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Institute for Energy Economics and Financial Analysis
IEEFA.org

An Aluminium-Led Energy & Industry Renewal for Central Queensland

A Case Study of Gladstone and Boyne Smelters in Queensland

Executive Summary

"The full emergence of Australia as an energy superpower of the low-carbon world economy would encompass large-scale early-stage processing of Australian iron, aluminium and other minerals."[1]

Australia has the potential to become a much more significant economic power in a decarbonised world. The country's renewable energy resources sit at the heart of this enormous economic opportunity.

Australia could lead the world in producing the components of low-carbon industrialisation: aluminium, steel, cement, silicon, lithium and rare earth minerals, with value-adding processing before exports to enhance Australian investment and employment.

Australia could lead the world in producing the components of low-carbon industrialisation.

This report explores how the country can both decarbonise and grow heavy industry with a focus on Gladstone, Queensland.

The generation of electricity is Australia's largest source of carbon emissions (33%). Closing the country's four aluminium smelters would reduce Australian electricity demand by 10% with a consequential reduction in emissions associated with electricity use.

However, electricity is also key to the rapid decarbonisation of other major emitting sectors such as transport, heating, industrial processing and manufacturing that account for 55% of the country's emissions.

Instead of closing the country's loss-making and high emitting aluminium smelters, these industries could transition rapidly to renewable electricity, invest in plant upgrades to support demand response management, and profit from the long-term growth of the metals and industrial processing markets.

Aluminium smelters could become giant virtual batteries.

[1] Garnaut, R. Superpower. 2019. p 11.

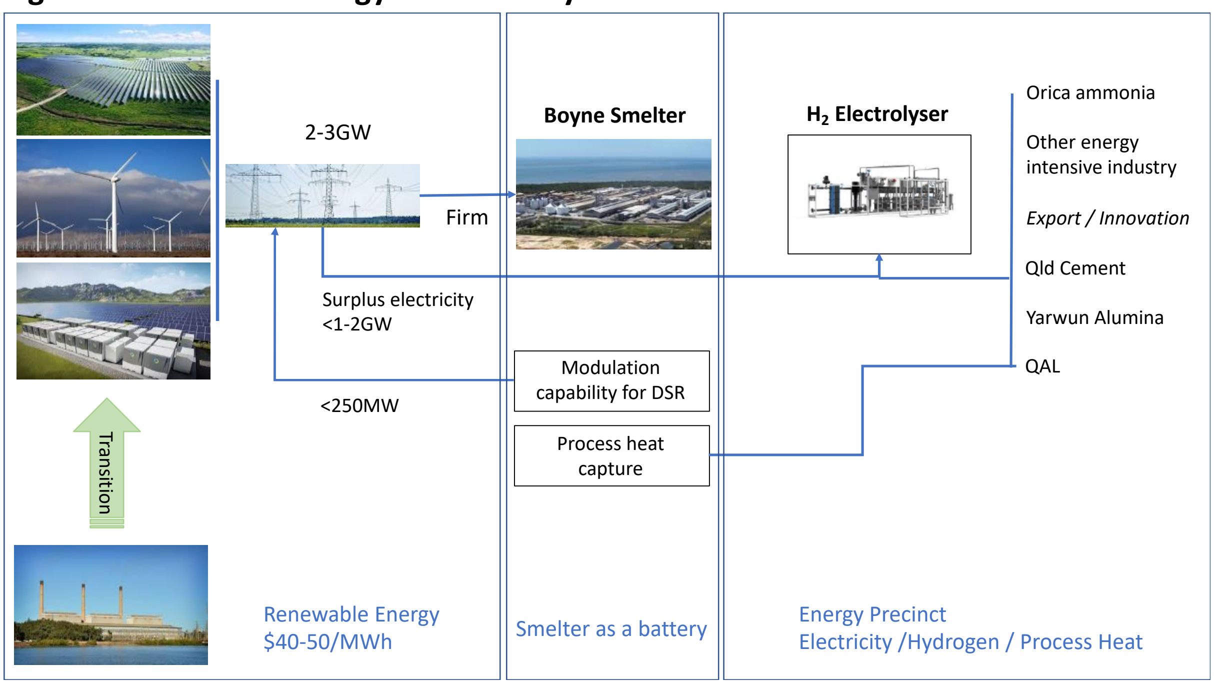
Transforming Gladstone

This briefing note examines the Gladstone region as a key opportunity for investment in jobs and growth in sustainable heavy industry, with a focus on Queensland's largest electricity user, Boyne Smelters Limited (BSL).

It is the right time to be talking about transforming Gladstone as:

- COVID-19 has focused attention on investment for recovery, and supply chain security is a key theme;
- There are several foundational industries that could fail or prosper, depending on their input costs, and aluminium is central among these; and
- The Queensland government has committed to invest in renewable energy zones, creating an opportunity to repower key heavy industries.

Figure 1: Gladstone Energy and Industry Precinct – A Possible Future



Source: IEEFA

Aluminium smelting is a critical driver of electricity demand in Queensland, consuming around 13% of all Queensland's electricity. As an interruptible demand load, it also provides a valuable grid stability function. About 4,500 jobs are vulnerable if Gladstone's heavy industry is not internationally competitive.

Green aluminium has a good long-term outlook. It will be priced separately by the London Metals Exchange (LME) from next year. This will make the commodity less volatile and likely to attract a premium over other aluminium over time. The demand drivers of aluminium include:

- **Transport** – increased use of aluminium as part of light-weighting and to counteract the weight of batteries in electric vehicles;
- **Construction** – increasingly concerned with embedded emissions and there will be a drive for low carbon metals;
- **Consumer Packaged Goods and Electronics** – companies such as Nespresso and Apple are insisting on low carbon aluminium.

About 4,500 jobs are vulnerable if Gladstone's heavy industry is not internationally competitive.

Electricity is the main factor in the competitiveness of aluminium smelting. If electricity can be generated and delivered to Gladstone at A$40-50/megawatt hour (MWh), Gladstone could be a low-cost energy hub centred on demand driven by the local aluminium smelter, BSL. This would support increased export competitiveness and jobs growth in all of Gladstone's heavy industry sectors – including alumina, cement and the development of a hydrogen industry.

With continually falling component costs, cheaper electricity price targets are now within reach, as:

- Battery storage and other means of electricity firming are now financially viable options to provide the level of reliability required by an aluminium smelter; and
- The right cost of capital and appropriate financial structuring can deliver globally competitive electricity pricing for industry and can support residential price reductions.

Investment in technology to increase BSL's ability to provide demand side response services would benefit the National Electricity Market (NEM) and there would be significant revenue generation potential for BSL, utilising Australian Energy Market Operator's (AEMO) wholesale demand side management pricing.

The scale of renewable energy required would create significant surplus electricity which could be used to produce hydrogen. This provides critical grid balancing, along with the smelter's demand side response, and could be used in the precinct to support transformation of industrial processes to create more competitive and greener heavy industry exports.

In combination, large-scale renewable energy supply, smelter-provided demand side response and hydrogen production would create a world-class Energy and Industry Precinct that would protect the thousands of jobs currently in Gladstone while generating growth for years to come.

IEEFA recommends a detailed feasibility study to assess the investment case for this concept.

Contents

Australia at a Crossroad: Embrace the Energy Transition or Decline With Fossil Fuels

A Good Time for Renewal

As Ross Garnaut points out in *Superpower*, Australia has the potential to become a much more significant economic power in a decarbonised world.

With abundant low-cost renewable energy sources, comparative advantage in the production of green (renewable) hydrogen, and huge deposits of a multitude of minerals that form the basis of industrial production, Australia could lead the world in producing the components of low-carbon industrialisation: steel, aluminium, cement, silicon, lithium and rare earth minerals, with value-adding processing before exports to enhance Australian investment and employment.

Australia has the potential to become a much more significant economic power in a decarbonised world.

Australia's renewable energy resources sit at the heart of this enormous economic opportunity.

At about 33%[2] of total output, the generation of electricity is Australia's largest source of carbon emissions.[3] But electricity is also key to the rapid decarbonisation of other major emitting sectors, such as transport, heating, industrial processing and manufacturing. These now account for 55%[4] of the country's emissions.

In addition, green hydrogen could be a transformative element in the decarbonisation of polluting activities such as steel production, ammonia manufacture, alumina and silica refining, transport and peaking electricity generation. For that to occur, hydrogen would have to be produced using renewable electricity. And that puts the Australian industrial economy at a crossroads: embrace the clean energy transition or decline along with fossil fuels.

Closing aluminium smelting, for example, would reduce Australian electricity demand by 10%[5], with a consequential reduction in emissions associated with electricity use (called scope 2 emissions). The closures however would also significantly impair the Australian economy and its industrial capacity and undermine the viability of the remaining coal-fired power stations, resulting in the loss of thousands of jobs. Alternatively, these industries could transition rapidly to renewable electricity, invest in plant upgrades to support demand response

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[2] Australian Government, Quarterly Update of Australia's National Greenhouse Gas Inventory. December 2019.

[3] All references to carbon emissions, CO_2 or emissions are to all greenhouse gas emissions – CO_2-e.

[4] Australian Government. Quarterly Update of Australia's National Greenhouse Gas Inventory. December 2019. Includes stationary energy, transport, fugitive emissions and industrial processes and product use.

[5] Calculated using smelter operators' published usage as a percentage of total Australian electricity consumption.

management, and profit from the long-term growth of the metals and industrial processing markets.

Australia's aluminium sector is particularly interesting right now because it is failing[6], with all smelter operators losing money and considering closure. This failure is linked to their enormous electricity demand which has historically been tied to Australia's largely fossil fuel-based electricity generation.

Australia's aluminium sector is particularly interesting right now because it is failing.

Australia is one of the world's most emissions-intensive aluminium producers.[7] Accelerated deployment of low-cost, zero emissions renewable electricity is a path out of this quagmire, but is it economically viable?

This briefing note examines the Gladstone region in Queensland, Australia as a key opportunity for investment in jobs and growth in sustainable heavy industry, with a focus on Queensland's largest electricity user, BSL.

Gladstone Heavy Industry

Losing Competitiveness

Situated on the coast some 550 kilometres north of the capital Brisbane, Gladstone is a centre of heavy industry in Queensland.

The region employs 1.2% of Queensland's workforce yet delivers 1.7% of its value-added.[8] There are approximately 4,500 direct jobs in heavy industry (including manufacturing and electricity generation) and the industry generated almost $3bn of exports in 2018/19.[9] It is notable that manufacturing delivers over 12% of the region's employment (compared with mining at around 3%) and a similar level of exports.

