 2025, 40% by 2030 and 60% by 2035 (Bloomberg News, 2019b, Bloomberg News, 2019a). This translates into approximately 7 million NEVs in 2025 (Yukun and Jia, 2019). The IEA, in its New Policies Scenario (effectively the most likely scenario) predicts that sales of EV's will reach 6.5 million by 2025 and 11 million by 2030. In the IEA's EV30@30 Scenario which represents the pledges of the Electric Vehicle Initiative's EV30@30 Campaign to reach a global 30% market share, annual sales of EVs in China would reach 14.5 million vehicles by 2030 (International Energy Agency, 2019). Thus, China's Five Year Plans have set the foundation for the emergence of a very large EV market over the next decade.

ii. Europe's integrated policy framework

Much of Europe's policy framework to address climate change, vehicle emissions and the development of regional manufacturing has been in development for many years.

Trans-European Networks (TEN)

TEN Regulation, an outcome of the Maastricht Treaty, required the development of networks for transport, telecommunications and energy to develop the markets and reinforce economic and social cohesion. Initial guidelines, issued in 1996, have been revised in 2004 and 2013. TEN-Transport (TEN-T) guidelines placed emphasis on environmentally friendly modes of transport, in particular rail projects, while TEN-Energy (TEN-E) projects sought to improve electricity networks. Revisions in 2004 to TEN-T included seeking to make sea routes more efficient and integrating short sea shipping with rail transport, while TEN-E sought to diversify sources of supply, strengthen links with non-EU countries, incorporate new member networks with particular attention given to compatibility with sustainable development goals. The 2013 revision to TEN-T aimed to integrate Member state rail/road networks into a coherent transport infrastructure, including the development of a 'Motorway of the Sea' (European Parliament, 2020). As part of the Green Deal, TEN-E Regulation will be reviewed to ensure consistency with climate neutrality objectives by seeking to deploy smart-grids, hydrogen networks, energy storage and carbon capture storage and utilisation, possibly funded by the EU

Emissions Trading System Innovation Fund. Transport energy considerations will be to end current tax exemptions including for aviation and maritime fuels and free EU ETS allowances for airlines and extend the EU ETS to the maritime sector (European Commission, 2019b).

Vehicle emission standards

In 1998, the EC reached agreement with the European Automobile Manufacturers' Association (ACEA) to reduce average emissions from new cars sold, to 140g CO2/km (6 litres/km) by 2008 and an objective to reach 120g CO2/km (5 litres/km) by 2012. By 2007 there was little likelihood that the objectives would be met, so emissions performance requirements for new passenger cards were issued in 2009 to reach 130g CO2/km (5.6 litres/km) in 2015 and 95g CO2/km (4 litres/km) in 2020 (European Environment Agency, 2019). Similarly, in 2011, new emissions performance requirements for light commercial vehicles were issued in 2011 to reach 175g CO2/km by 2017 and 147g CO2/km by 2020.Passenger car emission targets were met in 2015 and light commercial vehicle targets in 2017 (European Environment Agency, 2019). In 2019, the EC issued new targets for passenger vehicles for 2025 and 2030 of 82g CO2/km (3.5litres/km) and 69g CO2/km (3 litres/km). A further incentive mechanism relaxes the achievement of the fleet target if 15% of fleet sales in 2025 and 35% of fleet sales in 2030 are made up by zero- and low-emission vehicles (ZLEV) (CO2 emissions of less than 50g/km) (European Commission, 2019a).

European Union Emissions Trading System (EU ETS)

In 2005, the EU ETS began as a 3-year pilot, covering only CO2 emissions from power generators and energy-intensive industries, with allowances given free to emitters based on generous national allocation plans. Phase 2 from 2008-12 lowered the cap, included aviation emissions within the European Economic Area (EEA) and reduced the proportion of free allocations. The GFC and the resulting reduction in economic activity led to a collapse of allowance prices (European Commission, 2019d). In the third phase an EU-wide cap was applied to reduce surplus allowances, more gases were included, free allocation of allowances was replaced with auctioning of allowances, and funds raised from 300 million allowances were set aside in the New Entrants Reserve to fund clean energy initiatives. Currently, the EU ETS operates in all EU countries plus Iceland, Liechtenstein and Norway, limits emissions from power stations, industrial plants and airlines and covers 45% of the EU's GHG emissions (European Commission, 2019c).

Europe's Green Deal

Announced in November 2019, Europe's Green Deal presents a comprehensive framework to integrate energy, climate, industrial and transition policy, bringing together many of the policies in development since the Maastricht Treaty. The European Commission President Ursula von der Leyen refers to The Green Deal as Europe's "man on the moon moment." (European Commission, 2019e). Some have suggested that this is indeed a meaningful comparison as the US shouldered the full cost for the "giant leap for mankind", which is similar to what amounts to Europe's rescue package for sustainable life on Earth (Valatsas, 2019). The Green Deal is considered to hold promise in achieving Europe's climate ambition of becoming carbon neutral by 2050 because the policy directs investment to the key pillars of carbon abatement, the shift of electricity supply to renewable energy, and the electrification of mobility. Not only will investment be directed to zero-carbon manufacturing but it will also be directed to regional areas in Europe that are most disaffected by a shift away from fossil fuel production, or have experienced disadvantage from the decline in European manufacturing capacity after the GFC. The scaffolding for this framework thus utilises energy policy, climate policy, and industry policy for regional development to achieve just transitions. Figure 1 shows the major policy elements of the Green Deal.

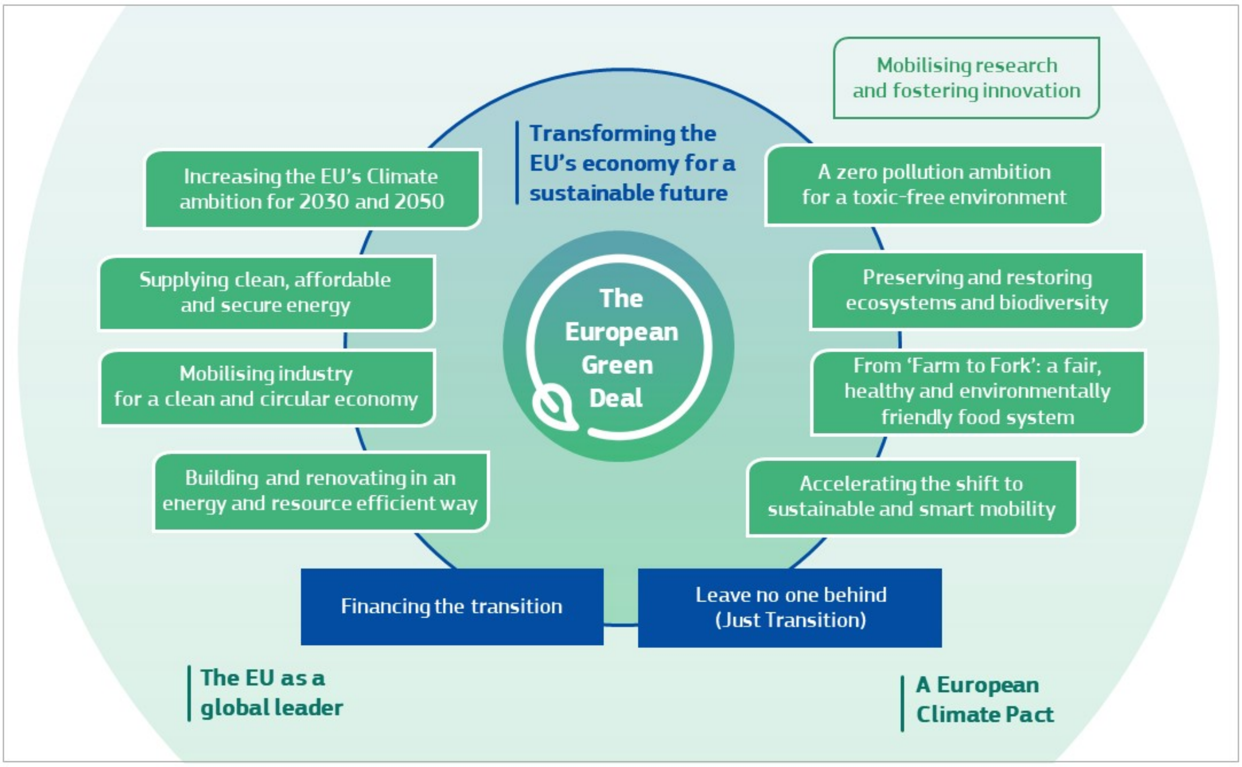


Figure 1: Transforming the EU's economy for a sustainable future (European Commission, 2019b)

