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SUSTAINABILITY OF ENERGY SUPPLY AND RESOURCES IN NSW

Organisation: NSW Minerals Council

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LEGISLATIVE ASSEMBLY COMMITTEE ON ENVIRONMENT AND PLANNING

INQUIRY INTO THE SUSTAINABILITY OF ENERGY SUPPLY AND RESOURCES IN NSW

SUBMISSION

September 2018

NSW MINERALS COUNCIL

NSW Minerals Council

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Executive summary

The NSW Minerals Council (NSWMC) has a broad membership of companies involved in energy supply and resources, including the producers of thermal coal for power generation and the minerals that are used to manufacture renewable energy infrastructure including metallurgical coal, gold, copper, silver, nickel and cobalt.

The NSW mining industry is a major pillar of regional NSW. Mining companies directly spent $10.7 billion on wages, suppliers, community contributions and NSW government payments in 2017-18, directly supporting more than 7,100 NSW businesses. The ABS reports that more than 35,000 people are employed in the NSW mining industry, the majority of which are in regional NSW.

Pleasingly, the outlook for the NSW minerals sector is positive. The export market is by far the most significant for the NSW minerals industry, as NSW takes advantage of our resource-rich geography to help supply the minerals needed to meet increasing living standards and population growth in Asia and India. The NSW Government's 2016-17 Intergenerational Report predicts royalty revenue to increase at an annual average of 4.2% over the period to 2056, largely based on thermal coal[1].

There is strong demand growth forecast in NSW's thermal coal export markets

The forecast growth in energy demand in South East Asia and India is phenomenal. In the Association of Southeast Asian Nations (ASEAN) alone, the International Energy Agency predicts demand for electricity to more than double between 2016 and 2040, leading to growth in all forms of electricity generation, including coal and renewables.

Contrary to claims of a decline in coal demand in our export markets, an analysis of Government policies in India and the Asian region by coal market experts Commodity Insights forecasts an increase in thermal coal demand of almost 500 million tonnes by 2040. If NSW is just to maintain our current market share, NSW thermal coal production would need to increase by 75 million tonnes over this period, more than outweighing any potential decline in domestic demand. This forecast presents a strong future for the State's 22,000 coal miners and the coal mining communities that rely on the industry as well as the flow on benefits to the broader NSW economy.

Cutting off NSW coal supply to these markets would force these countries to source their coal from other markets, which are likely to supply poorer quality coal that create higher carbon emissions.

Increasing global demand for metals creates significant opportunities for regional NSW

Similarly, demand for traditional metals such as gold, copper and silver, and emerging metals such as cobalt and lithium, is expected to surge over the coming decades and present more opportunities for economic growth and diversification in regional NSW.

Copper, for example, is integral in electronic equipment. As the world becomes increasingly digitalised and electricity takes over a greater share of energy supply, demand for copper will also grow. For example, electric vehicles contain around four times the amount of copper as a petrol vehicle, and wind turbines contain several tonnes of copper.

[1] NSW Budget 2016-17 Intergenerational Report https://www.treasury.nsw.gov.au/sites/default/files/2017-01/Budget_Paper_5_-_Intergenerational_Report_2016_-_full_report.pdf

Just based on historical growth rates, around the same amount of copper will need to be mined from now until 2042 that has been mined in all history. Similar trends can be seen across other metals[2].

However, with production across current NSW metalliferous mines declining within a decade[3], more needs to be done to discover and develop the next generation of metalliferous mines that can position NSW to contribute to this increasing demand.

A suite of technologies will be needed to deliver a secure, reliable and low emissions electricity supply for NSW

As a large user of electricity – around 6 per cent of the state's consumption - the NSW minerals industry has a keen interest in ensuring electricity prices are kept as low as possible to make sure our industry remains internationally competitive.

Traditional forms of energy (coal, gas and Snowy Hydro) still generate more than 90% of the state's electricity[4] and are key to supporting heavy industry with reliable 24/7 electricity. While wind and solar PV are an important and growing part of the energy mix, NSW is at the early stages of integrating these renewables and the costs and complexities as their share increases have not been felt to the same extent as elsewhere.

While statements are often made that wind and solar PV are the 'cheapest' form of new electricity to build, these statements fail to acknowledge their total system costs, which include backup storage and reserve capacity, transmission infrastructure and grid security services. Analysis published by ARENA[5] in 2018 identifies that 'dispatchable' renewables – that is renewables firmed with some form of storage – cost one and a half to two times the cost of wind and solar alone, which still excludes the costs of transmission and grid security measures.

Modelling of the total system costs of various forms of generation technologies for the National Electricity Market[6] demonstrates that while wind and solar PV provide the initial least-cost emissions reductions, their integration costs increase exponentially as they are deployed more broadly.

As the electricity system becomes dependent on these highly variable forms of generation, they can fluctuate from oversupplying demand to making a minimal contribution in a matter of hours, as well as having extended periods of wind 'droughts' or overcast conditions. This necessitates ever increasing volumes of capacity, storage, backup and transmission infrastructure to ensure reliability and maintain grid security.