When the jobs multiplier for manufacturing is considered (around 7 times[10]), it is clear heavy industry is the foundation of the Gladstone regional economy. With coal exports challenged (Gladstone coal terminals are operating at 71% capacity[11]), manufacturing could be renewed to bolster the Port of Gladstone and provide jobs

[6] AFR. Generators call for notice as smelters teeter on the brink. 18 October 2019; Pacific Aluminium reported an EBITDA loss of $US22 million in 2019.
[7] Australian CO_2-e intensity averages 12.5 per tonne of aluminium compared with world average of 11.5 – Aluminium Council sustainability report; Aluminium Insider. Leaders Emerge in the Aluminium Industry's Race to Zero Carbon. 2 April 2019.
[8] Gladstone Regional Council. Gladstone Regional Council area: Industry sector analysis.
[9] Gladstone Regional Council. Gladstone Regional Council area: Industry sector analysis.
[10] Economic Policy Institute. Updated employment multipliers for the U.S. economy. 23 January 2019: Each manufacturing job results in 7 jobs in related sectors.
[11] Argus Media. Australian coal ports struggle with debt load. 20 April 2020.

and exports for years to come, but significant change is needed to make heavy industry in Gladstone internationally competitive.

The Problem with Aluminium

High Electricity Consumption and Concerning Carbon Emissions

Aluminium is known as "solid electricity" for good reason. It is created by applying electricity to alumina derived from bauxite. Electricity is roughly one-third of the production cost, with alumina making up another third and operating costs the balance.[12]

In Australia, aluminium smelting uses approximately 10% of the country's electricity[13] and creates 6.5% of Australia's total greenhouse gas emissions[14] (largely scope 2 emissions[15] from the electricity itself), while aluminium exports are worth approximately 0.2% of GDP.[16] There are also other emissions and pollutants created in the smelting process[17] (and significant emissions and pollutants are created in the alumina refining process).[18] But it is the heavy consumption of electricity sourced from coal-fired generation that creates the overwhelming majority of greenhouse gas emissions.

The heavy consumption of electricity sourced from coal-fired generation creates the overwhelming majority of emissions.

In response to Rio Tinto's recent commitment to invest $1.5bn to cut its carbon emissions globally, Glyn Lawcock, lead mining analyst at UBS was quoted as saying: "*We couldn't help but notice the closure of Pacific Aluminium alone would reduce*

[12] According to the head of Rio Tinto Aluminium, in Alf Barrios. Reuters. Rio Tinto Flags Higher Costs, Cloudy Australian Aluminium Future. 31 October 2019.
[13] Calculated using smelter operators' published usage as a percentage of total Australian electricity consumption.
[14] Calculated using disclosed operators' greenhouse gas emissions as a percentage of total Australian emissions, Clean Energy Regulator 2018.
[15] Scope 2 greenhouse gas emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity: Clean Energy Regulator.
[16] Calculated using approximately A$4.3bn of exports (Australian Aluminium Council 2018), A$1.86tn GDP (IMF World Economic Outlook Database 2019).
[17] Nitrogen oxides (NOx) and Sulphur oxides (SOx) can be removed using abatement units, or 'scrubbers'. CO_2 emissions are also caused by the use of carbon anodes in the smelting process.
[18] Alumina refining is another emissions-intensive industrial process, that accounts for 10 million t CO_2-e per annum in Australia. It can be decarbonised by replacement of the existing steam generated heat with process heat generated by renewable electricity.

emissions by approximately 25%."[19] At 10.3 million tonnes CO_2-e[20], Rio Tinto's Australian smelters are among the most emissions-intensive in its global fleet.

Aluminium Market Worldwide Has Been Unpredictable

The global aluminium market has been difficult for suppliers for many years.

Over the last decade the aluminium price has ranged between US$2,750 per tonne (t) in 2011 to a low of US$1,450/t in 2016. From there, the price rose to the second quarter of 2018 then fell sharply to around US$1,500/t in March 2020 (pre COVID-19). It is currently trading at around US$1,750/t.

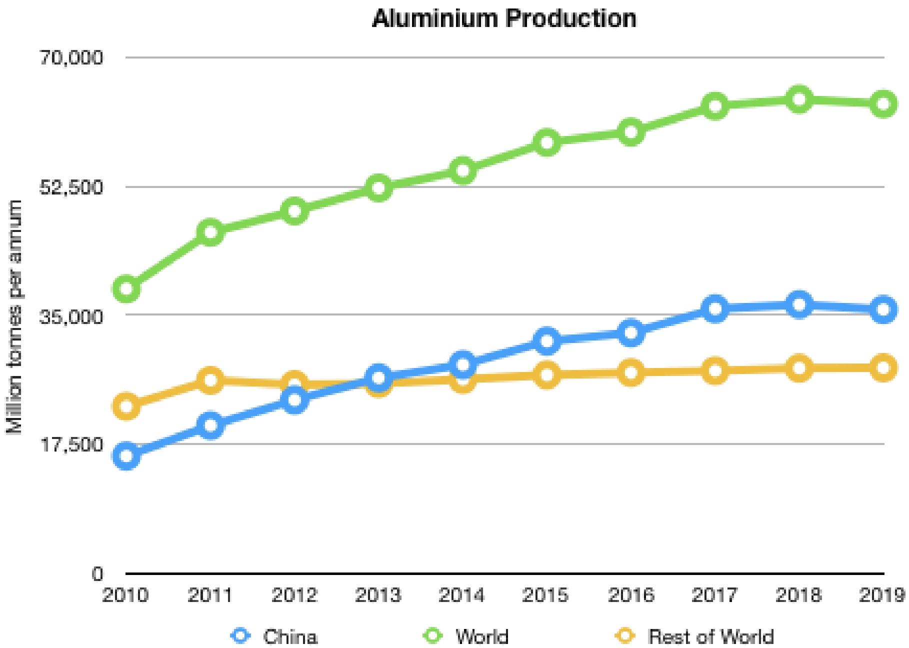
Figure 2: World Aluminium Price 2010-2020 (US$/t)

Source: Trading Economics, 31 August 2020

Global production has grown at an average rate of 4% a year over the last decade but the last two years have seen a sharp slowdown, to 1.5% and -1.0%, respectively. The main driver has been China's production, which grew significantly in the first half of the decade and now represents over 56% of world production (up from 41% in 2010).

[19] Sydney Morning Herald. Smelters 'stick out' in Rio Tinto's $1.5b push to cut carbon emissions. 28 February 2020.
[20] 2018 greenhouse gas emissions from Pacific Aluminium (includes NZ); 2018 Group greenhouse gas emissions were reported in the Rio Tinto Climate Change Report 2019 as 31.8Mt CO^2e, making Pacific Aluminium more like 32% of total emissions.

Figure 3: Aluminium Production – China and the Rest of the World 2010-2020



Source: www.world-aluminium.org/statistics

This, together with high electricity prices, especially in smelters without integrated electricity generation, has undermined aluminium's profitability in many countries, including Australia.

Australian Operators' Current Situation - Considering Their Futures

There are four aluminium smelters in Australia. Rio Tinto along with joint venture partners is involved in three under the banner of Pacific Aluminium (**Boyne Island** in Queensland, **Tomago** in NSW and **Bell Bay** in Tasmania) while Alcoa is partnered with Alumina Limited, Citic and Marubeni in the **Portland** smelter in Victoria.

Pacific Aluminium (now Rio Tinto Aluminium) reported an 'earnings before interest, taxes, depreciation and amortization' (EBITDA) loss of $22m in 2019. Portland also made a loss despite a four-year $200m support package (which expires in 2021) from the state government of Victoria.[21] Alcoa was quoted at the time as saying the Portland smelter was in "one of the highest energy price markets on the planet".[22]

Since then, wholesale electricity prices in Australia have come down materially, as has the Australian dollar exchange rate. Likely further deflation in Australian electricity prices and the associated progressive decarbonisation provides a

[21] AFR. Portland Smelter Owners Want Out of the "Subsidy Cycle". 5 December 2019.
[22] ARF. Alcoa says Australia's power prices highest 'on the planet'. 16 January 2020.

valuable opportunity to modernise and reposition the Australian aluminium smelting sector.

Table 1: Australian Aluminium Production – Key Facts

Australian Aluminium				
Production: 1.57 million tonnes per annum 1.45 million tonnes pa of exports Approx. 2.5% of global production	**Smelters**	**Production capacity** ***tonnes***	**Employees / contractors**	**Electricity consumption** ***GWh***
	Boyne Island (Qld)	500,000	935 / 120	7,000 *13% of Qld*
	Tomago (NSW)	595,000	950 / 160	8,300 *12% of NSW*
	Portland (Vic)	350,000	500 / 150	5,200 *12% of Vic*
Carbon Emissions: 6.5% of Australian tCO_2-e 16% of electricity sector emissions	Bell Bay (Tas)	190,000	435 / 60	3,000 *27% of Tas*
	TOTAL	1,635,000	2,920 / 490	23,500 *~12% of Aust*

2018/19 Figures
Sources: Operator websites
Australian Energy Regulator
Clean Energy Regulator

Boyne Island Smelter

Boyne Smelters Limited (BSL) operates the smelter in Boyne Island, Gladstone. It is managed by Rio Tinto and its corporate structure is as follows:

Shareholder	Percentage Shareholding
Rio Tinto	59.39%
YKK Aluminium *Japanese zippers and metals*	9.5%
UACJ Australia *Japanese aluminium company*	9.29%
Southern Cross Aluminium *Sumitomo and Marubeni*	7.71%
Ryowa Development II *Mitsubishi*	6.46%
Ryowa Development	5.19%
Sumitomo Chemical	2.46%

Reduced Production Levels

All of Rio Tinto's partners are large aluminium users. Boyne Island smelter has a nameplate capacity of 585,000 tonnes but production was scaled back to 500,000 tonnes in 2017. At the time, Boyne Smelters general manager Joe Rea said it was "due to sustained high [electricity] pricing this year."[23] This reduction in production reduced revenue by approximately $110m per year and removed 30 fulltime jobs.

Pot Cell Technology

An aluminium smelter uses huge amounts of electricity applied to "pot cells" to extract aluminium from its oxide (using the Hall-Héroult process). BSL uses three different types of pot cell technology. Its original two potlines were commissioned in 1982 with 240 Sumitomo S-170 reduction cells, while the additional potline added in 1997 at a cost of $1bn uses 264 Pechiney AP-30 cells. A test group of five Comalco B32 cells was commissioned in 2002.[24]

Sub-Optimal Electricity Supply Arrangements

In the early 1990s, world aluminium supply from the West was managed by a memorandum of understanding (MOU) among major aluminium producing nations, including Australia. Similar to how OPEC operates, aluminium companies managed supply to keep prices at a level that was profitable for producers.

Presumably encouraged by that environment, the owners of BSL decided to expand its capacity in 1994 - 1997. To secure electricity supply, they formed a joint venture together with U.S. energy company NRG Inc to acquire the Gladstone Power Station from the Queensland Government. As part of that arrangement, the joint venture agreed to supply BSL with its required electricity load and granted Stanwell Corporation, a Queensland government-owned electricity company, the exclusive rights to sell the surplus electricity into the National Electricity Market (NEM). In 2011, the role of nominated generator was assigned by the Queensland Government to its other state-owned generation company, CS Energy.