The policy context is the unique opportunity that the challenge of climate change presents. It seeks to foster growth that is decoupled from fossil fuel use and unsustainable resource extraction where the benefits are distributed fairly across society. The policy recognises that transitioning away from fossil fuel use presents large challenges for people, places and industries but that engagement with, and participation by, workers, regions and businesses will increase the likelihood of success. The ambition for the project is not limited to action within the EU, it also seeks to co-ordinate international efforts to build financial systems and trade policies to encourage and influence other nations to improve their sustainable development goals.

The Green Deal will make consistent use of all policy levers: regulation, standardisation, investment, innovation, national reforms, dialogue and co-operation. Policy levers pertinent to energy include prioritisation of energy efficiency, an extension of the EU Emissions Trading System (ETS) to new sectors (including the maritime, road transport and air transport sectors), alignment of the Energy Taxation Directive to the principles of reducing carbon emissions and a carbon border adjustment mechanism to reduce the risk of carbon leakage (European Commission, 2019b). The Commission will accelerate the deployment of zero- and low- emission vehicles and vessels through adjustments to the Trans-European Transport Network (TEN-T) Regulation to impose more stringent air pollutant emission standards for ICEs and support the deployment of public recharging and refuelling stations (the Alternative Fuels Infrastructure Directive). It is expected that these actions will provide for an estimated 13 million zero- and low-emission vehicles by 2025 (European Commission, 2019b). Funding will be made available to facilitate disruptive innovation and secure competitive advantage in the new transition technologies. Figure 2 shows the roadmap of the strategic priorities to climate neutral economies.

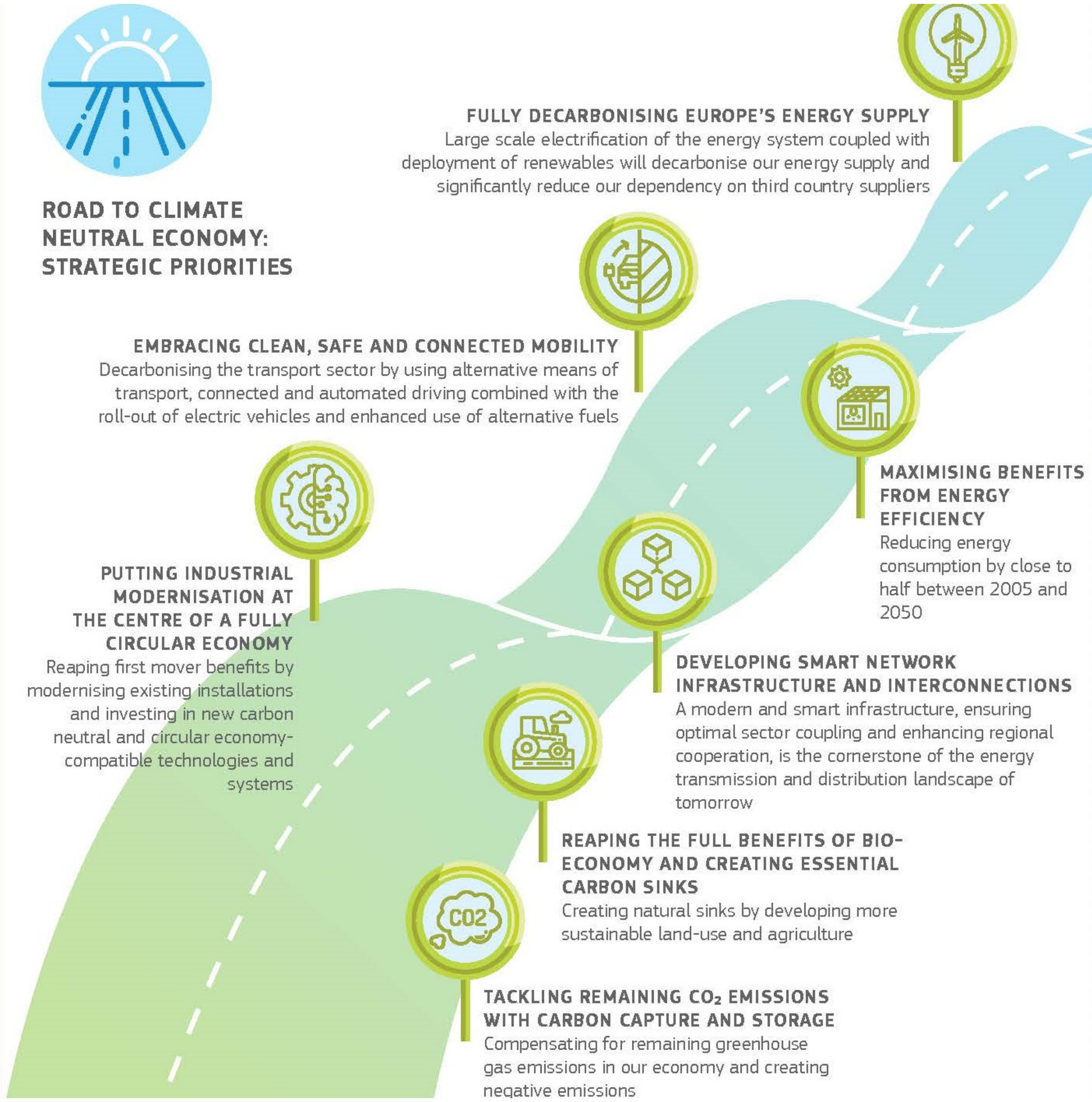


Figure 2 : Roadmap to Climate Neutrality (European Commission, 2019f)

The Commission estimates that the Green Deal 2030 targets will require Euro 260 billion of annual investment, which will be sourced from the proceeds of EU ETS allowance auctions, tax reforms that remove subsides for fossil fuels, additional taxes on pollution or waste, the EU budget and the private sector.

The sustainable future will be directed by a green oath – to 'do no harm'. This extends as much to enhanced environmental outcomes through a commitment to circular economies, as to enhanced social outcomes through commitments to regional development, just transition and fair trade agreements.