The study of total system costs indicates the lowest cost pathway for emissions reductions, while at the same time ensuring the stability of the grid, involves a mix of technologies beginning with renewables, then moving to gas, then either coal or gas with carbon capture and storage.

Modern coal fired plants are more efficient (i.e. produce less carbon emissions per unit of electricity generated) than NSW's existing fleet and can be designed to be more flexible so they can ramp up and down in response to the fluctuating generation by wind and solar PV. When paired with carbon capture and storage, deep cuts in emissions can be achieved.

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[2] MinEx Consulting, *Long term trends in global exploration – are we finding enough metal?,* 31 October 2017 http://minexconsulting.com/wp-content/uploads/2019/04/FEM-Conference-FINAL-Oct-2017.pdf
[3] NSW Minerals Strategy, p9
[4] Australian Energy Statistics, March 2019 https://www.energy.gov.au/sites/default/files/2019_aes_table_o_march_2019.pdf
[5] ARENA, Comparison of dispatchable renewable electricity options. p. 65 https://arena.gov.au/assets/2018/10/Comparison-Of-Dispatchable-Renewable-Electricity-Options-ITP-et-al-for-ARENA-2018.pdf
[6] [6] Boston, A., Bongers, G., Byrom, S., and Staffell, I. (2017) Managing Flexibility Whilst Decarbonising Electricity – The Australian NEM is Changing, Gamma Energy Technology http://anlecrd.com.au/wp-content/uploads/2017/07/Managing-Flexibility-NEM-2017-Report.pdf

Recommendations

1. **Contribute to existing efforts to diversify regional economies** – Given the positive outlook for coal and other minerals, the evidence does not demonstrate the need for any general 'transition' strategy for mining communities, aside from some tailored measures that may be needed in response to closure of domestic coal fired power stations. Instead, the ongoing economic development and diversification of regional economies should be supported, including the development of metalliferous mines and the potential switching of domestic coal suppliers to production for export markets if domestic demand falls.

2. **Support a technology-neutral approach to energy policy to ensure emissions reductions are achieved at least cost** – Technology-specific policies, such as renewable energy targets, have skewed investment and led to higher electricity prices and a less secure grid. Policies should value reliability and grid security services and allow all technologies to compete to deliver the least cost electricity and emissions reductions.

3. **Support investment in pre-competitive mineral exploration and measures to attract mineral investment to NSW, including the NSW Minerals Strategy** – The predicted growth in global demand for minerals is significant and NSW needs to take advantage of this opportunity. However, with reserves in existing mines declining, NSW could miss out. The Government should support investment in mineral exploration to discover the next generation of mines, which would deliver significant benefits to regional communities. The NSW Government's *NSW Minerals Strategy* recognises the growth opportunities for the metalliferous sector and presents a range of tangible actions to take advantage of these opportunities.

4. **Support NSW becoming Carbon Capture and Storage ready** – As the Governments of the UK and Norway, German Chancellor Angela Merkel, and the International Energy Agency all recognise, Carbon Capture and Storage (CCS) is an essential technology to meet climate targets. The scale of the task to meet NSW's net zero emissions commitment is immense and will be virtually impossible without CCS for emissions from coal and/or gas fired power generation, from industrial processes such as cement, chemical and steel manufacturing, and to achieve 'negative' emissions by using bioenergy with CCS. The NSW Government should develop a plan to make NSW CCS ready and support near-zero emissions from our energy, manufacturing and industrial sectors, positioning these industries for a low carbon future.

1 Background

1.1 About the NSW Minerals Council

The NSW Minerals Council (NSWMC) is the peak industry association representing the NSW minerals industry, including the owners and operators of coal, metalliferous and mineral sands mines, mineral explorers and associated service providers. NSWMC has around 90 member companies.

NSWMC works closely with government, industry groups and business and community leaders to foster a sustainable mining industry in NSW. NSWMC supports the development of a strong and diverse state economy and an effective regulatory framework in which the industry can operate profitably and make a meaningful contribution to the state and the people of NSW.

NSWMC encourages innovation and leading practice to improve the health and safety of our people and minimise our impacts on the environment.

NSWMC does not represent the gas or power generation industries.

1.2 The Committee's Terms of Reference

The Committee on Environment and Planning (the Committee) self-referred the following terms of reference for the inquiry:

> *That the Committee on Environment and Planning inquire into and report on the sustainability of energy supply and resources in NSW, including:*
>
> 1. *The capacity and economic opportunities of renewable energy.*
> 2. *Emerging trends in energy supply and exports, including investment and other financial arrangements.*
> 3. *The status of and forecasts for energy and resource markets.*
> 4. *Effects on regional communities, water security, the environment and public health.*
> 5. *Opportunities to support sustainable economic development in regional and other communities likely to be affected by changing energy and resource markets, including the role of government policies.*
> 6. *Any other related matters.*

This submission aims to address the main issues likely to be considered by the Committee as they relate to the NSW mining industry.