When BSL expanded the plant's capacity in 1997 by adding a new potline, it did not change the electricity supply agreement with Gladstone Power Station. Instead, 15% of the smelter's electricity demand was acquired through a power purchase agreement.

The question here is, why couldn't the 1,680MW Gladstone power station supply all of BSL's needs? It certainly could have.

According to an Australian Competition and Consumer Commission (ACCC) determination[25], BSL's allocated capacity is 1,104MW. Given Tomago aluminium

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[23] Australian Mining. Boyne aluminium smelter poised to slash workforce, lower production. 20 January 2017.
[24] JOM. Prebake Cell Technology: A Global Review. 2000.
[25] ACC Determination. Application for authorisation lodged by Rio Tinto Aluminium Limited & Others. 2 June 2010.

smelter operates with 950MW and has the same aluminium production capacity – 585,000t – presumably Gladstone Power Station could supply all BSL's needs.

Did BSL choose not to take up the additional supply when it expanded its capacity in 1997 because market prices seemed more attractive than the arrangement under the pooling agreement? The precise details are confidential. Another consideration is that the power station commenced operations in 1976.[26] It is at or near the end of its life. According to research conducted by The Australia Institute, Gladstone Power Station is the third least reliable coal-fired power station in Australia.[27]

Joe Rea was quoted in May 2016 as saying the $750m smelter upgrade completed in 2012, that involved construction of a new more energy efficient furnace to reduce CO_2 emissions, meant the smelter would continue manufacturing "in line with our vision to be 'proudly Australian, operating beyond 2030'."[28] And yet, barely six months later, the company was slashing production and jobs because electricity prices were "un-Australian".[29]

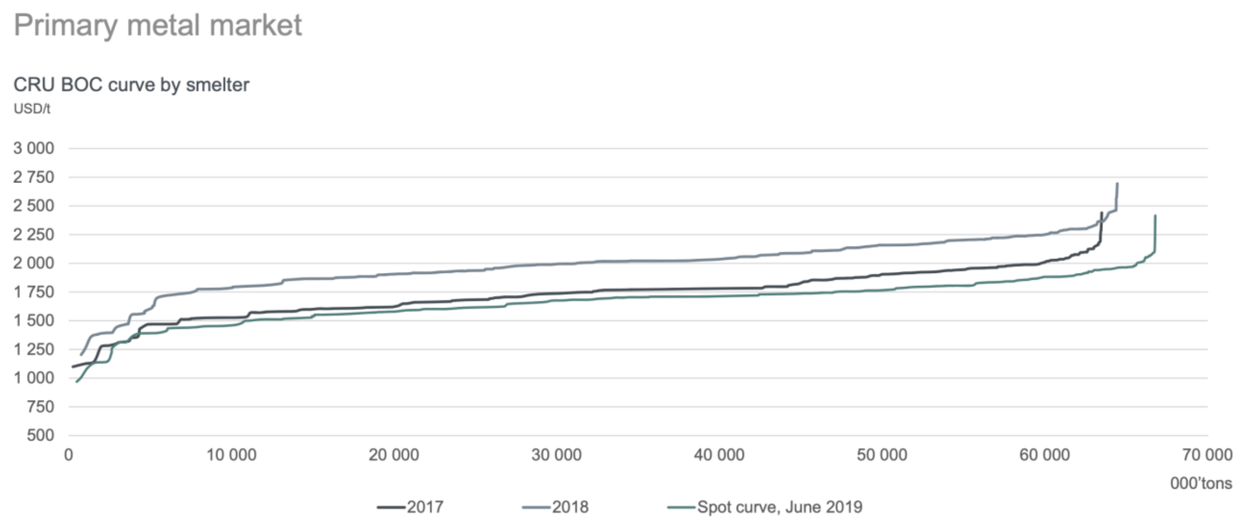
At the time, BSL was purchasing 15% of its electricity requirements at the spot price because it could not agree terms with either Stanwell or CS Energy. The CEOs of each company said they had offered BSL competitive pricing but it had been rejected and BSL "chose not to accept our offers and instead left itself exposed to the volatile spot market."[30] The dispute played out in the media and there is ongoing litigation concerning interpretation of the Gladstone Power Station agreement.[31] It is fair to assume the relationship between BSL and Queensland's electricity suppliers is fraught.

Global Smelter Costs Are Falling but the Aluminium Price Is Volatile

Figures 4 and 5 below shows the wide range of cost structures of aluminium smelters around the world and the sensitivity to the aluminium price. The Australian smelters have moved to the right as electricity costs have increased.

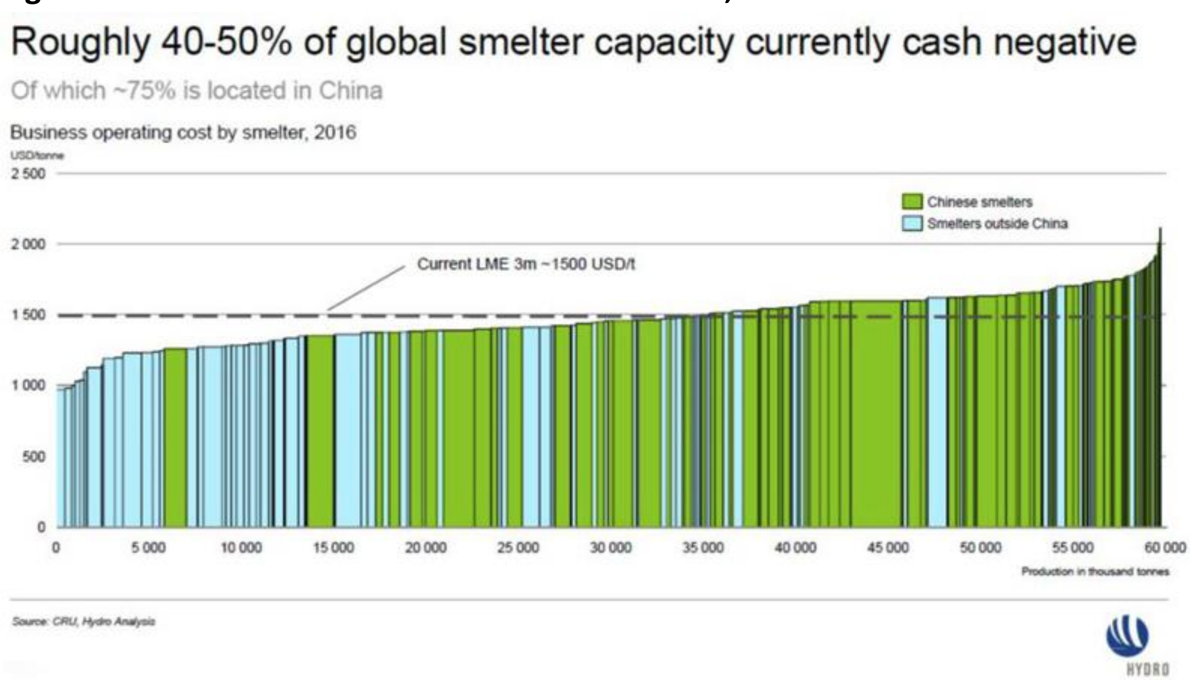
[26] NRG Gladstone Power Station.
[27] The Australia Institute. Fossil Fails in the Smart State. February 2020.
[28] Institute of Managers and Leaders. What is the secret to Boyne's success? 27 May 2016.
[29] AFR. Rio Tinto's Boyne Island smelter slashes jobs and production as power bites. 19 January 2017.
[30] CS Energy media release. CS Energy has offered competitive power prices to Boyne Smelter. January 2017; Gladstone Observer. Boyne Smelter to close cells, cut production after power price spike. 21 January 2017.
[31] GPS Power Pty Ltd v CS Energy [2020] QSC 93.

Figure 4: Global Cost Curve of Aluminium Smelters, 2019



Source: Hydro Investor Presentation, Second Quarter 2019, July 2019

Figure 5: Global Cost Curve of Aluminium Smelters, 2016



Source: Hydro

All Australian smelters are struggling with the aluminium price at around $1,750/t, but due to international corporate structures their finances are opaque.[32]

However, on the assumption that US$30/MWh is internationally competitive electricity pricing, then A$40-50/MWh delivered to the smelter is the target to provide BSL a platform for success.[33]

Tomago Aluminium CEO Matt Howell was recently quoted as saying Tomago did not have a future at A$70/MWh for firmed renewables[34] but he indicated that a price of around A$45/MWh would work if the supply was reliable and the plant was not exposed to "freezing in an uncontrolled manner."

Impact on the Australian Economy

The Smelter's Survival or Loss Affects Jobs and Export Income

According to BSL, its operations "employ about 1,000 people and indirectly supports about 6,700 jobs nationally, with 3,000 of these jobs in the Gladstone region. The smelter contributes more than $1.4bn annually to Australia's Gross Domestic Product."[35]

Their owners say the four smelters together contribute around $4bn per annum to the Australian economy, in addition to exports.[36] This contribution includes direct employment and contracting of over 3,500 workers, supply contracts, and the multiplier effect of investment and expenditure in regional communities.

Effective Demand Side Response

BSL has a significant role as a provider of core demand for electricity. Reducing demand for Queensland's electricity by 13% would place a huge burden on the existing generation infrastructure to adapt. These foundational loads have historically created stability of demand for generators and provided a basis for investment. More importantly, large interruptible electricity loads could play a critical role in the move towards a low cost, modern electricity system of the future, balancing supply and demand during times of extreme volatility—hot summer days, or when end of life coal-fired power plants have unplanned outages, for example.

At a time when Australian industry needs to demonstrate its resilience and be well prepared to recover from the economic effects of COVID-19, a plan to reinvigorate Australia's smelting sector could underpin billions of dollars of investment in energy

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32 For example, CSR shows its interest in Tomago generating a significant profit contribution in FY20 but Rio Tinto offers no explicit figures on individual smelters.

33 ANFRE. Global smelters' production costs on decline. October 2019. Electricity costs vary widely depending on the region, with power tariffs around US$20/MWh in the Middle East, US$35-40/MWh in the USA and Europe, and around US$55/MWh in China, after the latest additional subsidies on electricity prices were introduced.

34 AFR. Tomago counts cost of energy transition. 7 February 2020.

35 The Queensland Times. Study shows $1.4b contribution to GDP by Boyne Smelters. 25 October 2013.

36 Tomago, Boyne Island, Bell Bay and Portland websites.

infrastructure. This ought to be an attractive option. But, as argued by Ross Garnaut, it requires a whole of economy industry plan that benefits grid stability while supporting electricity sector decarbonisation and creating an attractive low risk return for infrastructure investors.