Aligning the EU ETS with the ambitions of the Green Deal will serve to deploy the EU ETS as an investment driver through a reduced cap, the inclusion of the maritime sector into the scheme and reduced free allowances to airlines. These actions are expected to increase the allowance price, the proceeds of which will be used for low-carbon investment.

iii. The USA's New Green Deal and President-elect Biden's Climate Plan

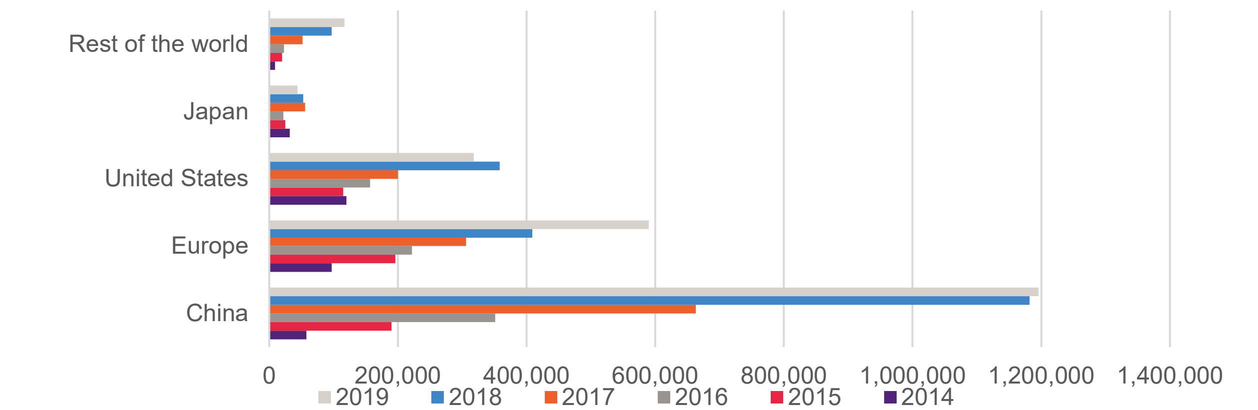
In similar vein to Europe's Green Deal, the US Green New Deal (GND) resolution was introduced by US Congresswoman Alexandria Ocasio-Cortez and Senator Ed Markey in 2019 (Ocasio-Cortez, 2019), co-signed by 111 US Federal legislators and endorsed by the majority of the Democratic Party's 2020 Presidential frontrunners (Galvin and Healy, 2020). It promotes the view that decarbonising the US economy through creating secure employment by investing in infrastructure is a duty of the Federal Government. It's announcements have resulted in mixed responses, including that it proposes a "Revolution in the way we live", that it is a "Communist economic doctrine", and that it is a "Green Dream" (Wolf, 2020).

Recently, President-elect Joe Biden announced a $1-7 - 2 trillion climate plan (Biden, 2020, Glueck and Friedman, 2020). Although not as ambitious as the GND, Biden's plan includes commitments to an emissions-free power sector by 2035, addressing building energy efficiency and committing to invigorating the US auto industry and its suppliers to lead the world on clean vehicle production (Glueck and Friedman, 2020).

It is worth noting that Tesla, the world's most valuable motor vehicle manufacturer (BBC, 2020), is the manufacturer of EVs originating in California. It is thus not inconceivable that the US too, under a new administration, will become a large market for electric vehicles and lithium-ion batteries.

iv. The impact of the world's response to the Coronavirus and COVID-19

Figure 3 shows the historic increase in sales of EVs in the major markets. However, predicting the trend going forward is complicated by the emergence of the Coronavirus and COVID-19, and the effect of international, national and local restrictions on human movement to protect against the spread of the disease, on economic plans and strategies announced in 2019.



Source: (EV Volumnes.com, 2020)

Figure 3: Global Battery Electric Vehicles and Plug-in Hybrid Electric Vehicles

Although it is too early to understand the short- to medium-term consequences of Coronavirus on the global transition to low-carbon energy sources, stimulus packages like the European Union's recent announcement abound, and suggest that there is consensus that stimulus is required and investment in clean energy is a logical part of any stimulus package (Barrett, 2020). The Coronavirus has not changed the need to act to reduce carbon emissions, nor has it produced any new technology to transform transportation to low-carbon energy sources. Consequently, it is unlikely that the long-term strategies of very large investment in EV and LiB manufacturing will cease to be valid and necessary.

b. Projections for BEVs and PHEVs

In response to ambitious vehicle tailpipe emissions standards by 2025, effectively 3 litres per 100km, EU carmakers jointly plan to spend around EU145 billion on electric cars by 2025 (Todts, 2019). Production plans are underway to increase the number of BEV/PHEV and FCEV models from around 60 at the end of 2018 to 214 models in 2021 and 333 in 2025. Greater numbers of models available, is expected to translate to fast-increasing annual sales of EVs to ensure that EU Car manufacturing CO2 standards are reached (Todts, 2019).

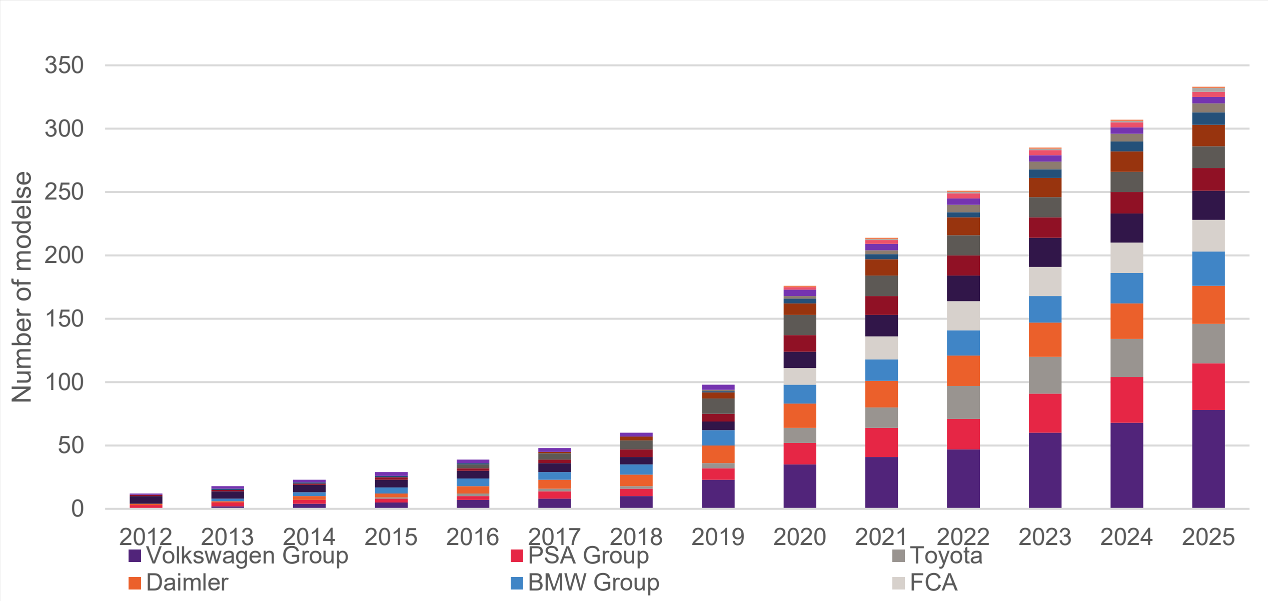


Figure 4: European Electric Vehicle models (BEV, PHEV, HEV)

China too has announced ambitious passenger vehicle tailpipe emissions targets. The corporate average fuel consumption limit for cars was decreased to 5 litres per 100km from 2020 and 4 litres per 100 kilometres from 2025 (International Energy Agency, 2019).

China's Ministry of Industry and Information Technology is said to have targets of NEVs making up 25% of all vehicle sales in 2025, 40% by 2030 and 60% by 2035 (Bloomberg News, 2019b, Bloomberg News, 2019a), which translates into approximately 7 million NEVs in 2025 (Yukun and Jia, 2019). The IEA, in its New Policies Scenario (effectively the most likely scenario) predicts that sales of EV's will reach 6.5 million by 2025 and 11 million by 2030. In the IEA's EV30@30 Scenario which represents the pledges of the Electric Vehicle Initiative's EV30@30 Campaign to reach a global 30% market share, annual sales of EVs in China would reach 14.5 million vehicles by 2030 (International Energy Agency, 2019).