1.3 Mining is a critical part of the NSW economy

Mining is cornerstone industry in regional NSW, often underpinning regional economies and contributing to the diversity in economic opportunities available to people living in regional NSW. Mining has successfully worked alongside other regional industries for decades, such as agriculture and tourism, helping to make regional towns more resilient while also supporting manufacturing and service industries in major towns and cities, including Sydney.

The total production value of mining in NSW during 2017-18 was $27.3 billion[7]. The industry generates close to 4% of NSW's Gross State Product, but in regional areas its contribution is much higher including the Hunter (18.1%), Illawarra (7.9%), Central West (10.9%) and Far West (29.2%).[8]

[7] Data provided by NSW Division of Resources and Geoscience
[8] NSW Mining Industry Expenditure Impact Survey 2018-19

The NSW mining industry:

- Employs more than 35,000 people across the state[9], mostly in regional areas
- Spent $10.7 billion on suppliers, wages, community contributions and local and state government payments during 2016-17, helping to support over 7,100 supplier businesses across the State[10]
- Generated more than $2 billion in royalties in 2018-19, with another $8 billion expected to be generated over the next four years[11]
- Produces the coal that delivers 80 per cent of the electricity generated in NSW
- Is the state's single largest export industry, with exports of approximately $25.3 billion in value, including coal at $19.7 billion in value[12]

There is strong community support for the mining industry and almost universal public recognition of its economic importance to NSW, including the role of the sector in providing jobs in the regions.

1.4 Mining uses a small proportion of NSW land and water

While mining is often the biggest primary industry in regional economies, its use of natural resources is relatively low when viewed in the context of its significant economic contribution.

Across NSW, mining uses around 0.1 percent of land, compared to 78 percent used by agriculture, 8 percent for National Parks and 1.8 percent for buildings and infrastructure[13].

Through the Upper Hunter Mining Dialogue, an industry-wide community engagement project in the Upper Hunter that has been in place for almost a decade, the industry has worked with community members, agricultural and environment groups on projects to better understand and manage the impact of mining in the region. One project involves data collation on the industry's land use in the region. This data shows that the land currently disturbed my mining in the Singleton and Muswellbrook Local Government Areas – the most concentrated region of mining activity in NSW – equates to 2.7 percent of the total land area[14]. Much of the surrounding buffer land is put to productive use, either for agricultural purposes or

Like other primary industries, water is a vital input into mining operations for purposes such as coal and ore processing operations, dust suppression and staff facilities. However, according to the ABS, the mining industry uses a very small proportion of water in NSW - just 1.5%, compared to the 70% used by agriculture, as shown in the following table.

[9] ABS 6291.0.55.003 Labour Force, Australia, Detailed, Quarterly, May 2019
[10] NSW Mining Industry Expenditure Impact Survey 2018-19
[11] NSW 2019-20 Budget Papers
[12] Data provided by NSW Division of Resources and Geoscience
[13] Australian Collaborative Land Use Mapping Project
[14] http://www.nswmining.com.au/getattachment/Dialogue/Latest-Projects/Land-Management/Rehabilitation-Principles-and-Commitments/Rehab_Infographic_A4Flyer.pdf

ABS Water Account 2016-17

Sector	Water Use	%
Agriculture	4,600	70.0%
Water supply and waste	658	10.0%
Households	569	8.7%
Other	387	5.9%
Manufacturing	121	1.8%
Mining	97	1.5%
Aquaculture, forestry, fishing and support services	73	1.1%
Electricity and gas supply	62	0.9%
Total	6,567	100.0%

Even in the Upper Hunter - the most concentrated region of mining activity in the state - the mining industry uses 6.3 gigalitres of water from the Hunter River, compared to 111.7 gigalitres used for other industries and town water supply.[15]

Mines can use lower quality water for much of their water needs, reducing their demand for higher quality water. This lower quality water includes saline groundwater inflows into mines in regions such as the Hunter Valley, which are of little use to other water users but are suitable for applications such as dust suppression. Many mines source the vast majority of their water through these lower quality groundwater inflows and onsite rainfall runoff, as well as reusing and recycling more than 50% of their water, reducing demand on regulated water sources.

1.5 The mining industry supports strong global action on climate change

NSWMC acknowledges that sustained global action is required to reduce the risks of human-induced climate change. NSWMC supports a measured transition to a low emissions global economy. This includes participation in global agreements such as the Paris Agreement, which would hold the increase in the global average temperature to well below 2°C above pre-industrial levels.

This will require a policy framework encompassing:

- Australia's participation in global agreements such as the Paris Agreement with greenhouse gas emission reduction commitments from major emitting nations.
- A combination of short, medium and long-term market-based policy measures that:
  - Provide for least cost abatement of greenhouse gas emissions
  - Maintain the international competitiveness of Australian industry
  - Minimise adverse social and economic impacts on households
  - Provide industry with policy certainty to make long-term investments.
- Substantial investment in a broad range of low emissions technologies and adaptation measures.