A Solution

If BSL could secure electricity:

- at a price fixed for the long term,
- that is internationally competitive, and
- sourced from a majority decarbonised source,

would the smelter be a good long-term proposition?

The Aluminium Market Has a Positive Long-Term Future

In a low-carbon world economy, there are several drivers of increased demand for aluminium, if it is produced using renewable electricity:

- **Transportation***:* The transition to electric vehicles will increase demand for aluminium as car makers look to compensate for the weight of batteries[37]; environmentally conscious consumers and state regulators will increasingly require low-carbon components.
- **Construction***:* Ongoing long-term growth in China and developing markets will underpin demand for aluminium but, in addition, increasing demand for low-emissions building materials (and regulatory focus on embedded emissions) will drive demand from producers that can supply low-carbon aluminium.
- **Consumer durables, especially electronics**: Companies such as Apple use a relatively small amount of aluminium but their prominence in consumers' lives, and Apple's (and its competitors') focus on reducing carbon emissions in supply chains, will increase demand for low-carbon materials across the consumer durables sector.

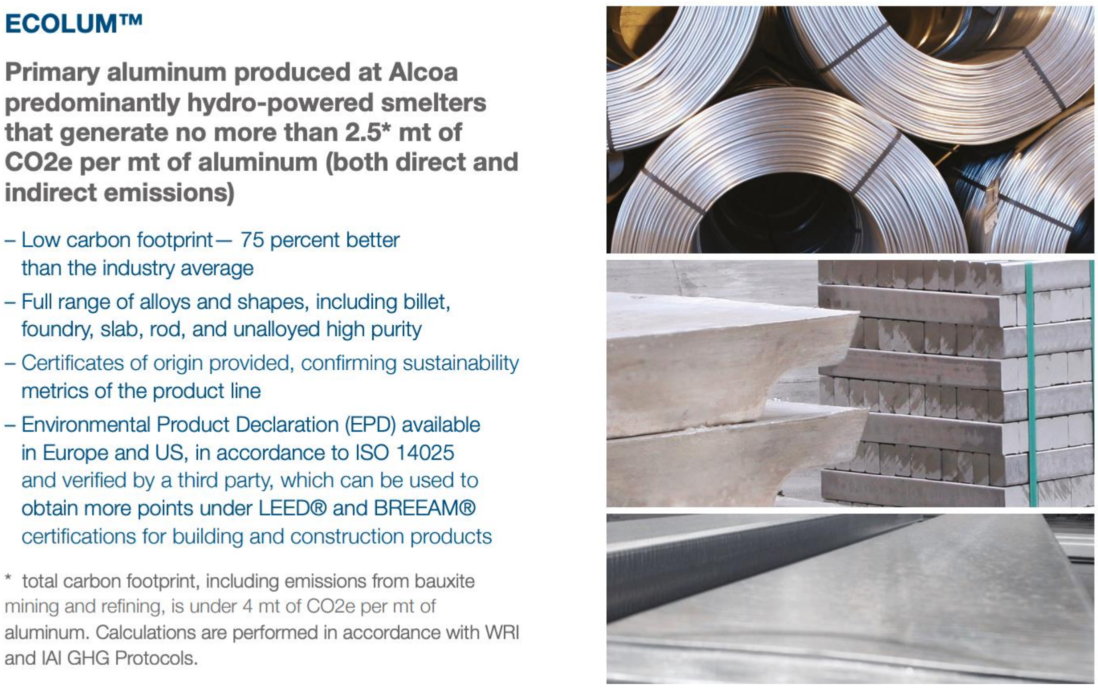
Volume growth of 4% p.a.[38] is estimated over the medium term, driven particularly by increased demand from the automotive sector. BMW, for example, uses low-carbon primary and recycled aluminium in its i3 electric car. BMW uses more aluminium each year than Boyne Island's entire production. Further, electric vehicles contain between 140kg for a battery-electric vehicle (BEV) and 180kg for a plug-in hybrid electric vehicle (PHEV); more aluminium on average than internal combustion engine vehicles.[39] Consumer packaging brands such as Tetra Pak and

[37] Automotive News. The Hidden Carbon Footprint of Aluminium Cars. 22 July 2019.
[38] Aluminium Insider. Low-carbon Aluminium Boosts Industry's Green Credentials. 15 November 2017.
[39] Ducker Frontier. Aluminium Content in European Passenger Cars. 10 October 2019.

Nespresso are also looking to reduce the carbon footprint of the aluminium they use.[40]

Low carbon aluminium is defined as aluminium that generates 4t CO_2-e per tonne of aluminium (including emissions from alumina refining) or lower. Many global producers now actively promote a low carbon product.

Figure 6: Alcoa's Low-Carbon Aluminium Product



The Aluminium Market Has a Positive Long-Term Future
Source: Alcoa[41]

It is possible that low carbon aluminium will attract a price premium at some stage. Edgardo Gelsomino, Wood Mackenzie Head of Aluminium, suggested a premium may be supported in the next year or so: "2020 may well be the year when there is a consolidation of the concept of a two-tier market for primary aluminium."[42]

The London Metals Exchange (LME) CEO Matt Chamberlain announced in June this year that trading in low carbon aluminium will commence in 2021. This will be attractive to any producers who use renewable energy and can meet the 4 tonnes CO_2 / tonne Al requirement. Chamberlain said, "There isn't enough low-carbon aluminium in the world to fulfil all the requirements. This [platform] will allow the

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[40] TetraPak website.

[41] Alcoa website.

[42] Wood Mackenzie press release. Global energy transition and supply issues key for aluminium in 2020. 3 February 2020.

low-carbon metal to flow to the consumers who are particularly concerned about that topic. There will still be markets for non-low carbon aluminium."[43]

Whether or not low carbon aluminium attracts a higher price, it will be shielded from the volatility caused by Chinese production and demand – Chinese aluminium is typically produced at 15 tonnes CO_2 / tonne Al (comparable to current Australian production) so would not participate in the low carbon market.

Investor and Supply Chain Pressure Will Drive Demand for Renewable Metals

The rapid rate at which global investors and leading corporates are signing on to the Task force on Climate-related Financial Disclosures (TCFD) means that, over time, investors will demand full accountability from manufacturers for emissions reduction in their supply chains as they transition to products whose demand is conditional on carbon emission reduction. BlackRock, the world's largest investor, committed in January this year to ask all companies globally to follow TCFD guidelines in public reporting,[44] changing TCFD from a voluntary to a now de facto mandatory reporting standard for global corporates.

If renewable energy in Australia can deliver internationally competitive electricity pricing at a fixed rate with zero risk over the long term, it could also position BSL as a supplier of low carbon aluminium while turning Australia into an attractive destination for energy-intensive manufacturing more broadly.

What Does Transition Look Like?

Transition to sustainable and reliable renewable energy in Gladstone and central Queensland involves taking a long-term and system-wide perspective to align the needs of the corporate supply chain (power generation and domestic bauxite mining plus refining into alumina and then aluminium for export) with the interests of the government and regional communities, rather than a narrow single corporate view.

This alignment would consist of key components such as:

- Sufficient renewable energy generation capacity;
- Sufficient transmission capability so that renewable electricity can be distributed to where it is needed;
- Increasing distributed generation to leverage scale and geographic diversification benefits and storage assets that will change the traditional demand profile across the grid;
- Firming and balancing at an optimal level to ensure a reliable supply of electricity to users regardless of the solar and wind conditions;

[43] Financial Times. London Metals Exchange plans 'low carbon' aluminium trading. 5 June 2020.
[44] BlackRock. Sustainability as BlackRock's New Standard for Investing. January 2020.

- Stability in the grid to cope with a far more complex ecosystem of utility and distributed generation assets, notably frequency control and demand response management;
- Potentially microgrid capability to share generation assets on a local basis;
- Storage to support firming, whether pumped hydro, battery or other technologies; and
- Control systems that can manage the interaction all of the above.

There are also many interested parties, including:

- Boyne Island's owners;
- Other major industrial energy users in the Gladstone region such as Queensland Alumina Limited, Rio Tinto Yarwun, Orica, Cement Australia, and also the various hydrogen projects being considered in and around Gladstone;
- CS Energy, Stanwell Corporation and CleanCo Queensland;
- Renewable energy generation developers and investors;
- Powerlink Queensland;
- The Federal government, Queensland government, and Gladstone local government; and
- The central Queensland communities that rely on sustainable jobs, maximised by a planned, orderly industry transition.

BSL Investors Need Energy Reliability and Price Stability

Investors in BSL need internationally competitive electricity, without the price volatility and grid reliability issues that have been evident over the last decade.

If BSL is to compete in the fastest-growing sector of the aluminium market (low-carbon), it also needs renewable energy that is reliable. The Sydney Morning Herald quotes Rio Tinto: "Repowering our aluminium assets and increasing the share of renewable electricity more broadly will be central to our decarbonisation strategy to 2030."[45]

Elsewhere in the world, Rio Tinto and its competitors have invested in upgrading aluminium smelters to improve efficiency, capacity and renewable generation. In Canada, for example, Rio Tinto spent C$4.5bn upgrading the Kitimat smelter and its captive hydro generation plant, as well as C$12m upgrading its Alma smelter in Quebec. Hydro Norsk, a shareholder in Tomago in NSW, invested at least US$172m in upgrading a smelter in Norway.[46]

Investors in BSL need internationally competitive electricity.

BSL Could Become a Top Quartile Aluminium Producer

BSL upgraded its operations to add a new potline in 1997. The technology used in the original two potlines is not in common use in the aluminium sector and, being installed in 1982, is likely due for replacement. With similar cell technology to the third potline, BSL is likely a highly efficient facility. It benefits from high-capacity grid transmission lines as a result of its relationship with Gladstone Power Station and stands between two major alumina refineries, Rio Tinto Yarwun and Queensland Alumina Limited.[47]

Smelters with renewable energy sources claim to produce aluminium at around 2.5 tonnes CO_2-e. Rusal, the Russian producer and the largest supplier after China, and Rio Tinto and Alcoa's joint venture Elysis (Canada), say they will have new "inert anode" technology in commercial operation by 2021[48] and 2024[49] respectively, which would reduce carbon emissions even further.

There is a question however over whether this incremental change will be financially justifiable and scalable. Assuming these recent conversions were based on a sound business case in both the Canadian and Russian smelters, the same commercial logic should justify upgrading BSL, if there is a supportive government framework to retain and modernise Australia's key heavy industry participants.

The key question, then, is certainty over the cost and emissions intensity of electricity supply.

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[45] Sydney Morning Herald. Smelters 'stick out' in Rio Tinto's $1.5b push to cut carbon emissions. 28 February 2020.
[46] Aluminium Insider. Hydro to Invest US$172mm in Upgrades to Idled Line at Husnes. 20 September 2018.
[47] Queensland Alumina, a joint venture between Rio Tinto and Rusal, refines alumina in Gladstone.
[48] Financial Times. Rusal targets 2021 to roll out carbon-free aluminium. 1 April 2019.
[49] Alcoa press release. 10 May 2018.