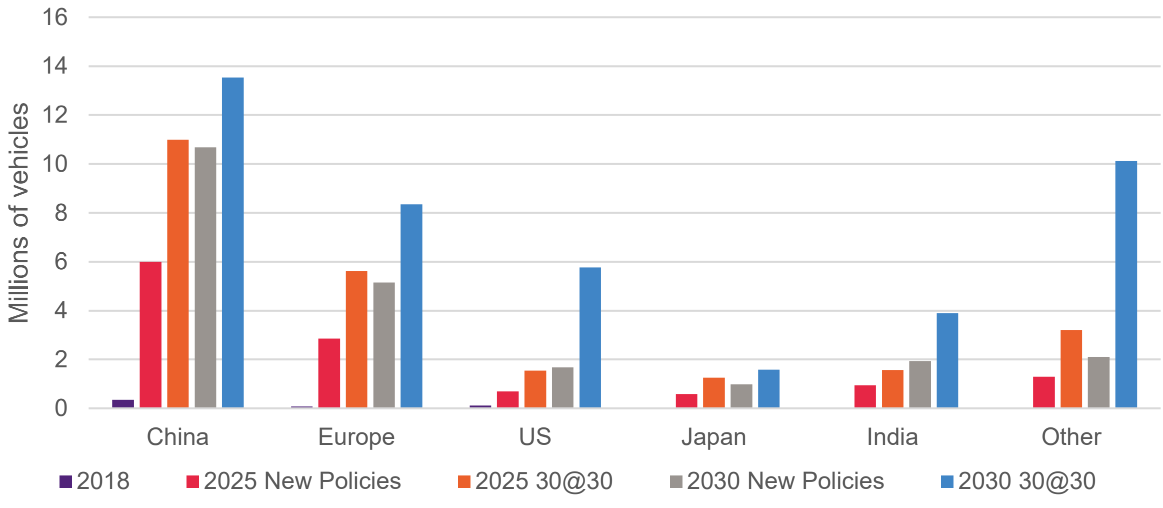


Figure 5: Global EV Annual Sales Outlook

The IEA estimates that under current policy settings global annual EV sales will reach 22.5 million in 2030 but potentially up to 43 million if there is a strong push by EV manufacturers (International Energy Agency, 2019). EV sales of this level will require very large investment in LiB manufacturing capacity.

c. Projections for Li-ion battery capacity (EVs and electricity systems)

The Global Battery Alliance (GBA), a public-private collaboration within the World Economic Forum, is tasked with addressing the challenges of enabling the Fourth Industrial Revolution through sustainable deployment of batteries (World Economic Forum, 2020). In their report on a *Vision for a Sustainable Battery Value Chain in 2030* (Global Battery Alliance, 2019), GBA discusses the growth in battery manufacturing capacity to 2018, and the projections for li-ion demand by 2030. It finds that demand for Li-Ion energy storage for EVs and stationary energy of 146GWh in 2018 grew 30% per annum from 2010, with annual sales of $40 billion. Their projections to 2030 are detailed in Table 1.

Table 1: Li-ion battery capacity projections

Country	Capacity 2018	Forecast capacity 2025	Forecast capacity 2030	Pa growth since 2018
China	100	446	1074	22%
EU	18	170	443	31%
USA	22	136	357	26%
Rest of World	6	161	681	48%
World Total	146	913	2555	27%

Source: (Global Battery Alliance, 2019)

The detail in Table 1 shows that China is forecast to dominate li-ion battery (LiB) production with 42% of the market by 2030, despite being the major supplier in 2018. This is as a result of large vehicle manufacturers in the EU announcing ambitious EV development and manufacturing plans. It is also associated with significant investment in LiB manufacturing capacity in the EU although much of the investment announced is from large manufacturing concerns in South Korea seeking a foothold in the European market. Analysis of announcements of LiB Giga-factory plans indicates that 40-50% of capacity in Europe will be attributable to investment from South Korean chemical engineering giants, LG Chem, SK Innovation and Samsung in partnership with European motor vehicle manufacturers.

The push for investment in Europe is largely attributable to the German car manufacturing sector acknowledging the looming risk to the internal combustion engine (ICE) motor vehicle industry from electric vehicles. As the major technology component for EVs is energy storage, and more specifically LiBs, being competitive in the EV industry will require advanced technological capabilities in LiB manufacturing. German monitoring of the energy storage industry found that Europe and the USA have technologically fallen behind the large Asian battery manufacturing concerns, and that Germany has at best until 2025 to reach adequate technological capability to produce LiBs for electric mobility before EV's shift from niche to mass market (Thielmann et al., 2018). Production close to car manufacturing plant secures reliable supply of batteries, such that European car manufacturers are requiring supply from LiB plant located in Europe rather than being sourced from China or South Korea. Based on recent announcements, Europe has 38GWh of LiB manufacturing capacity in 2020, which will increase to 396GWh of capacity by 2025 and 576GWh of capacity by 2030 (Fraunhofer, 2020). Assuming 50kWh batteries per EV, this suggests that LiB manufacturing capacity in Europe currently supplies approximately 760,000 EVs but will rise to approximately 8 million in 2025 and 11.5 million in 2030 (potentially 50% of the non-commercial market in 2025 and 70% in 2030).

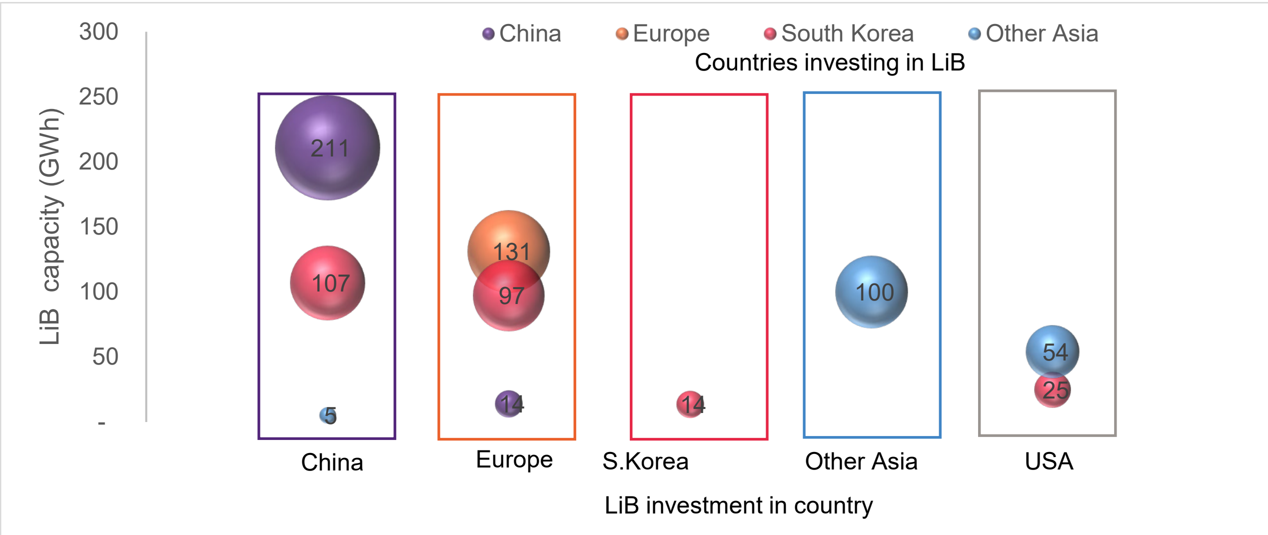


Figure 6: Countries investing in Li-ion battery manufacturing

Not all analysis supports the bullish forecasts of Fraunhofer. The European Federation for Transport and Environment indicates 180GWh by 2025 and Benchmark Mineral Intelligence indicate 131GWh in 2023 (Todts, 2019). The IEA's NPS finds that capacity will increase to 1300GWh in 2030 but 1700GWh if BEV sales are 50% higher and 900GWh if BEV sales are 50% lower. In the EV30@30 Scenario, battery capacity reaches 2800GWh per year (International Energy Agency, 2019). Notwithstanding the discrepancy in projections, there is very large investment being directed to the LiB manufacturing sector in Europe.