[15] http://www.nswmining.com.au/getattachment/Dialogue/Latest-Projects/Water/Minerals-Council-of-Australia-Water-Accounting-Fra/WAF-2017-detailed-water-use-infographic.pdf

Access to reliable and affordable energy is central to the long term sustainable success of our economy. Policy measures must deliver reliable and affordable energy at least cost while putting Australia on a pathway to meeting its emissions reduction targets. A national coordinated approach to climate and energy policy needs to recognise the energy and resource intensive nature of the Australian economy.

The NSW Minerals Council believes a technology-neutral approach should be adopted for all low emissions energy sources where no one technology is favoured to the exclusion of others. Any policy approach should aim to reduce energy costs in Australia and focus on securing reliable lowest cost dispatchable energy supply that is available 24/7, while meeting emissions reduction targets.

2 A suite of technologies is needed to deliver affordable, reliable and low emissions electricity

2.1 The role of renewables

Renewables have an important role to play in the energy supply mix. Onshore wind and solar PV supply a small but growing proportion of the state's electricity, having received subsidises through the Renewable Energy Target since 2001, which will continue to 2030. They are now mature technologies and costs have fallen considerably.

However, like all forms of generation, renewables have their limitations. While the falling cost of solar and wind generation has been widely reported, there is less discussion about the impact these forms of generation have on the reliability and security of the electricity system. These issues have been highlighted by the Australian Energy Market Commission.[16]

Solar and wind energy is not dispatchable; i.e. it cannot be produced on demand – only when weather conditions are suitable. Wind farms only generate around a third of their nameplate capacity on average, and for solar PV the annual average capacity utilisation is in the 20 to 25 percent range. However, their output fluctuates widely and to manage these fluctuations wind and solar need to be supported by storage or some other form of backup generation. Exacerbating the problem, there is a degree of negative correlation between electricity demand on the one hand and wind and solar generation on the other. In particular, at times of high demand (typically hot summer evenings), wind and solar generation fall off as demand is rising and make almost no contribution to meeting the peak.

Looking beyond peak demand times, extended wind droughts are not uncommon, so any electricity system reliant on a significant proportion of wind capacity will require large backup and/or storage capacity. The June 2017 wind drought in South Australia has been widely reported, with output from South Australia's wind farms around half that of June 2016 despite an increase in installed capacity[17]. Analysis of NSW weather patterns over 2006-2015 shows 15 wind droughts lasting more than 1 week in duration and a 1-in-5-year drought lasting 12 days.[18] This phenomenon, and the analogous conditions of numerous consecutive cloudy or rainy days, particularly in winter when solar radiation is already low, present the greatest engineering and economic challenge for electricity storage.

Conversely, during favourable conditions for wind generation, the stability of the electricity system can be compromised. This has triggered AEMO to direct high cost open cycle gas turbines to come online in South Australia to maintain system strength, even at times when wind generation exceeds demand. Victoria is then called on to absorb the excess generation. This arrangement can work because South Australia's power system is small, and Victoria's is large. It would create major problems if the South Australian approach was extended to Victoria and/or New South Wales and scaled up proportionately.

Having 'cannibalised' thermal plant revenues and driven coal plants to close, wind is now cannibalising its own revenues. This reflects the rapidly diminishing economic and market value of wind and solar as their share of generation increases, which has been recognised in the literature for some time. Hirth (2013) for example, found that the 'competitiveness gap' (required subsidy) increased materially with

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[16] Reliability Panel AEMC, Annual Market Performance Review 2017, https://www.aemc.gov.au/sites/default/files/2018-03/Final%20report.pdf

[17] McCardle, P., Where's the wind gone? NEM-wide wind farm operation lowest in 5 years (maybe ever, on like-for-like basis?), WattClarity, 30 June 2017 http://www.wattclarity.com.au/2017/06/wheres-the-wind-gone-nem-wide-wind-farm-operation-lowest-in-5-years-maybe-ever-on-like-for-like-basis/

[18] Boston, A., Bongers, G., Byrom, S., and Staffell, I. (2017) Managing Flexibility Whilst Decarbonising Electricity – The Australian NEM is Changing, Gamma Energy Technology http://anlecrd.com.au/wp-content/uploads/2017/07/Managing-Flexibility-NEM-2017-Report.pdf

generation market share, more than cancelling out the learning effect observed in falling unit capacity costs. The paper contains a comprehensive discussion of the market value of variable renewable energy (VRE), and the abstract provides a good summary of the problem:

> *The inherent variability of wind speeds and solar radiation affects the price that VRE generators receive on the market (market value). During windy and sunny times the additional electricity supply reduces the prices. Because the drop is larger with more installed capacity, the market value of VRE falls with higher penetration rate. This study aims to develop a better understanding on how the market value with penetration, and how policies and prices affect the market value. Quantitative evidence is derived from a review of published studies, regression analysis of market data, and the calibrated model of the European electricity market EMMA. We find the value of wind power to fall from 110% of the average power price to 50–80% as wind penetration increases from zero to 30% of total electricity consumption. For solar power, similarly low value levels are reached already at 15% penetration. Hence, competitive large-scale renewable deployment will be more difficult to accomplish than as many anticipate.*[19]

The problem is not merely a market design problem - as some observers have claimed - but reflects a basic underlying engineering and economic problem characteristic of these resources. It is clear that as variable renewable capacity expands, it must be paired with reliable backup generation and storage, which can significantly increase the total system costs of integrating these forms of generation.