Towards A$40/MWh Electricity in Gladstone

Bearing in mind capacity factors, 2-3GW of solar/wind generation capacity would be needed to supply Boyne Smelters' demand. The installed capital cost is in the range of A$4-5bn.

Renewable Energy Zone and Transmission Upgrade

There are excellent solar and wind resources near Gladstone. There is a current proposal to develop 2GW of solar and wind generation with storage in the 'Fitzroy Renewable Energy Zone'.[50]

Although the regional transmission capacity needs to be upgraded, the Queensland Government recently announced funding to address this. Queensland premier, Anna Palaszczuk, said, "We commit $145m for the creation of three Queensland Renewable Energy Zones located in southern, central and northern Queensland. With the right support from governments, these zones will help connect new renewable energy to our power network, and attract industries wanting new energy to a series of connected commercial and industrial power hubs across the state."[51]

Component Pricing Is Falling Rapidly

Solar module prices have been falling by more than 10% annually over the last decade. IEEFA expects this trend to continue over the coming decade, given dramatic ongoing improvements in technology and economies of scale.[52]

A recent study by Andrew Blakers and Matthew Stocks at Australian National University (ANU) suggests solar pricing could be A$30/MWh as a result of continuing technology advancements and increasing manufacturing scale.[53] This ongoing module price deflation has been masked in Australia by the devaluation of the AUD. While onshore wind is a more mature technology, ongoing deflation is still expected as average installed turbine sizes are expected to double over the coming five years from 2-3MW to 4-6MW per turbine, and average utilisation rates will continue to rise over time with technology refinements.

Battery costs continue to fall quickly, down 87% from 2010 – 2019.

For capacity at this scale, physical firming using a mixture of batteries, pumped hydro, and hydrogen production could be feasible. Battery costs continue to fall quickly, down 87% from 2010 - 2019 and

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[50] PV Magazine. 2GW of renewable energy and "Just Transition" heading to Central Queensland". 19 May 2020.
[51] PV Magazine Australia. Queensland announces funding for renewable energy zones. 20 August 2020.
[52] PV-Tech. Solar manufacturing expansion plans for Q1 2020 top 500GW in unprecedented record. 5 April 2020.
[53] Renew Economy. Technology leaps driving cost of solar PV electricity in Australia to just A$30/MWh. 7 May 2020.

forecast to be US$100/kWh by 2023, according to BloombergNEF.[54] And the scale of new projects is expanding massively (Neoen is planning a battery in South Australia ten times the size of the Hornsdale power reserve[55]). Battery storage is an increasingly attractive investment proposition.

ANU research[56] recently identified 3,000 promising sites for off-river pumped-hydro capability in Australia, concluding it is most cost-effective when provided as NEM-level storage rather than as a behind-the-meter solution. Far North Queensland could well deliver pumped hydro storage to support an industry-wide renewable energy solution. CleanCo's Wivenhoe (a 570MW pumped hydro facility) offers a good example of the sort of storage solutions that could feed into the Queensland grid.

Precinct Demand Load Creates Economies of Scale

Gladstone's current advantage as an energy precinct includes the power station and the smelter being on a private grid. This creates an interesting opportunity for Central Queensland to invest in and deliver significant, low cost energy to support not just the smelter but other energy intensive industries. Using the smelter demand load as a foundation would create many other opportunities in the precinct.

Firmed renewable energy costs were referenced at below A$70/MWh in 2018.[57] However, it is highly likely providers will be able to put together contracts for firmed renewable energy supply in the target US$25-30 (A$40-50/MWh) range at some point over the next 3 to 8 years, using a mixture of financial structuring (insurance, hedging) and physical firming (pumped hydro storage, gas peakers and/or batteries). The scale benefits of infrastructure capacity to meet a demand load the size of BSL's could further reduce prices.

Cost of Capital Reduced With Government Support

The key cost of renewable energy is the long-term cost of capital. We note the U.S. 10-year bond rate has dropped from an average of 2.9% in 2018 to just 0.7% today[58], a 75% reduction in just two years that dramatically and permanently reduces the cost of capital for a new renewable infrastructure project. Australian government 10-year bonds have similarly dropped from 2.6% in 2018 to 0.8% today.[59]

A key consideration for BSL, and any large electricity user, is counterparty risk. The criticality of the electricity supply to the smelter makes the ability to rely on the

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[54] Bloomberg New Energy Finance. 2019 Battery Price Survey. 3 December 2019.
[55] Renew Economy. Neoen files plans for $3bn wind and solar farm with battery 10 times bigger than Hornsdale. 20 August 2020.
[56] ANU media release. ANU finds 530,000 potential pumped-hydro sites worldwide. 1 April 2019.
[57] Renew Economy. Snowy Hydro smashes price benchmarks for "fair dinkum" wind and solar. 2 November 2018.
[58] Macrotrends. 10 Year Treasury Rate – 54 Year Historical Chart. Accessed 17 April 2020.
[59] Investing.com. Australia 10-Year Bond Yield Streaming Chart. Accessed 17 April 2020.

supplier, both operationally and financially, one of the key factors in considering alternative arrangements.

There is a role for the Queensland state government (directly or through CleanCo) and/or the Clean Energy Finance Corp (CEFC) to facilitate a low-risk structure and provide debt financing and/or counterparty support in the form of a long-term government-backed power purchase agreement. This would make the project attractive for long term low cost of capital equity, while addressing counterparty risk.

The future of the Gladstone Power Station is another important factor. As an ageing plant with a significant site rehabilitation obligation, there may be a role for CleanCo to facilitate a practical transition.

A Precinct Approach

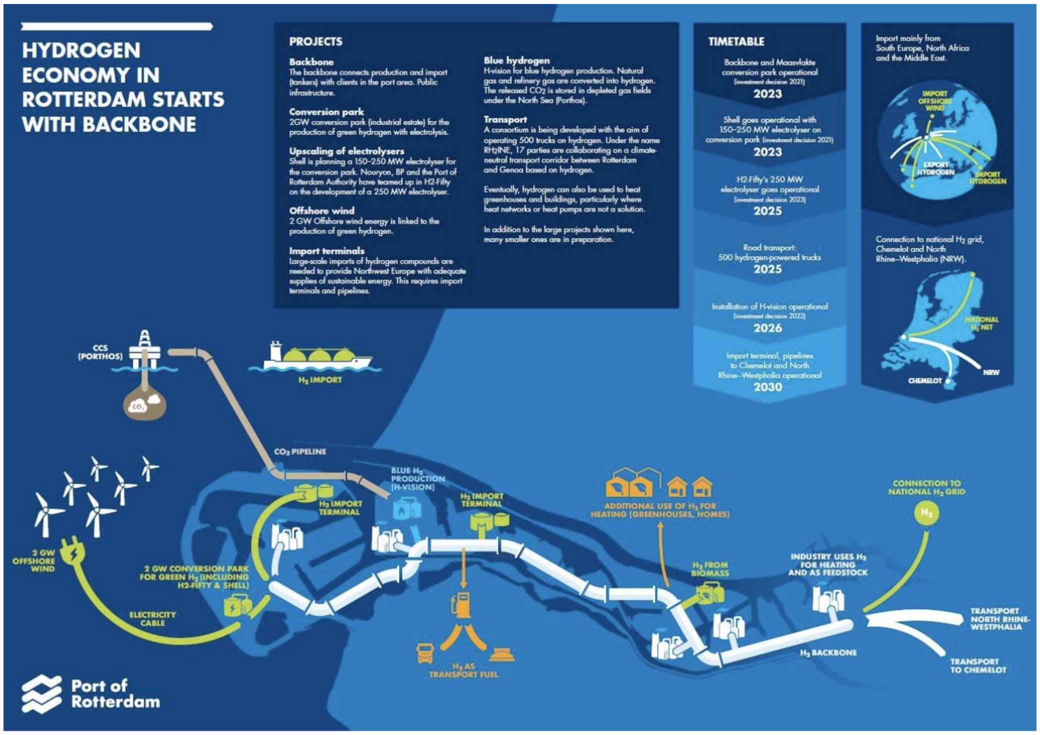
Low Cost Renewable Energy Will Drive an Industrial Precinct

Aluminium smelting provides the base load demand, but Gladstone has the necessary characteristics for a successful heavy industry precinct.

The concept of balancing the interests of heavy industry in a region, and using the combined requirements and capabilities to mutual effect, has been well developed in Europe. Examples include:

- the Port of Rotterdam's net zero and circular port initiative;
- Flanders BioBased Valley driving €7 billion of bio-innovation in Belgium;
- the Helsingborg industrial symbiosis park driving sustainability and productivity in Sweden's chemical industry; and
- Deux Synthe Park near Dunkirk in northern France where small and medium-sized enterprises (SMEs) in the steel, metals and petrochemicals industries come together to share resources, expertise and facilities and create sustainable and circular precinct processes.

Figure 7: Port of Rotterdam Energy Precinct



Source: Port of Rotterdam

These models create a platform for further investment and each industry benefits from collaboration and sharing of resources.

Demand Load Provided by the Smelter Will Support Lower Cost Electricity for All Heavy Industry

A renewable energy solution that meets BSL's needs would create a great deal of value for the Gladstone region. The ability to balance supply and demand in a single section of the Queensland grid and provide stability for the rest of the network would also have tremendous value to AEMO and would benefit all participants in the NEM.

In order to deliver the firmed electricity BSL requires, the energy solution would need to have significant additional generation capacity to account for intraday variability of renewable energy supply. Currently that is regarded as a concern in the NEM because it can lead to massive price volatility and periods of extremely low or negative pricing that disrupts incumbent economic models. By taking a precinct approach to the energy solution, this issue can be addressed. The surplus electricity could be used by significant energy users in the Gladstone region and, in the process, support their long-term viability and path to decarbonisation.

There are three industries in Gladstone that could benefit greatly from this solution:

- Alumina
- Cement
- Hydrogen and Ammonia

Like BSL, these manufacturers have the ability to modulate their demand within a range, scaling up when electricity is cheap and scaling down if the value of providing demand side response to the NEM is greater than the value of marginal production.

In addition, the establishment of a low-cost energy precinct situated next to a world class deep water industrial port with a skilled labour pool creates an opportunity for development of other kinds of energy-intensive export-oriented manufacturing.

Alumina

Gladstone currently has two alumina refineries:

Yarwun	Queensland Alumina Limited
Owned by Rio Tinto	80% Rio Tinto, 20% Rusal
10kms northwest of Gladstone	Gladstone
3.1m tonnes per annum	3.7m tonnes per annum

Alpha HPA proposes to establish a third plant in Gladstone, making ultra-high purity alumina for inclusion in lithium ion batteries and LED lighting.