Based on recent announcements, Figure 6 provides detail on the existing capacity and planned investment in LiB manufacturing capacity to 2024. Existing and planned capacity in China is forecast to reach 323GWh by 2023-4, 65% of which is led by Chinese companies. Capacity in Europe is forecast to reach 242 GWh in the same period, 54% of which is led by European companies and 40% by South Korean companies. Existing capacity in the USA is primarily the Panasonic Tesla Giga-factory in Nevada with joint ventures between South Korean companies and General Motors planned to increase US capacity by 46%. In the rest of Asia, Panasonic has an existing 20GWh factory in Japan, a joint venture between Indian and South Korean companies plans a 30GWh factory in India and a Thai entrepreneur is planning a 50GWh factory for the Thai market. Tesla is the only US manufacturer discussing LiB investment plans in Berlin, in Germany, and Shanghai, in China. For now Tesla's plans remain fluid but there are reports that it is prioritising the production of its Model 3 in China.

d. Li-ion battery raw material and mineral processing supply chain

Lithium-based battery manufacture relies on a set of raw materials with specific technical properties. There are five minerals which are frequently identified as being the core raw materials required for the industry; namely cobalt, graphite, lithium, nickel, and rare earth minerals. Figure 7 shows the minerals required for each stage of LiB production,

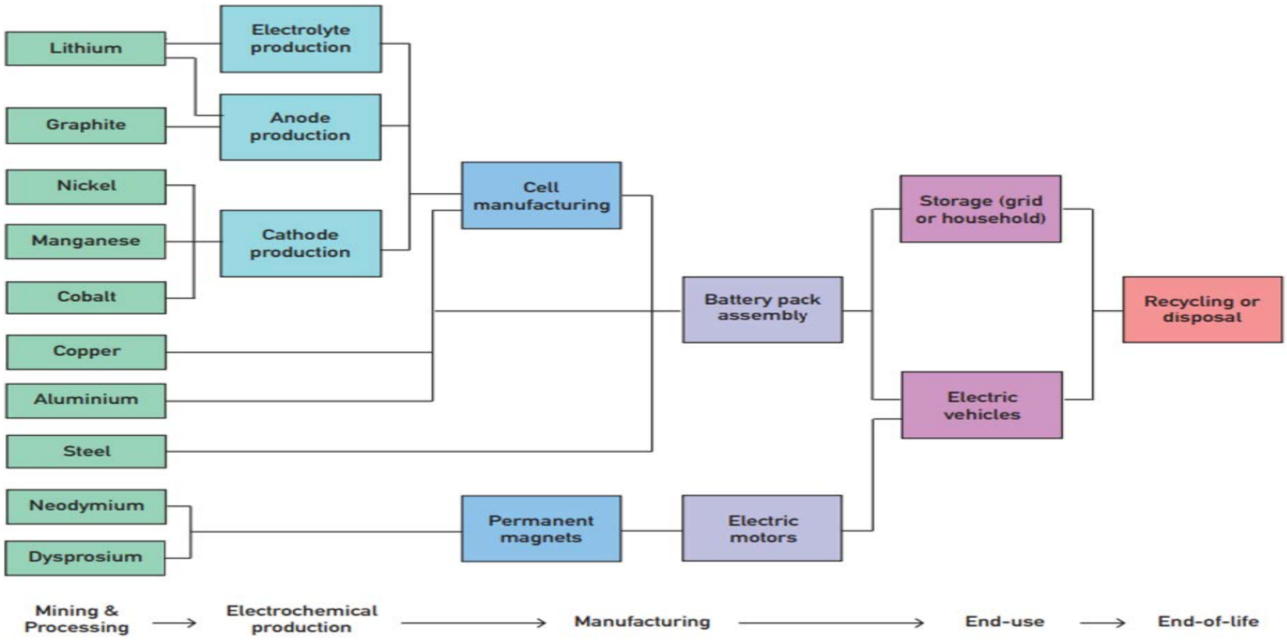


Figure 7: Raw materials for LiB supply chain
Source: (Best and Vernon, 2020)

i. China's dominance in the li-ion battery supply chain

China dominates the global battery supply chain from extraction, to refining and processing of battery minerals.

Extraction

China is the dominant producer of three of the six battery minerals: graphite (70%), rare earths (80%) and vanadium (56%) (Wilson and Martinus, 2020)

Mineral refining

Lithium: more than half of global lithium refining (conversion of primary lithium to carbonates or hydroxide) occurs in China, notwithstanding the fact that it produces only 9% of global primary lithium. While lithium occurs as a salt in Latin America, in Australia it occurs as spodumene, a hard rock ore. The higher purity of lithium in spodumene is the feedstock for lithium hydroxide, required for high-nickel cathode materials for longer-range LiBs. Australia currently exports all spodumene concentrate to Chinese conversion plants for lithium hydroxide processing. China is reported to produce 80% of global lithium hydroxide (Nicholas, 2020).

Cobalt: The majority of global cobalt is located in the Democratic Republic of Congo (DRC) but China is said to control 7 of the largest mines in the DRC, and the remaining mines export cobalt to Chinese refineries such that China supplies 80% of the world’s battery-ready high-grade cobalt (Todd, 2019). Others estimate that China accounts for only 58% of global refined cobalt (Wilson and Martinus, 2020).

Graphite: In 2019, China was the only commercial-scale producer of spherical graphite, LiB anode precursor material, controlling close to 100% of graphite processing (Lasley, 2020, Willing, 2020)

Nickel: China accounts for 29% of refined nickel (Wilson and Martinus, 2020).

Rare earths: China has the majority of the world’s rare earth’s resource, but also 85% of global rare earth processing capacity (Daly, 2019).

Mineral	Used to produce	Economic resources (mt)	Largest economic resource	Australian economic resource	China Refinery capacity
Lithium (Spodumene)	• Electrolytes • Anodes	17	61% (AUS)	61%	80% (lithium hydroxide)
Cobalt (Cycle stability)	• Cathodes	7	51% (DRC)	19%	58-80%
Nickel (Storage capacity)	• Cathodes	89	24% (Indonesia)	22%	29%
Graphite (Energy density)	• Anodes	300	30% (Turkey)	3%	100%
Rare earths (Tesla Mod 3)	• Magnetic motors	120	38% (PRC)	3%	85%
Sources: (Austrade, 2020, Nicholas, 2020, Todd, 2019, Wilson and Martinus, 2020, Best and Vernon, 2020)					

Chemical processing

In processing lithium carbonate or hydroxide for cell manufacture, China produces 56% of global chemical lithium derivatives (Wilson and Martinus, 2020).

Cell manufacture

China accounts for 83% of world overall lithium-ion cell manufacture but this reflects China's dominance in cell manufacture for consumer electronics, supplying 75% of consumer electronics battery demand. China's supply of cells for energy storage systems is lower at approximately 26% of global demand (Wilson and Martinus, 2020). Other large manufacturers or li-ion cells for energy storage are the US (approximately 30%), EU (approximately 30%) and Japan (5-15%) (Wilson and Martinus, 2020).

ii. Queensland's potential role in the li-ion battery supply chain

China's dominance in extraction, refining and processing of battery minerals, creates a significant supply chain risk for European EV manufacturers seeking to compete directly with Chinese EV manufacturers.

Queensland has resources of cobalt, graphite and rare earth minerals and possible access to nickel from New Caledonia. West Australia has quality resources of graphite, nickel, cobalt, lithium and rare earth minerals. Australia has 28% of global lithium ore economic resources with 61% of global lithium ore production and 19% of cobalt global economic resources with 5% of global cobalt production (Best and Vernon, 2020, Wilson and Martinus, 2020, Austrade, 2020).

Access to the new economy minerals from Queensland/Australia would significantly simplify and strengthen the new economy mineral global supply chain. Couple the availability of the necessary raw materials, with low energy costs from solar and wind energy, and the competitive advantage for energy storage manufacturing in Queensland becomes apparent.