Analysis published by ARENA[20] in 2018 identifies that 'dispatchable' renewables – that is renewables firmed with some form of storage – cost one and a half to two times the cost of wind and solar alone, which still excludes the transmission and grid security costs.

Modelling of the total system costs of various forms of generation technologies for the National Electricity Market[21] demonstrates that while renewables provide the initial least-cost emissions reductions, their integration costs increase exponentially as they are deployed more broadly.

The study indicates the lowest cost pathway for emissions reductions, while at the same time ensuring the stability of the grid, involves a mix of technologies beginning with renewables, then moving to gas, then either coal or gas with carbon capture and storage.

2.2 Policies must be designed to support electricity security, reliability and emissions reductions

In NSW, our power system has been designed around thermal generation, predominantly coal supported by gas and Snowy Hydro peaking power. As well as providing dispatchable electricity supply, these forms of generation provide essential system security services, such as inertia, frequency control, voltage control, ramping and system re-start services, many of which have been provided free of charge. In other electricity systems around the world, these services are provided by nuclear power and baseload hydro power, which while producing zero emissions electricity, are not a possibility in Australia due to a lack of baseload hydro potential and prohibitions on nuclear power.

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[19] Lion Hirth (2013) The market value of variable renewables: the effect of solar wind power variability on their relative price, Energy Economics 38 pp. 218–236

[20] ARENA 2018 report - Comparison of dispatchable renewable electricity options. p. 65 https://arena.gov.au/assets/2018/10/Comparison-Of-Dispatchable-Renewable-Electricity-Options-ITP-et-al-for-ARENA-2018.pdf

[21] Boston, A., Bongers, G., Byrom, S., and Staffell, I. (2017) Managing Flexibility Whilst Decarbonising Electricity – The Australian NEM is Changing, Gamma Energy Technology http://anlecrd.com.au/wp-content/uploads/2017/07/Managing-Flexibility-NEM-2017-Report.pdf

Wind and solar PV energy provide few of these ancillary services and can in fact erode system security as they out-compete existing coal generation on an energy-only basis. Batteries and pumped hydro can perform some of these functions but have limitations. For example, pumped hydro can provide inertia when it is generating, however it is more likely to be pumping rather than generating at times of high wind and solar PV generation when inertia is needed.

Policies that have focused only on emissions reduction have been implemented to the detriment of system security, reliability and affordability. Renewable energy targets are the most significant example of this.

It is important that all the elements that contribute to a secure, reliable and low emissions grid are appropriately recognised and valued, and that all technologies can compete on an equal footing to provide these services so that the overall system costs are minimised.

It is not yet clear whether renewables supported by storage can provide an affordable alternative to support energy intensive industry. Efforts to rapidly transition to a high proportion of renewables are likely to be costly, with AEMO stating that *"Maintaining existing coal-fired generation up to the end of its technical life is a key element of a least-cost approach."*[22]

2.3 Carbon Capture and Storage is essential to meet climate goals

The production and use of fossil fuels generates greenhouse gas emissions but fortunately the technology exists to address these. This includes modern, high efficiency coal plants.

The current thermal efficiently of NSW's coal-fired fleet is about 35% but efficiencies of up to 47% now operate around the world, with further improvements anticipated.[23] When coal fired plants are combined with carbon capture, utilisation and storage this opens up a pathway to make deep cuts in emissions.

Moreover, new coal generation technologies exist that can ramp up and down faster than existing plant, enabling them to provide a quicker response to back up fluctuating wind and solar PV generation and help overcome their intermittency. This is important because switching away from coal too quickly could leave an energy gap in NSW if there is not enough renewable power to meet demand.

By helping advance low emission coal technologies NSW can contribute to the global development of safe and reliable CCS. This in turn will help the state continue to derive economic benefit from its vast, high quality coal resources.