Alumina is the feedstock to make aluminium. Alumina, or aluminium oxide, is a chemical compound of aluminium and oxygen molecules (Al_2O_3) made from refining bauxite using the Bayer process. Industrial heat and steam are required in that process, typically generated using gas, coal or oil. Refining requires approximately 200°C heat to generate steam that is used in the digestion and evaporation parts of the process and then a rotary kiln that heats the alumina to 1000°C in the calcination part of the process.[60] The International Aluminium Institute notes that, "The average specific energy consumption is around 14.5GJ per tonne of alumina, including electrical energy of around 150kWh/t Al_2O_3."[61] Fossil fuels can be entirely replaced with renewable generated electricity and/or combined heat and power (CHP).

The major carbon emissions contributor to low carbon aluminium (ie. aluminium made using renewable energy) comes from the alumina refining process. (The carbon anodes and coke used in the smelting process are the remaining sources of emissions). If this process could be decarbonised, along with renewable energy in

[60] Alcoa World Alumina Australia. Existing Wagerup Refinery. May 2005.

[61] Aluminium for Future Generations. Energy Efficiency.

the smelting process, Australia could be the lowest carbon aluminium producer in the world. Electrification of the alumina refining process (both digestion and calcination stages) would result in significant emissions reduction and, with the right long-term pricing, ought to be financially compelling, especially in Australia where gas prices are high. The QAL and Yarwun refineries would consume at least as much electricity as BSL if fully electrified. The refining process is also more easily modulated than aluminium smelting so the refineries could provide invaluable large-scale demand response.

BSL also generates a huge amount of process heat which, if it could be captured and piped, would make an interesting industrial heat solution along the lines of Northern European district heating.

The logistics of capturing and piping heat to the Gladstone alumina plants might be challenging but IEEFA believes it is worth investigating.

Cement

Cement Australia, a joint venture between two of the world's largest cement manufacturers, Heidelberg Cement and Lafarge Holcim, operates the largest cement plant in Australia in Gladstone. It has a production capacity of 1.7 million tonnes per annum and employs more than 150 people.

The cement production process contributes more carbon emissions than any other industrial process: approximately 8% of worldwide greenhouse gas emissions. Decarbonising it is not easy as 60% of the CO_2 emissions are produced by the chemical reaction when limestone is converted to lime (the clinker process). The other emissions in the cement manufacturing process come from energy usage.

There are several technologies in the development stage to address this problem, some of which involve new types of materials made from polymers. However, concrete is such a widespread and important part of the construction industry, it is critical that any solution is low risk and cost-effective. Calix, an Australian company, has developed a calcination kiln technology that separates CO_2 from lime and captures it. The CO_2 can be supplied to the industrial market for CO_2 (the food and beverage sector is the largest purchaser of CO_2[62]) or fed into a sequestration facility. Calix's calcination kiln has been installed in a demonstration plant in Belgium owned by Heidelberg Cement.[63] Heidelberg Cement has now contracted to expand use of the technology at a larger facility in Germany. This is part of a broader strategy by Heidelberg Cement to achieve its 2030 objective of 30% lower emissions than 1990 and

Renewable energy plus innovation in the clinker process could reduce most of the emissions generated.

[62] Business Wire. Global Carbon Dioxide Market Analysis. 28 August 2019.
[63] AuManufacturing. Australian-Led Cement Carbon Capture Project Commissioned In Belgium. 4 April 2019.

CO_2-neutral cement by 2050.[64] Cement Australia's other shareholder, Lafarge Holcim, has already reduced its emissions by 29% from 1990 and aims to achieve further reductions through a combination of lower-emission clinker alternatives, renewable power and carbon capture and storage (CCS).

Cement Australia could benefit from an energy precinct being able to transition from gas-sourced energy to renewable electricity. The combination of renewable energy plus innovation in the clinker process could reduce most of the emissions generated in the manufacturing process.

Another way of reducing the CO_2 emissions contributed by the cement industry is to replace Portland cement with geopolymer cement.[65] Geopolymer cement is made from fly ash, a waste product from coal-fired power stations, and can use red mud, a waste product from alumina refining. Gladstone is a good site to develop geopolymer cement production, using Gladstone Power Station fly ash and Yarwun and QAL red mud. Combined with carbon capture in the existing calcination process, this would make Cement Australia in Gladstone a leading low carbon cement manufacturer and would help its shareholders to achieve their emissions reduction objectives.

Green Hydrogen Production Taking Off

In Australia, hydrogen is predominantly made using fossil fuels: steam methane reforming. Electrolysis enables the production of hydrogen using water molecules and electricity, resulting in no greenhouse gas emissions.

As confirmed by the International Energy Agency (IEA), green hydrogen is the focus of massive global interest: "Hydrogen is today enjoying unprecedented momentum. The world should not miss this unique chance to make hydrogen an important part of our clean and secure energy future."[66]

IEEFA forecasts there will be a significant green hydrogen shortfall in supply by 2030.

Gladstone has a number of competitive advantages when it comes to developing a green hydrogen industry - world class solar energy, available land, and an established energy exports industry. Gladstone is also well located to supply green hydrogen to potential hydrogen importing countries such as China, Japan, South Korea and Singapore.

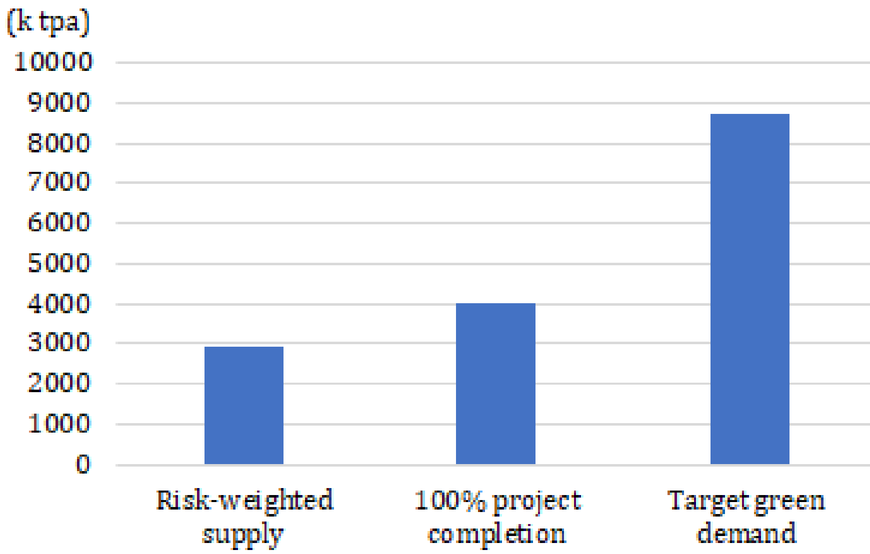
Hydrogen is one way of storing and exporting renewable energy to the world. Other options for exporting renewable energy include via high-voltage undersea

[64] Heidelberg Cement Sustainability Report 2019.
[65] Beyond Zero Emissions. Rethinking Cement. 2017.
[66] IEA. The Future of Hydrogen. June 2019.

electricity cables, or as embodied renewable energy in products like green steel, iron, aluminium, copper, plastics, fertilizer and chemicals. Green hydrogen can also be used to make green steel in Australia, for export.[67]

IEEFA forecasts there will be a significant green hydrogen shortfall in supply by 2030.

Figure 8: Global Green Hydrogen Supply Shortfall by 2030



Source: Various agencies, IEEFA estimates

There are four major hydrogen projects in the planning stages in Gladstone:

- **Hydrogen Park Gladstone**[68]: a 175kW electrolyser to deliver green hydrogen into Gladstone's fossil gas network;
- **Austrom Hydrogen**: an ambitious 3.6GW proposal to make hydrogen for export;
- **Hydrogen Utility**: a proposed $1.6bn facility to make hydrogen and ammonia; and
- **Symbio's Northern Oils Plant** is proposing to generate hydrogen from waste for use in a biofuels process.

Although Gladstone is a good location for hydrogen, the liquefaction, storage and transportation costs associated with hydrogen make exporting it a speculative prospect at the moment. Bloomberg New Energy Finance estimates $637bn of

[67] Grattan Institute. 2020
[68] Australian Gas Infrastructure Group. Australia's first whole of network decarbonisation project.

storage infrastructure is needed globally to meet energy security requirements using hydrogen instead of fossil fuels.[69]

However, there is already considerable potential demand for domestic use of hydrogen in the Gladstone industrial area and this could make the transition to commercial production possible in the near term.

Orica imports ammonia to its Yarwun facility and uses that to make 500,000 tonnes of ammonium nitrate per year for explosives used in coal mining. A hydrogen electrolysis plant in Gladstone could be used to make ammonia on site. This would create a significant base level of demand for hydrogen and justify a commercial grade facility. Further, ammonia is a safe and economical way to store and transport hydrogen – less volatile than gas hydrogen and much cheaper than liquid hydrogen. It is worth noting that Orica has 30,000 tonnes of ammonia storage in Gladstone, the largest storage of its kind on the eastern seaboard.[70] This is currently an import facility, but it would not be difficult to use it for export.

Ammonia production capability at Orica's Newcastle facility has been severely undermined by the trebling of fossil gas prices in NSW this past decade, given gas represents 85% of its variable costs. Orica's CEO Alberto Calderon was quoted last year as saying: "Orica has two comparable ammonium nitrate plants, one in Kooragang Island near Newcastle in NSW which is fuelled by gas from the Sydney hub. The other is in Carseland in Alberta, Canada, which sources cheaper local gas."[71]

Orica has only recently upgraded the Kooragang Island plant at a cost of A$100m. It employs 150 workers directly and is responsible for an estimated 1,000 additional jobs in the region. A progressive transition to hydrogen would not only change the financial dynamics, it would position Orica as a producer progressively pivoting to 'green ammonia'. A feasibility study for a similar project is being considered by Dyno Nobel in Queensland and has been funded by ARENA.[72]

A hydrogen electrolysis facility could take surplus renewable electricity and so improve the utilisation of renewable generation whilst helping manage its variability. At a system level, this would enable a greater supply of lower cost but variable electricity, reducing the cost for BSL.