2. Queensland's energy storage manufacturing expertise and potential

i. Current research on the battery industry in Australia

The Future Battery Industries CRC, was established in 2019, with the objective of enabling the growth of battery industries to power Australia's future. FBICRC brings together 58 industry, academic and government partners for 6 years to address industry-identified gaps in the battery industries value chain. It aims to investigate opportunities for greater efficiencies in the extraction and refinement of battery minerals, including facilitating the steps beyond mining and concentrate production to cathode production and the manufacture and testing of battery components and systems. It also plans to co-create the tools and technologies needed to ensure Australia is leading the way in the battery revolution from mining and processing to manufacture and deployment in households, communities and industry, and in the recycling of batteries.

The FBICRC project summary lists the research project pipeline, which seeks to advance technology associated with batteries and battery supply chains (FBICRC, 2020). The projects include:

- Maximising community value from mining in an environmentally safe manner;
- Establishing a National Battery Testing Centre;
- Finding economic alternative leach technologies for extraction of nickel and cobalt from waste streams;
- Improved technology for the extraction of lithium minerals and refining of battery grade lithium chemicals;

- Increasing the value chain of battery manufacturing in West Australia by developing a Pilot Plant and establishing technical and processing capabilities to manufacture nickel-rich cathode active material precursors;
- Developing capability across the anode material value chain to produce high power anodes;
- A software platform for improved decision-making of investment and operation of batteries;
- Establishment of fabrication and electrochemical testing facility for lithium-ion battery materials;
- Facilitate cost reduction throughout the battery energy management value chain for Australian battery manufacturers;
- Develop new and improved processes for vanadium and manganese extraction and purification, and the optimisation of vanadium bearing electrolytes of Vanadium Redox Flow Batteries;
- New electrolyte systems to improve Li-ion device performance in niche applications;
- Ethnically sourced, high-grade battery material provenance authentication for the next generation battery supply market;
- A quantified environmental basis to ensure traceable, sustainable production of Australian battery minerals, metals and materials;
- Reduction of battery waste for a more sustainable and circular economy for Australian battery industries;
- Facilitate regional synergy and investment around downstream battery industry development
- A holistic system approach to mine electrification with batteries deployed in stationary and mobile applications.

FBICRC has published two reports:

- State of Play: Australia's battery industries (Best and Vernon, 2020)
- The governance of battery value chains: security, sustainability and Australian policy options (Wilson and Martinus, 2020)

Both reports make the same observations:

- There is no shortage of resources or technical expertise to establish battery industries
- There is a lack of battery-specific initiatives in Australia with ***no policies designed specifically to facilitate the growth of the battery industry***.
- Policy design by governments, and project development by businesses, need to be calibrated to the specific governance features and needs of global battery value chains.
- Governments and businesses should actively pursue international trade, investment and technology partnerships with key global players.

ii. Queensland's existing energy storage industry

Queensland already has a (small) energy storage industry including:

- Century Yuasa's Intelepower brand which combines DC power electronics, industrial uninterruptible power systems, off-grid power and commercial energy storage systems (Century Yuasa, 2019);
- Redflow's zinc-bromine flow batteries designed for high cycle-rate, long time-base stationary energy storage applications, which are currently manufactured in Thailand (Redflow, 2019);

- Redback Technologies manages the capture, storage and dispatch of solar energy (Redback Technologies, 2020); and
- RedEarth which engineers and assembles li-ion storage (RedEarth, 2020).

Queensland's capacity to become a significant part of the global energy storage supply chain has already been recognised by investors including:

- Imperium3 Consortium has recently concluded a successful feasibility study into a Li-Ion Battery Storage Plant located in Townsville (Maisch, 2019).

In support of battery manufacturing, several projects to extract or produce important components required for battery manufacture are already underway:

- Strategic Metals Australia claims to have discovered Lithium deposits near Georgetown in Queensland (Gluyas, 2019), Lithium Australia has three exploration projects in North Queensland (Lithium Australia, 2020)
- Australian Mines Limited Sconi project has completed a feasibility study to mine cobalt sulphate and nickel sulphate, confirming that the project could commence soon (Proactive Investors, 2020).
- Pure Minerals through its subsidiary, Queensland Pacific Metals, is proposing to develop a processing plant for nickel sulphate and cobalt sulphate in Townsville (Pure Minerals, 2020).
- Multicom Resources' Saint Elmo Vanadium Project to mine and produce vanadium is currently under development for use in Vanadium Redox Flow Batteries (Barry, 2019).

Although not much discussed in Australia liquid air energy storage (LAES) is a very promising large-scale 'baseload' energy storage technology (Highview Power, 2020). The developer, Highview Power, has completed 2 successful pilots of the technologies and has recently secured investment from Sumitomo Heavy Industries to move to more robust electricity grid 'baseload' storage implementations (Spector, 2020). This is relevant for LAES because the technology is closely aligned with the liquefaction technology associated with liquefied natural gas (LNG). Queensland has developed a large liquid natural gas (LNG) export facility in Gladstone. The skills acquired for the LNG industry could underpin the development of a liquefied air energy storage (LAES) industry in Queensland.

3. A policy framework to facilitate energy storage manufacturing in Queensland

While the FBICRC is undertaking valuable technology research, it has no clear objective to design policies that will facilitate relationships with key global players, facilitate investment and seize global market opportunities. The research findings that result from FBICRC will provide valuable input and examples to key global players and international investors, but may not help formulate a policy framework to make investment in energy storage manufacturing attractive, in Queensland, or indeed Australia.

a. Evidence of successful industry policy frameworks

Since the 1980s, industry policy and economic development are policy frameworks that have been associated with attempting to 'pick winners' while in effect subsidising inefficient domestic industries. Consequently, research and application of these policy frameworks in Australia, and internationally, declined. Recent research findings on economic recovery from the Global Financial Crisis indicate that industry policy plays a valuable economic development role. In particular, the research finds that high fiscal deficits and adverse current account balances, combined with a small manufacturing base, have led to persistent economic decline after the GFC. By comparison, the large manufacturing base in Ireland helped the country increase employment by 11,000 (Republic of Ireland Central Statistics Office, 2020b) and GDP by Euro 21 billion between 2008 and 2020 (Republic of Ireland Central Statistics Office, 2020a). Thus, industry policy in Europe is focused on manufacturing to promote economic development in locations in need of support (Iammarino et al., 2017) to address what are considered to be systemic and market failures (Kitson, 2019). Thus policy frameworks in Europe are being designed to facilitate connections between firms, research agencies and innovators to create sector ecosystems to grow and enrich the manufacturing base (Bailey et al., 2019). This re-engagement with industry policy seeks to promote new technologies to advance climate and energy policy and support environmental and societal long term goals (Aiginger, 2014), whilst also acknowledging concepts like “Just Transitions” for those who will be most disadvantaged by change (Stanley et al., 2018).

The US has always pursued regional industry policy. Support for coal mining in Appalachia, oil extraction in Texas and Louisiana, agriculture and ethanol production in the Midwest, and defence in the South and West all provide recent evidence of this policy framework (Bailey et al., 2019). In this framework, regulatory hurdles have been relaxed through the creation of Enterprise Zones (Hooton and Tyler, 2019) and the formation of the National Network of Manufacturing Institutes (NNMI) has sought to advance industry ecosystems to connect new technologists with manufacturers (Clark and Doussard, 2019), and thereby advance regional economic development. Going back even further, the US itself industrialised behind the protection of industrial tariffs from the late 18th century right up to the end of World War 2, when US industry had achieved supremacy (Wade, 2003).