Around the world, recognition of the importance of carbon capture and storage (CCS) to meeting climate goals is virtually universal. Some examples include:

- Fatih Birol, Executive Director International Energy Agency - Nov 2018 - *'without CCS as part of the solution, meeting climate global goals will be practically impossible'*
- Angela Merkel, Chancellor of Germany - May 2019 - *"I am firmly convinced that [net zero emissions] can only be done if one is willing to capture and store CO_2."*
- The Rt Hon Clare Perry MP, UK Minister of State for Energy and Clean Growth – *"we share in the broad international consensus that CCUS will be essential to meet the ambitions set out in the Paris Agreement"*

CCS will be essential if NSW is to have a realistic chance of achieving the aspirational target of net zero emissions by 2050 set by the NSW Government. Firstly, complete decarbonisation of the electricity grid may be extremely difficult, and some coal and/or gas generation paired with CCS is likely to be required. Furthermore, given there is a range of emission sources for which there is no feasible way to eliminate

[22] AEMO Integrated System Plan, July 2018
[23] Improving the thermal efficiency means less coal needs to be burned for the same power output and thus fewer greenhouse gas emissions are produced by the generation plant.

emissions (e.g. some industrial processes and agriculture) some form of offsets will be required. Analysis by the University of Queensland Energy Initiative indicates that while land based offsets (i.e. tree planting) may provide some of this sequestration, there is insufficient land in NSW to meet the task[24]. Other measures, including international offsets, direct carbon capture and storage and 'negative' emissions achieved through biomass burning with CCS will be needed.

CCS is a proven technology, having been used in enhanced oil recovery operations for decades. Its application to power generation and industrial sources is still in the early stages, however there are examples at Boundary Dam coal fired power station in Canada and the Petra Nova coal fired power station in the US. As it is deployed more broadly its costs will come down significantly, like has been seen with other forms of low emission technology.

CCS was reviewed by the NSW Public Accounts Committee in its report 6/55 November 2012 'The economics of energy generation', which concluded that:

> *This technology has particular significance for New South Wales, which is dependent on black coal both for electricity generation and export. … The location of potential storage sites is critical to the viability and economics of carbon capture and storage, and the Committee considered that there is a role for government to be involved with this research.*

The NSW government subsequently joined with the federal government and industry to develop a CCS roadmap for Australia.[25]

The application of CCS in NSW needs ongoing support. Further efforts to identify the best geological storage sites for NSW should be made, along with planning for associated infrastructure, so CCS can be implemented as it becomes a viable option in future.

[24] University of Queensland Energy Initiative (2016), *The NSW Climate Change Policy Framework – important considerations for taking the aspirational goal seriously. A public interest discussion paper*.
[25] See https://anlecrd.com.au/projects/a-ccs-roadmap-for-australia/

3 The outlook for NSW thermal coal exports is strong

3.1 Thermal coal demand in NSW export markets is forecast to increase by nearly 500 million tonnes by 2040

To assist the committee's deliberations regarding Terms of Reference 2 and 3, NSWMC commissioned Commodity Insights to prepare a report into the export market for NSW thermal coal out to 2040.

The study analyses the official energy policies of governments in our major exporting regions of Asia and India, and uses this information, together with United Nations population forecasts and per capita electricity consumption forecasts, to predict the potential change in demand for thermal coal.

The report, *Market Demand Study – NSW Export Coal* – is attached to this submission. Some findings from the study to note include:

- Demand for thermal coal in our major export markets is forecast to increase by 495 million tonnes between 2018 and 2040
- Small reductions in demand from China and Japan are offset by large increases in demand from other countries, particularly India, Vietnam, Philippines, and Bangladesh
- NSW would need to increase thermal coal exports by 75 million tonnes by 2040 just to maintain our current market share.

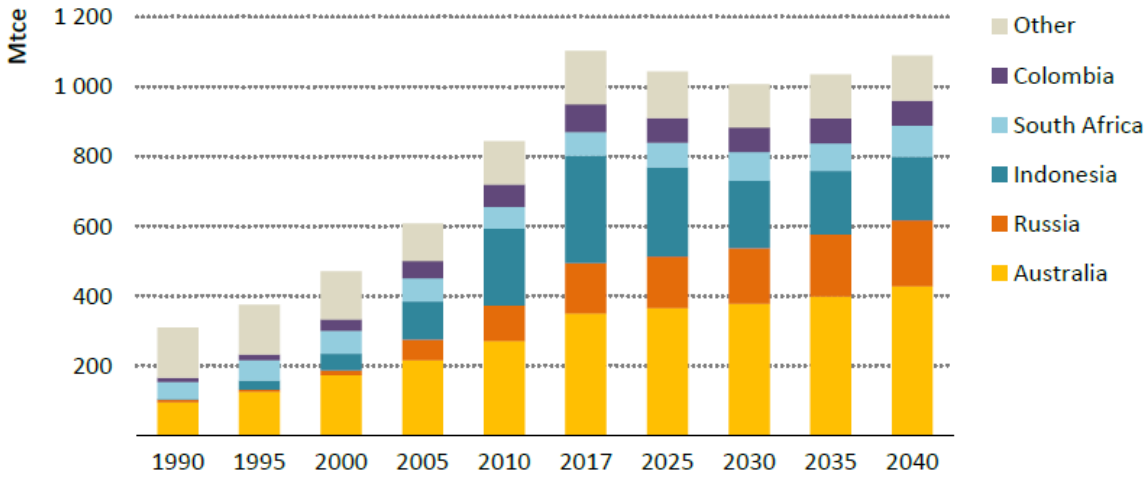
The Commodity Insights work is generally consistent with the projections of the International Energy Agency (IEA). As the IEA notes[26], there are strong regional variations in the outlook for coal as the developed economies of Europe and North America reduce coal use, which is balanced by a much greater increase in coal use in the developing economies of India and South East Asia – NSW's major export market.