Other countries have started: Ningxia Baofeng Energy in China recently announced a $200m investment in a solar electrolysed hydrogen plant that aims to generate A$135m per annum revenue and reduce carbon emissions by 445,000 tons.[73]

IRENA notes in the *Global Renewables Outlook 2020* report: "Production costs of around US$2-3 per kilogram for green hydrogen are feasible in the coming decade

[69] Bloomberg New Energy Finance. Hydrogen Economy Outlook. 30 March 2020.
[70] At Fisherman's Landing – Orica management discussions.
[71] Newcastle Herald. The High Price of Gas has made the Operation Uncompetitive on a Global Level. 8 March 2019.
[72] Arena. Renewable hydrogen could power Moranbah ammonia facility. 30 September 2019.
[73] Xinhuanet Yinchuan. Baofeng Energy Builds an Integrated Solar Electrolytic Water and Hydrogen Energy Storage Application Project. 20 April 2020 (link in Mandarin).

in the best locations. Low cost can also be achieved earlier at locations with good renewable energy resources."[74] Investment may well generate sufficient returns at a system level (taking into account employment, industry support and use of surplus renewable energy) to justify taking this learning-by-doing step now. This would position Gladstone to drive the Australian Government's "H2 under $2" target in its draft Technology Investment Roadmap.[75]

LNG

The three LNG export projects in Gladstone - Queensland Curtis LNG (QCLNG), Gladstone LNG (GLNG) and Australia Pacific LNG (APLNG) – process upwards of 1200PJ of LNG for export each year. These projects use a great deal of energy to liquefy and compress gas:

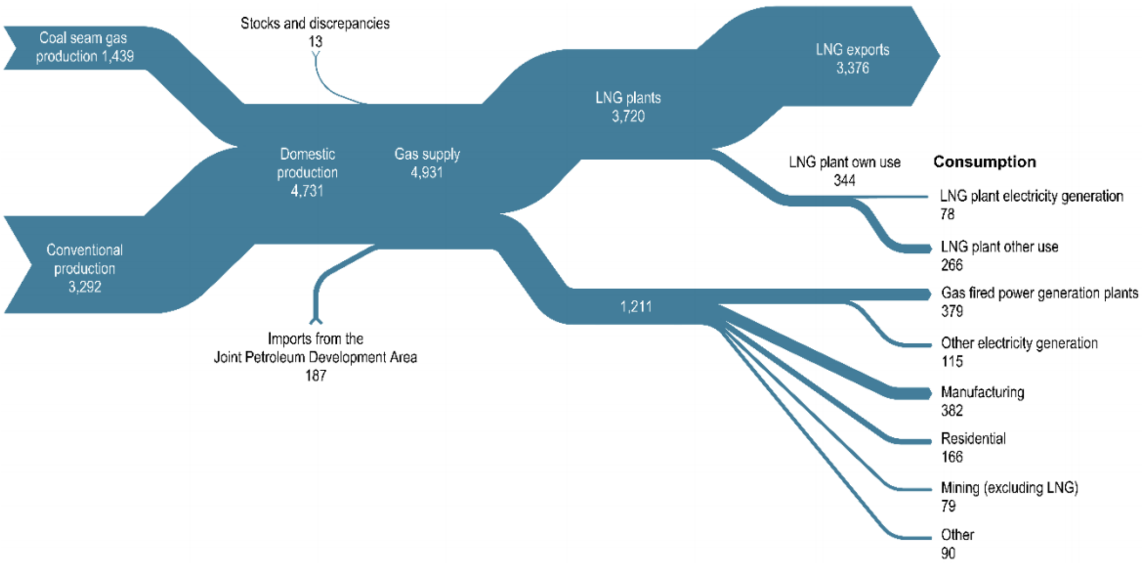
- Approximately 9%[76] of the gas processed is used in the liquefaction and compression process – approximately 100PJ of energy[77], depending on the level of production.
- Approximately 6,000GWh per year of electricity is currently used, generated on-site behind the meter by gas turbines with approximately 650MW of capacity across the three projects.[78]

Gas consumption by LNG plants is one of the largest sectors of usage.

As shown in chart 5, gas consumption by LNG plants is one of the largest sectors of usage (around 20% of total Australian consumption) and is the fastest growing.[79]

[74] IRENA. Global Renewables Outlook 2020. April 2020.
[75] AFR. Taylor sets a target for hydrogen under $2. 28 February 2020.
[76] Lewis Grey Advisory for AEMO. Projections of Gas and Electricity Used in LNG. 19 December 2017.
[77] Estimate by Rystad. Upstream Analytics Australasia. March 2020.
[78] Lewis Grey Advisory for AEMO. Projections of Gas and Electricity Used in LNG. 19 December 2017.
[79] Australian Government. Energy Update 2019. September 2019.

Figure 9: Australian Gas Supply



Source: Department of the Environment and Energy (2019) *Australian Energy Statistics*, Tables A and F and internal sources

These projects are financial disasters: Shell has recently written down the value of its Australian gas assets by up to 40%[80], and Santos has once again written down the value of its investment in GLNG.[81] If the projects were able to electrify their entire energy requirements, they would provide a demand load of as much as 3GW of electricity. That would completely change the electricity generation equation in Queensland and, if sustainable, could support conversion of more than 20% of Queensland's entire generation capacity to renewable generation.[82] Given the age and reliability issues of many of the Queensland coal-fired power stations, this would create an opportunity to reset Queensland's power supply and lower the cost structure materially whilst improving grid reliability, with enough scale to justify major investment in central and north Queensland transmission capacity.

These projects are financial disasters.

From a gas perspective, removing this amount of domestic demand for gas would remove the already dubious investment case for Narrabri gas fields and reduce the

[80] Argus Media. Australia bears the biggest brunt of Shell writedown. 3 July 2020.
[81] Renew Economy. Santos latest to write down gas investments as total Australian losses near $20 billion. 21 July 2020.
[82] Queensland installed electricity generation capacity is approximately 13,500MW: www.business.qld.gov.au, accessed 10 August 2020.

pressure of the COVID Commission to subsidise a gas pipeline from Western Australia.[83]

Even if it is unlikely (for engineering and commercial reasons) that the projects would replace gas usage with electricity entirely, by just committing their current electricity demand to renewable power purchase agreements over time, Gladstone Energy and Industry Precinct would have an additional 650MW of demand to support renewable generation.

Oil and gas companies are slowly coming to realise the need to reduce the emissions in their fossil fuel production process. As Wood Mackenzie notes, "Renewable energy, which is becoming highly efficient and cost-competitive, is not only environmentally responsible but can help midstream companies reduce operating costs and drive profitability."[84]

Oil and gas companies are slowly coming to realise the need to reduce the emissions.

Energy-Intensive Export Industries

The Port of Gladstone is a world-class deepwater facility. When combined with abundant land for industrial use and low-cost renewable electricity, Gladstone would be a prime location for new energy intensive manufacturing.

Downstream aluminium transformation is one additional industry that could be developed. Casthouse, rolled and extruded products could be manufactured in Gladstone, creating jobs and adding value prior to export.

In addition, the world's largest silica sand mine is located at Cape Flattery, 1,000 kilometres north of Gladstone. The mine is owned by Mitsubishi Corporation and all the production is exported. However, silicon production is a highly energy intensive process. China currently produces two-thirds of the world's silicon and is vulnerable to high costs of electricity. Gladstone could be a very competitive alternative. Other energy-intensive industries, such as steel making and the use of biomass (from Queensland sugar cane) to make chemicals and industrial materials (such as low emission carbon fibre), also become attractive for investment.

Demand Response Management

Smelter-As-A-battery

Some successful smelters generate considerable revenue from supplying energy or energy services, the so-called demand-side response. Smelters with captive generation capability—Rio Tinto's Kitimat in Canada and Hydro in Norway—view

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[83] Renew Economy. Covid Commission advised Morrison to underwrite gas pipelines, but ignored green jobs. 11 August 2020.
[84] Wood Mackenzie. It's time for midstream companies to explore renewable energy. 12 August 2020.

integration of electricity and smelting as critical to manage both aluminium and electricity price volatility. They can make an objective, value-maximising choice between ramping up aluminium production (and using more electricity) when aluminium prices are attractive, and curtailing production (and selling surplus electricity) when that provides a better return. Similarly, a smelter without captive generation can be configured to modulate energy use up or down to optimise its productivity.

In this respect, it is worth re-imagining a smelter as a giant virtual battery, one that also produces aluminium. Tomago Aluminium CEO Matt Howell has acknowledged this key change in thinking in comments supporting the continuation of the Australian Energy Market Operator's Reliability and Emergency Reserve Trader (RERT) scheme: "We've got a very large load that can come off in a very short space of time to avoid large-scale rolling blackouts, and that has value." He referred to 600MW of capacity that can be switched off in minutes. Most smelters can provide a very periodic reserve system of demand response, notably the ability to occasionally reduce electricity demand for up to 3 hours at a time. But without a technology upgrade, this capacity does present significant risk to the integrity of smelter potlines. An unplanned 5½ hour outage at Portland in Victoria in 2016 reduced smelting capacity to 27% for many months.[85] Investing to upgrade the smelter to have greater technology and operational controls would allow more flexibility whilst reducing the risks to the smelter investment.

It is worth re-imagining a smelter as a giant virtual battery.

Modulation Technology Can Create System-Wide Benefits

IEEFA suggests that one corporate entity should not be required to bear a disproportionate share of the costs and risks of the much-needed Australian economic transition.

Being responsible for around 13%[86] of the state's total demand, BSL is potentially the key enabler of Queensland's energy system modernisation, but this requires a significant investment that needs to be de-risked and valued according to the system strengths it would enable (in terms of total system cost reductions, decarbonisation and system reliability).

One aluminium business, Trimet in Germany, has employed EnPot[87] heat exchange technology to increase its ability to modulate smelter production. EnPot technology claims to increase modulation to +/-30% without any risk to the pots and the

[85] ABC. Portland smelter to operate at just 27pc capacity after unexplained power failure. 5 December 2016.
[86] 810MW contract = approx. 7 TWh pa / 55TWh pa Queensland consumption (AER data)
[87] Patented technology developed by the Light Metals Research Centre at the University of Auckland and commercialised by Energia Potior Limited.

reduction in energy usage can last indefinitely.[88] This is because the EnPot heat exchanger system traps heat that would normally be expelled into the atmosphere (approximately 50% of energy used by the pots is expelled as waste heat to keep the pot cell in balance) and uses it as insulation to maintain the required pot temperature (of around 960°C). It also protects the pots in the case of a complete power outage by preserving heat without electricity for longer.

This is not the only way to improve a smelter's modulation capacity. Evolution of cells design to increase thermal reserve would improve BSL's ability to modulate downwards and provide demand side response (DSR) to the NEM. If that reserve can be increased to 8 hours (from around 3 hours now), BSL could trade electricity and maximise the facility's total profitability by altering/optimising the balance of electricity usage and aluminium production. The commercial model drives the investment decision: when electricity is expensive and DSR provides no financial return, the investment focus is naturally on energy efficiency; if, however, BSL could generate a better return by providing demand side response, investment in more robust cells with increased thermal reserve would be justified.

Our analysis would suggest BSL wears a disproportionate share of the investment risk with, currently, little financial incentive to provide demand response management services to the grid. With the Australian government also removing the price on carbon pollution by cancelling the emissions trading scheme (ETS) back in 2014, there is no policy framework to encourage Australian industry to progressively decarbonise (particularly in contrast to Europe and South Korea, global leaders in terms of their ETS).