Asia too has successfully pursued industry policy for economic development. Between 1970 and 2015, a focus on industry policy has enabled Asian manufacturing value add (MVA) to increase 3160% (world: 286%), industry value add (IVA) 1301% (world: 207%), average GDP/Person 553% (world: 91%), and Asian share of global GDP 264% from 6.2% I n 1970 to 22.7% in 2015 (Chang and Zach, 2019). Many, including the World Bank, have claimed that successful economic development has resulted from macro-economic stability, a government led push for exports of manufactures, subsidized credit to targeted uses but not industry policies to support specific sectors (World Bank, 1993). However, according to others, there is little robust evidence to support this view (Wade, 2003, Evans and Heller, 2019, Chang and Zach, 2019, Rodrik, 2011, Stiglitz, 2002, Amsden, 2001).

Some Asian countries have industrialised more and/or faster than others, but even those with the lowest aggregate growth 1970-2015, show larger economic growth than the global aggregate (Chang and Zach, 2019). The process of industrialisation has never happened automatically because of inertia-creating social structures, scarcity of economic inputs and political propensity to support entrenched elites over public good (Chang and Zach, 2019). Therefore, historically and currently, governments have, and continue to, intervene in markets if only to ensure the safety and soundness of the system - although intervention needs to be appropriate and tailored to the country and context (Stiglitz, 2002). The newly industrialised Asian countries have implemented a variety of industry policies in pursuit of economic development, but no one policy has been identified as achieving success in every implementation (Chang and Zach, 2019). There have, however been common outcomes from different mechanisms that point to success, for instance achieving high savings rates. What is notable is that all of the economies in the region used industrial policies (except Hong Kong, which was subject to policies implemented in China) which suggests, in the absence of robust evidence to the contrary, that industry policies were an important contributor to their growth outcomes (Stiglitz, 2002). Taking a high-level perspective, Asia’s success in fast industrialisation, and the presence of industry policies, appropriately planned, implemented, monitored and adapted, indicates a powerful tool for economic development.

b. Policy framework for sector specific industry development in Queensland

The Harvard economist, Dani Rodrik, who commented on the challenges of Globalization and Democracy in “The Globalization Paradox” (Rodrik, 2011), has more recently discussed the challenges of new technologies and global value chains, in a National Bureau of Economic Research Working Paper (Rodrik, 2018). In summary, global value chains (GVC) represent the dissemination of the manufacture of new technology to take advantage of lower costs of elements of production in each location, for the benefit of large firms based in countries with mature markets. In effect, GVCs allow smaller nations (developing and developed) to access global markets without having to support a large manufacturing sector with commensurate international marketing structures. However, recent trends in technology, including automation and robotics, increase the demand for skilled, rather than unskilled, labour, in addition to a favourable business environment, and existing logistics and transport networks. As a result, Rodrik predicts that re-shoring of supply chains will become more common because the new technologies disproportionately favour rich economies, well-endowed in skills and capital. In addition, "*countries may require more proactive policies of government-business collaboration targeted at strengthening the connection between the highly productive global firms, potential local suppliers, and the domestic labour force. This collaboration will be underpinned by a simple quid pro quo: government assistance in removing specific bottlenecks these firms face*" (Rodrik, 2018)

If Queensland has all the factors required to meet GVC requirements, what are the bottlenecks that need to be removed in order to facilitate Queensland's participation, in the li-ion Battery supply chain to Europe's car manufacturers? In an environment of post-Covid19 economic recovery, with historically low interest rates, identifying investors and investment is considered unlikely to result in a bottleneck. The mining sector in Queensland is mature and well-developed, and perhaps also a lower-order priority than building a network of manufacturing sector participants and li-ion battery customers. This suggests that the bottlenecks for the supply of inputs to Europe, and the sectors requiring government assistance, are:

- the identification and collaboration with the large automobile firms in Europe which require the processed minerals and are in the market for a reliable supply of LiB inputs;
- the identification of Queensland firms for processing of lithium spodumene, cobalt, nickel, graphite, and rare earths who will require access to renewable energy to limit the carbon content of the output;
- a market-place for matching manufacturers with renewable energy investors to ensure low-carbon output; and
- the identification of Queensland firms which have emergent technology to facilitate the production of higher-order technology as LiB technology matures

What is the support that the Queensland government can provide to eliminate the bottlenecks above?

In order to attract Network of European LiB customers:

- Trade delegations to Germany to negotiate with customers
  Who, where, when
- Potential incentives
  Over and above support from CEFC, ARENA, etc
- Queensland energy storage strategy to give visibility
  Commitments by industry, engineering consultants, Queensland Government, CSIRO, etc
- Queensland clean energy strategy for low carbon content
  Commitment by Queensland Government to facilitate
- Showcase of Queensland technology R&D, pilots and early deployment
  Comprehensive list and commitment to participate in showcase
- Support for the creation of energy storage industry networks
  Including supply chain networks from mining to processing to manufacturing and recycling

4. First step: Queensland Energy Storage Manufacturing Strategy

An energy storage manufacturing industry would have significant benefits for many Queensland stakeholders including engineering consultancies, existing energy storage companies, research organisations, the electricity sector, miners, investor groups, trades-union, local state and federal governments. Consequently, and much like the process for the development of Australia's national hydrogen strategy (Finkel, 2019), a wide ranging discussion on the feasibility and potential of a Queensland energy storage manufacturing sector is needed. This discussion should be business-led rather than government-led though clearly several Queensland government departments are critical to the discussion. The rationale for a business focus is that the project may be more enduring if focused on the commercial opportunities identified by the business community.

a. There is interest in developing a strategy

i. Energy Storage Sector

The researcher contacted representatives from energy storage companies Redback Technologies, Century Yuasa, Redflow, and Evergen. All indicated an interest in being involved in the development of a Queensland Energy Storage Manufacturing Strategy to focus on the opportunities possible from developing this sector. Further informal meetings were held on Zoom, after the Coronavirus shutdown. The following represents a summary of views:

- the opportunity for a large global market exists and Queensland should develop a strategy to bring new technologies currently under research at QUT and UQ to be manufactured in Queensland over the next decade.
- Sourcing batteries from Queensland manufacturers would remove supply chain and currency risks and complexities, and give greater competitive advantage to the energy storage sector through access to product development.
- Queensland Government assistance is required to help develop the industry. A study to assess potential supply chain costs and benefits from manufacturing in Queensland could be funded by the Queensland government to provide clarity for investors and policy makers.
- Energy storage will play a significant role in stable supply of electricity in Queensland, but the Queensland Government needs to develop policy that will accommodate high levels of electric vehicle charging and energy from residential solar which diminishes as demand increases for the evening peak. To harness the domestic solar generation and EV storage opportunity, the Queensland Government needs to enlist the support of the Energy Security Board, AEMO and AEMC to develop effective markets for the residential sector's participation in the National Electricity Market.
- Developing an energy storage sector presents a very good opportunity for jobs to install solar and batteries on residential and commercial rooftops but also for chemical and process engineering for energy storage manufacturing. With the slow-down in the LNG industry, career pathways for chemical engineering and process engineering students graduating from Queensland universities are now curtailed. The Australian Power Industry working group is observing good bursary graduates with no job placement offers in Queensland. A pipeline of opportunities for unskilled, skilled and educated workers is dependent on an effective policy framework.
- An energy storage manufacturing strategy should include input from research scientists, miners, policy makers, safety standards and the commercial sector to help set the strategy and the roadmap to develop the industry.