In the IEA's New Policies Scenario, which reflects both the current and announced policies of governments, including those under the Paris Agreement, demand for coal is predicted to increase by 492 million tonnes coal equivalent. While noting the uncertainties associated with the New Policies Scenario, the IEA states that *"Australia is the only export-oriented country projected to significantly ramp up coal production over the period to 2040. Benefiting from its strong resource base and its proximity to growing markets in Asia, Australia's production exceeds that of the United States by the late-2020s."*

The IEA goes on to say: *"Australia, the world's largest exporter continues to be well positioned to serve coal import needs in the Pacific Basin."* This is illustrated in figure 5.12 on page 238 of *World Energy Outlook 2018*.

[26] International Energy Agency World Energy Outlook 2018

Major coal exporters in the IEA New Policies Scenario



While there is the potential for the energy policies of our major export markets to change, the forecast growth in energy demand in these developing nations is significant and coal will play a role in meeting this increased demand. As Commodity Insights states, *"Even half the growth estimated (circa 2050Mt) is still substantial and significantly more than total Australian thermal coal exports in 2018 (207Mt)".*

3.2 The evidence does not suggest there is a need for coal mining communities to 'transition' to other industries

Economic diversification is important for any community to help provide resilience in the face of changing economic cycles. Mining is an industry that helps provide this economic diversification in regional NSW and has helped to provide ongoing economic stimulus during tougher times for agriculture, such as the ongoing drought.

While some groups have warned of the economic ramifications of a rapid decline in the state's coal mining industry, the evidence currently available does not support this prediction. To the contrary, the evidence suggests that demand for NSW coal will continue to be strong, driven by the phenomenal growth in energy demand in India and Asia.

Some recent calls for NSW to develop coal region 'transition' plans have been based on a fundamental misunderstanding of the outlook for NSW coal export markets.

Others have sought to use 'transition' as an attempt to disrupt supply of NSW coal to export markets by prematurely ending coal mining in NSW despite strong demand for NSW export coal.

Given the positive outlook for coal and other minerals, the evidence does not demonstrate the need for any general 'transition' strategy for mining communities, aside from some tailored measures that may be needed in response to closure of domestic coal fired power stations.

Instead, the ongoing economic development and diversification of regional economies should be supported, including the development of metalliferous mines and the potential switching of domestic coal suppliers to production for export markets if domestic demand falls.

4 Growth in demand for metals presents a major economic opportunity for regional NSW

NSW is home to some world class metalliferous mines, including Newcrest's Cadia gold and copper mine, Evolution's Cowal gold mine and the CMOC Northparkes copper mine. Several other major projects are at various stages of development, including the Clean TeQ Sunrise Project that will produce cobalt, nickel and scandium, and the McPhillamy's Gold Project.

The NSW Government has recognised the future growth opportunities for the NSW metalliferous sector through the release of the NSW Minerals Strategy in February 2019[27], which has the goal *"To significantly grow investment in mineral exploration and mining in NSW to position the state as a major global supplier of metals for the economies of today and the future."* NSWMC fully supports this goal.

The minerals that NSW produces or has the potential to produce are essential in a range of modern transport, electricity and telecommunications technologies. Copper is a fundamental component of electronic equipment, including wind turbines, solar panels, electric vehicles and battery storage. Its use is set to increase significantly along with the exponentially increasing demand for these technologies. For example, electric vehicles contain around four times the amount of copper as a petrol vehicle, and the International Energy Agency conservatively predicts sales of electric vehicles to increase 10-fold by 2030. Wind turbines also contain several tonnes of copper. Just based on historical growth rates, around the same amount of copper will need to be mined from now until 2042 that has been mined in all history. Similar trends can be seen across other metals[28].

Similarly, cobalt is an essential input into lithium ion batteries that are used in electric vehicles and other energy storage. NSW has the potential to become an important and stable supplier of cobalt, with the Democratic Republic of Congo currently dominating global supply.

However, exploring for minerals is a commercially risky activity and very few exploration programs lead to the discovery of economically significant resources. The NSW Minerals Strategy states that 80% of the land mass of NSW essentially remains unexplored, with historical exploration focusing in shallow areas around known deposits.

A 2014 report commissioned by the NSW Government and prepared by minerals exploration expert Richard Schodde stated *that "There is an urgent need to find large new deposits now. Without them, there is a real risk that mine production (and revenues and employment) could significantly decline in 10-15 years' time."* This highlights the long lead times between discovery and development of mineral resources and the need to continually invest in exploration to find new discoveries that can be developed into profitable mining operations. The NSW Minerals Strategy confirms that the production life of current metalliferous mines in NSW sees declining production from 2026.