As a result of this failure of national energy policy to look forward and deliver on Australia's Paris Agreement commitments, an Australian evaluation of an investment in an EnPot technology smelter retrofit (at a capital cost of perhaps $100m) has to-date not made commercial sense.

However, IEEFA believes it is in AEMO's and BSL's interests to maintain reliable electricity supply and support grid stability, while it is in Australia's national interest to put the economy on a progressive path to decarbonisation, with all the benefits of energy system price deflation this could bring.

It is in Australia's national interest to put the economy on a progressive path to decarbonisation.

Assuming the Reliability and Emergency Reserve Trader pilot was successful, there would be strong business case, at a system level, for investment in all aluminium smelters to enhance their ability to provide demand response management. BSL alone could provide demand side response of approximately 2.4GWh to the grid if it could dial down its electricity demand by 30% for 8 hours at a time. Consequently, there ought to be a contractual and/or

[88] Energia Potior. Transforming the Future of Aluminium Smelting.

investment solution that can enable this if all the relevant long-term vested interests can be aligned.

The Federal Government has the tools available to evaluate (via ARENA, the Australian Renewable Energy Agency) and then underwrite, or help to structure (through CEFC, the Clean Energy Finance Corporation) a low risk, long term investment in modernising a critical key part of Australian industry, along with the benefits of securing the many thousands of jobs involved.

By approaching the challenge of internationally competitive pricing and grid reliability at a regional level, Gladstone could create a precinct that balances its electricity supply and demand, provides valuable grid stability services to the NEM, while offering an attractive platform for the growth of heavy, export-oriented industry in the region.

Regional Economic Development

The Gladstone Region is varied and diverse in its economic base, with considerable industry strengths, from mining, gas and heavy industry to tourism and agriculture. There are many opportunities to make use of low-cost electricity in existing sectors. Overlaying an industrial district heat energy plan for the Gladstone area could add additional system value (novel in Australia, but a mainstream business structure in Germany, for example). BSL generates a huge amount of surplus heat that is lost in the electrolysis process but could be captured and piped to neighbouring industry applications. This is particularly relevant to alumina, which requires a large amount of medium level process heat. Other manufacturing processes, such as food and beverage processing (abattoirs, for example) would benefit from low cost process heat.

In and around Gladstone there is a large area of unproductive land. Quarantined industrial wasteland could be used for renewable generation siting and expansion of low carbon heavy industry. If the industry potential in the region and community and workforce needs could be viewed as a whole, the business case for investing in large-scale renewables backed by firming is far stronger. In addition, the energy load used by heavy industry could be utilised for demand response management: it would be small compared to BSL's usage, but it could cost-effectively help balance supply and demand as well as enhancing grid reliability and system strength.

Investment in a regional energy usage and supply plan would improve energy security and be a key enabler of Queensland's growth. Tying AEMO's Integrated System Plan and the Queensland Government's funding of renewable energy zones to a coordinated approach to heavy industry in Gladstone would result in lower energy costs for all users because investment risk can be mitigated by harnessing demand.

Investment Considerations

In order to support the necessary investment, developers require a financial investment proposal that at least matches the cost of capital available. The riskier the investment proposition, the higher the cost of capital. At the scale required for long term sustainability, the most attractive equity capital comes from long term infrastructure investors: superannuation and pension funds, sovereign wealth funds such as Australia's Future Fund, and other low-risk, long-term investors (including, for example, Japanese investors such as Mitsubishi, Mitsui and Sumitomo, which have a long history of investing in large scale industry in Queensland where it supports their trading activities).

Large long-term capital investors have not participated in renewable energy infrastructure to-date in Australia in any material way for four main reasons:

1. **Scale**: Given the size of their funds and the amount of capital they need to deploy, large investors look for $500m plus equity investments. Other than AGL-QIC's Powering Australia's Renewable Future (PARF) Fund, there have been no large-scale renewable infrastructure opportunities in Australia.

2. **Term**: Infrastructure timeframes are usually in the 40 year plus range, certainly more than 20 years. Securing a long-term power purchase agreement in Australia is problematic. Likewise, term debt capital of more than 4-8 years is not standard in Australia.

3. **Risk**: Policy uncertainty has made the sector unattractive for long-term investors. With more than a dozen material policy proposals or changes since 2007, the Australian energy sector has been hard to gauge over the short term, much less the timeframe for long-term investors. Further, price volatility and technology risk have added to the return profile required to make investment in this sector attractive.

4. **Politics**: The global imperative to invest in a progressive decarbonisation consistent with the Paris Climate Agreement has not been converted into policy in Australia, even though many of the required financial and technology institutions of world-leading stature are in place (ARENA, CEFC, CSIRO).

Scale

A BSL-centred renewable energy investment addresses scale. A financial structure, incorporating additional investors that manage the risk of mismatched power purchase agreements (PPA) terms with the life of the assets as well as pricing volatility and policy uncertainty, could deliver infrastructure returns at a level of risk typically priced by long-term investors. Further, this structure could accommodate additional assets (for example, a similar scale infrastructure investment could be replicated in New South Wales to supply low cost, zero emissions electricity for the Tomago smelter, and in Victoria at the Portland smelter), providing a key investment opportunity for deployment of more capital to replicate this move once the commercial case has been proven.

Risk and Term

Layers of risk include:

- Construction and grid connection,
- Long term: ownership of commissioned renewable energy generation with power purchase agreements for up to 25 years,
- Credit risk managed by high quality counterparty,
- Volatility risk addressed by insurance/hedging,
- Currency, mirroring the loan currency exposure with the US$ nature of aluminium pricing to lower the cost of long-term fixed price financing,
- A gap in market power purchase agreements and the desired term taken by equity investors with higher return hurdle; potential for CleanCo or other electricity generators to participate in this equity.

Transmission

Transmission capacity and marginal loss factors have become a major factor inhibiting investor interest in large scale renewable energy infrastructure. In 2019, the energy consultancy Rystad estimated that there were 8GW of projects north of Gladstone competing for only 300MW of transmission capacity, and 4GW of projects in Central West Queensland with only 100MW of grid capacity.[89]

BSL has a direct connection with Gladstone Power Station. This ensures the reliability of transmission essential for smelting and reduces exposure to broader grid planning. A larger energy and industrial precinct could operate in a similar way, with direct transmission capacity between the generation capacity and the industrial precinct of users, with connectivity into the main grid so Gladstone could provide a critical grid stability function. This would be more financially viable for the precinct and generation investors as well as providing a solid economic foundation for securing the wider Queensland grid.

[89] AFR. Huge renewables bottleneck looms in North Queensland. 10 September 2019.

Swing for the Future – Get 5 Years Ahead or Fall 5 Years Behind

This Gladstone plan is a template for expansion across the aluminium sector, and is also applicable in Victoria and New South Wales.

By focusing on large scale, low cost of capital, zero emissions renewable infrastructure tied to significant energy users with long-term growth prospects in a low carbon economy, there is a real chance to build momentum for the Superpower that Garnaut discusses. If the aluminium sector could be reinvigorated and put on a globally competitive footing, Australia can get five years ahead on the decarbonisation path. However, if the smelters close and all that load is lost, building this kind of investment momentum will be far more difficult and Australia could fall five years or more behind forward-looking countries.

The aluminium sector could be reinvigorated and put on a globally competitive footing.

A Gladstone Energy and Industry Precinct offers an opportunity to build, on a foundation of renewable energy and aluminium production, sustainable and internationally competitive heavy industry with world-leading low carbon alumina and cement production, while providing an enhanced path for a scalable green hydrogen generation capability for adjacent domestic usage and ultimately for export.

The current COVID-19 crisis is an appropriate time to reassess the strategic importance of reinvigorating our domestic manufacturing industry at scale, and to provide scope for a green investment stimulus. The Prime Minister has raised the question of 'economic sovereignty' in light of the supply chain issues highlighted by COVID-19. When asked what Australia needs to reinvigorate local manufacturing to address this sovereignty issue, former Manufacturing Australia chair and board director, Sue Morphett pointed to internationally competitive energy prices.[90] This can only be achieved in any sustainable way by a concerted industry effort.

The Queensland Government has a key facilitation role. A study to detail the economics of the approach described in this briefing note and to map out an implementation path would be invaluable in galvanising government, community and industry support for change. By announcing its intention to close the Tiwai Point smelter in New Zealand in July 2020, Rio Tinto has raised awareness of the pending closure threat for BSL.

Now is the time to reimagine Australian industry and to put it on a path to sustainability. Pricing energy system flexibility is a key to viability, for BSL and Australian heavy industry more widely.

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[90] ABC Radio National interview. 13 April 2020.

IEEFA recommends a feasibility study to investigate the following components necessary to establish the Gladstone Energy and Industry Precinct:

- **Infrastructure**: Assess siting (including existing projects) for 2-3GW of renewable energy with reliable and cost-effective transmission to BSL. Assess whether the Gladstone Energy and Industry Precinct can operate in a behind-the-meter renewable energy zone like the existing Boyne Island-Gladstone Power Station ring.

- **Cost**: Determine the lowest $/MWh cost of delivering electricity to BSL using that infrastructure, using demand load and Queensland Government support to attract lowest cost of equity funding.

- **Firming**: Design a firming solution that can be implemented to ensure sufficient reliability to protect smelting operations at a price that meets the $40-50/MWh international benchmark.

- **Demand Response Management:** Assess demand response management options to: (a) make BSL a more flexible user of electricity; and (b) provide a financial contribution that supports a lower electricity price. Assess the right investment structure to facilitate demand response management.

- **Hydrogen:** Assess hydrogen production options to use variable renewable energy supply to generate revenue for Gladstone that would support firming and demand response management.

- **Industry Plan:** Explore Queensland Government investment options in Central Queensland to facilitate private investment and reinvigorate Gladstone's heavy industry as a low-carbon employer of thousands of workers and a growing contributor to Queensland's gross state product, with particular reference to:

    - Reducing the equity investment risk in renewable energy to support internationally competitive electricity pricing in Gladstone;

    - Facilitating a smooth transition from Gladstone Power Station to renewable generation;

    - Addressing marginal loss factor, network access and transmission cost issues by developing the Fitzroy renewable energy zone specifically to support the Gladstone Energy and Industry Precinct;

    - Investing in a hydrogen electrolysis plant to demonstrate the domestic use business case and to create a path for the development of a full-scale, commercial green hydrogen industry in Gladstone.

- **Timeline:** With the Gladstone coal-power plant turning 50 in five years, planning needs to commence now to ensure a stable transition path for new replacement generation capacity.

About IEEFA

The Institute for Energy Economics and Financial Analysis conducts research and analyses on financial and economic issues related to energy and the environment. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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Clark Butler is an IEEFA guest contributor, and a corporate adviser with a background in the technology and finance sectors. In additional to being a director of and investor in technology and data companies, he is exploring technology and financing solutions to encourage investment in renewable energy solutions.