- There appears to be large interest in hydrogen but hydrogen has been proposed as an energy source for 20 years and yet we appear to be no closer to cost effective deployment. Even with all the attention given to hydrogen through Australia's Hydrogen Strategy, there are few successful business cases. Generating electricity from hydrogen is too expensive to make it affordable in Queensland.
- Australia offers a good environment for deployment and development of product in remote, hot, inhospitable locations, to develop robust electricity supply systems.
- The sector is hopeful that the Queensland Government recognises renewable energy as a strategic sector for industry development. The sector is not looking for handouts, but hand-ups like Government procurement, deployment of storage in state owned enterprises and the visibility for the industry that would come from a Queensland energy storage manufacturing strategy. Some battery technologies need to be recycled to avoid waste issues, and commitment to a policy to prepare for and develop a recycling industry would also assist the sector.

ii. Engineering consultancies

The researcher contacted representatives from engineering consultants, Advisian and Aurecon. Both consultancies are extremely interested in being engaged in the development of a QESMS.

- The Lithium-ion battery manufacturing opportunity is massive - too big to quantify. It is being driven largely by development of EVs and a secondary wave of residential batteries and smaller utility scale storage. Each will grow exponentially bigger than they are today. There is an acceptance from the automotive industry that EVs are inevitable. Even if the opportunity curve is not as steep as projected by some, there are no arguments against the generally upward direction of the curve.
- Energy storage is one of the key growth sectors and essential to integrate VRE for reliable power supply. In Australia, we're still in the early stages although a few subsidised projects have given confidence about the technology.
- There appears to be regulatory reluctance by NEM governing bodies to engage proactively with the VRE potential. There are plenty of examples that VRE and storage can work but caution and a conservative approach by regulatory and governance bodies has constrained opportunity. The governance and regulatory bodies need to start talking to people who are in the field and have the knowledge and skills to secure supply from VRE.
- Australia has potential to scale up VRE and storage significantly, and Queensland has shown form by successfully fast-tracking VRE plant, extracting CSG and developing the export industry for LNG over the last 6-7 years. Australia and Queensland now has a trained labour force to take the VRE electricity supply industry to scale, but ongoing employment in the energy sector requires global investors and the Queensland Government should be helping to attract global investment in Queensland's renewable energy opportunity.
- The view that Australia is not successful at manufacturing limits the scale and scope of developing a value chain in Queensland that will improve the resilience of the economy and employment in the regions. The argument that manufacturing needs cheap labour fails to recognise that the world has moved on and it's now the cost of capital and entrepreneurial spirit driving competitive advantage globally. Queenslanders have enough entrepreneurial spirit and technical expertise to be as competitive as any nation.
- With its huge amount of open space and good solar resources, energy generated from solar in Queensland will produce low cost of energy for all forms of manufacturing. Ross Garnaut's vision of competitive energy costs in Australia will facilitate local manufacturing. A commitment to zero carbon will also drive opportunities for Queensland.

- Collaborative frameworks comprising investors, technology developers, off-takers, and government could work proactively to develop projects that meet strategic goals.
- An industry body to develop standards and lobby for the sector is needed. The academic sector and all levels of government also need to collaborate to build credibility and patronage. A visible patron for the energy storage sector (energy, climate, carbon, economic) would be valuable - someone with political clout that can walk a middle road. The existence of a visible industry body would give confidence to investors.
- The Queensland Government needs to facilitate policy certainty about long-term and medium term goals, provide capital for trial demonstrations and proof of concept, and consider small steps of government assistance with low cost - like facilitating workshops and cross industry collaboration mechanisms to provide a catalyst to and support for entrepreneurial capacity. If the policy settings are right, the private sector will find the opportunities.
- Hydrogen is good but it is not the answer for all opportunities. The hydrogen opportunity will be mostly taken up with heavy duty vehicles and aviation with the major market in Asia. It won't be used for making steel because it will be too expensive. Hydrogen and energy storage can work together - the hydrogen opportunity will not come at the expense of battery storage.
- Australian politics complicate plans for a future including renewables. If politicians do not clearly articulate the specific opportunities for future employment, voters will not elect them. A good political message would be that "Low cost renewables brings back manufacturing, and manufacturing brings back reasonable jobs". It is important to frame the story not as a moral argument but as a global transition. The Queensland Government needs to create momentum to respond to this global transition.

iii. CSIRO

The researcher met with Anand Bhatt who leads a battery research team in CSIRO's energy business unit, which is currently involved in:

- *Large program on the grid*, which looks at commercial system applications (second life and end-of-life), cell-development;
- *Minerals research areas,* a mission to look at critical metals and how we can do life-cycle in Australia;
- *Transition plans and pathways,* are being developed but still a couple of years away. CSIRO is also developing a *Critical metals mission* (10-100M activity) to investigate the pathways for all critical energy metals including batteries and to identify where Australia has options and opportunities to move down the value chain. At the end of this year a *mission plan for energy storage* is to be delivered to the executive team for endorsement and approval to move to stage 1 development prior to implementation. Thereafter the Mission will be developed into something more real than a concept - expand across all CSIRO business units and partner with industry and Stakeholders throughout the value chain. CSIRO's plans will have a technological focus and Anand Bhatt is interested in combining with Queensland policy makers to develop business and government led opportunities.

b. Next steps

The Coronavirus lockdown led to the cancellation of the inaugural workshop on 27 March 2020 to discuss the feasibility and potential for a Queensland energy storage manufacturing strategy, hosted by the

Queensland Chief Entrepreneur, Leanne Kemp, and attended by representatives from the energy storage sector, engineering consultancies, CSIRO and appropriate Queensland Government Departments.

The opportunity still remains. It is suggested here that the momentum should be reinvigorated. The following steps should be followed:

Step 1: Convene a workshop to discuss the opportunities that might arise from a Queensland energy storage manufacturing strategy

A workshop should be re-scheduled to initiate the discussion. Persons invited should include those who have indicated an interest in being involved in the creation of a Queensland Energy Storage Manufacturing Strategy including representatives from the existing Queensland energy storage industry and engineering consultancies. Although it is proposed that this be a business-led proposal, appropriate Queensland Government representatives should be invited to participate in the discussion on the role that the Queensland Government may play.

Step 2: Discuss and establish the Terms of Reference for the proposal for a strategy

The Queensland Energy Storage Manufacturing Strategy proposal could take a similar form to the initial proposal for a hydrogen strategy made by Alan Finkel to COAG (Hydrogen Strategy Group, 2018). Matters for discussion should include:

- Queensland, Australian and global potential for energy storage: 2030 and 2050;
- classes/technologies of energy storage required for electrification of transport sector and high levels of variable renewable energy to meet Queensland, Australian and global potential: Li-ion, Flow, LAES, pumped hydro (standardised);
- current global energy storage manufacturing capacity and research;
- costs of current global energy storage technologies and predicted cost curves over the next decade;
- cost of manufacturing in Queensland compared to manufacturing in China;
- benefits to manufacturing in Queensland – which of the energy storage technologies are best suited to Queensland’s resources, infrastructure and requirements;
- economic conditions that the Queensland Government could influence to attract investment – potential policy levers to attract investment;
- high-level implementation pathways;
- linkage between energy storage manufacturing and hydrogen strategy;
- adherence to principles of hydrogen strategy of: ambition; clear goals and objectives; use of partnerships; technology neutrality; commercially focused; sustainable development.

Step 3: Establish a Queensland Energy Storage Manufacturing Strategy Proposal Group

A group to guide the development of the proposal needs to be established under Leanne Kemp, the chair. Appropriate group members need to be identified and invited to participate. Consideration should be given to the extent of participation by Queensland Government representatives versus interested parties from business.

Step 4: Develop a framework for attracting private investment

The large pipeline of solar and wind power projects registered with AEMO in response to the Queensland Government’s 50% Renewable Energy Target by 2030, and the ongoing investment in rooftop solar, is evidence of private investors’ enthusiasm to invest in renewable energy. The Queensland Government should develop a framework for attracting private investment in energy storage manufacturing in Queensland. Alongside harnessing local investors, consideration should also be given to seeking out partnerships with South Korean LiB manufacturers and European vehicle makers, to attract investment by offering cost effective energy storage manufacturing to respond to European and Asian transport strategies.

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