Metalliferous mining has the real potential to inject significant economic stimulus into regional NSW. Government policies have a big role to play in supporting the discovery and development of the state's mineral resources. This is reflected in the Fraser Institute's annual international survey of mining companies, in which NSW has ranked as the last placed Australian jurisdiction on the 'Policy Perception Index' for four years in a row[29]. This index assesses how the policy framework affects investor perceptions.

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[27] https://www.resourcesandgeoscience.nsw.gov.au/__data/assets/pdf_file/0007/852505/DPE8828-Minerals-Strategy-FINAL_V2_approved-by-ALL_WEB.pdf
[28] MinEx Consulting, *Long term trends in global exploration – are we finding enough metal?,* 31 October 2017 http://minexconsulting.com/wp-content/uploads/2019/04/FEM-Conference-FINAL-Oct-2017.pdf
[29] https://www.fraserinstitute.org/sites/default/files/annual-survey-of-mining-companies-2018.pdf

The NSW Government has set a target to increase the Policy Perception Index score for NSW, which NSWMC supports. Some of the measures that could be taken include:

- Delivering on the actions outlined in the NSW Minerals Strategy
- Investing in pre-competitive exploration data that can be used by explorers to inform their exploration programs
- Ensuring a streamlined regulatory framework for explorers, including titles application processes, environmental approval processes and arrangements for accessing land, which should reflect the fact the exploration is a low impact activity.

5 Recommendations

NSWMC makes the following recommendations to the committee:

1. **Contribute to existing efforts to diversify regional economies** – Given the positive outlook for both coal and other minerals, the evidence does not demonstrate the need for any general 'transition' strategy for mining communities, aside from some tailored measures in response to individual closures of coal fired power stations. However, the economic development and diversification of regional economies should be supported, including the development of metalliferous mines and the switching of domestic coal suppliers to export markets if domestic demand falls.

2. **Support a technology-neutral approach to energy policy to ensure emissions reductions are achieved at least cost** – Technology-specific policies, such as renewable energy targets, have skewed investment and led to higher electricity prices and a less secure grid. Policies should value reliability and grid security services and allow all technologies to compete to deliver the least cost electricity and emissions reductions.

3. **Support investment in pre-competitive mineral exploration and measures to attract mineral investment to NSW, including the NSW Minerals Strategy** – The predicted growth in global demand for minerals is significant and NSW needs to take advantage of this opportunity. However, with reserves in existing mines declining, NSW could miss out. The Government should support investment in mineral exploration to discover the next generation of mines, which would deliver significant benefits to regional communities. The NSW Government's *NSW Minerals Strategy* recognises the growth opportunities for the metalliferous sector and presents a range of tangible actions to take advantage of these opportunities.

4. **Support NSW becoming Carbon Capture and Storage ready** – As the Governments of the UK and Norway, German Chancellor Angela Merkel, and the International Energy Agency all recognise, Carbon Capture and Storage (CCS) is an essential technology to meet climate targets. The scale of the task to meet NSW's net zero emissions commitment is immense and will be virtually impossible without CCS for emissions from coal and/or gas fired power generation, from industrial processes such as cement, chemical and steel manufacturing, and to achieve 'negative' emissions by using bioenergy with CCS. The NSW Government should develop a plan to make NSW CCS ready and support near-zero emissions from our energy, manufacturing and industrial sectors, positioning these industries for a low carbon future.

6 Attachments

Commodity Insights, Market Demand Study – NSW Export Coal, 6 September 2019

NSW Government, NSW Minerals Strategy, February 2019

Commodity Insights

Final Report

Market Demand Study: NSW Export Coal

NSW Minerals Council

6 September, 2019

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The conclusions expressed in this report are as on the 6th September 2019. The outlook is only appropriate for this date and may change in time in response to variations in economic, market, legal or political factors, in addition to ongoing operational results.

Table of Contents

1. Executive Summary

New South Wales exported 164.6Mt of coal in 2018, of which 143.4Mt was thermal coal used for power generation. Thermal coal exports from NSW have increased from 79.5Mt in 2008 to 143.4Mt in 2018, supported and driven by strong Asian demand growth. Japan is the major destination for Australian thermal coal, accounting for 45% in 2018, while China, Korea and Taiwan are also important destinations.

New South Wales thermal coal is highly desired in the seaborne market and is generally viewed as the highest quality thermal coal available. The key price indices for Pacific Basin thermal coal are based on Newcastle-specification coal. The popularity of NSW thermal coal is driven by many factors, including a high energy content, power plant design dependency on Australian thermal coal in north Asia, end-user mine and infrastructure equity agreements, take or pay contracts which provide supply stability and visibility, and strong economic stability in the historically important markets of Japan, Korea and Taiwan.

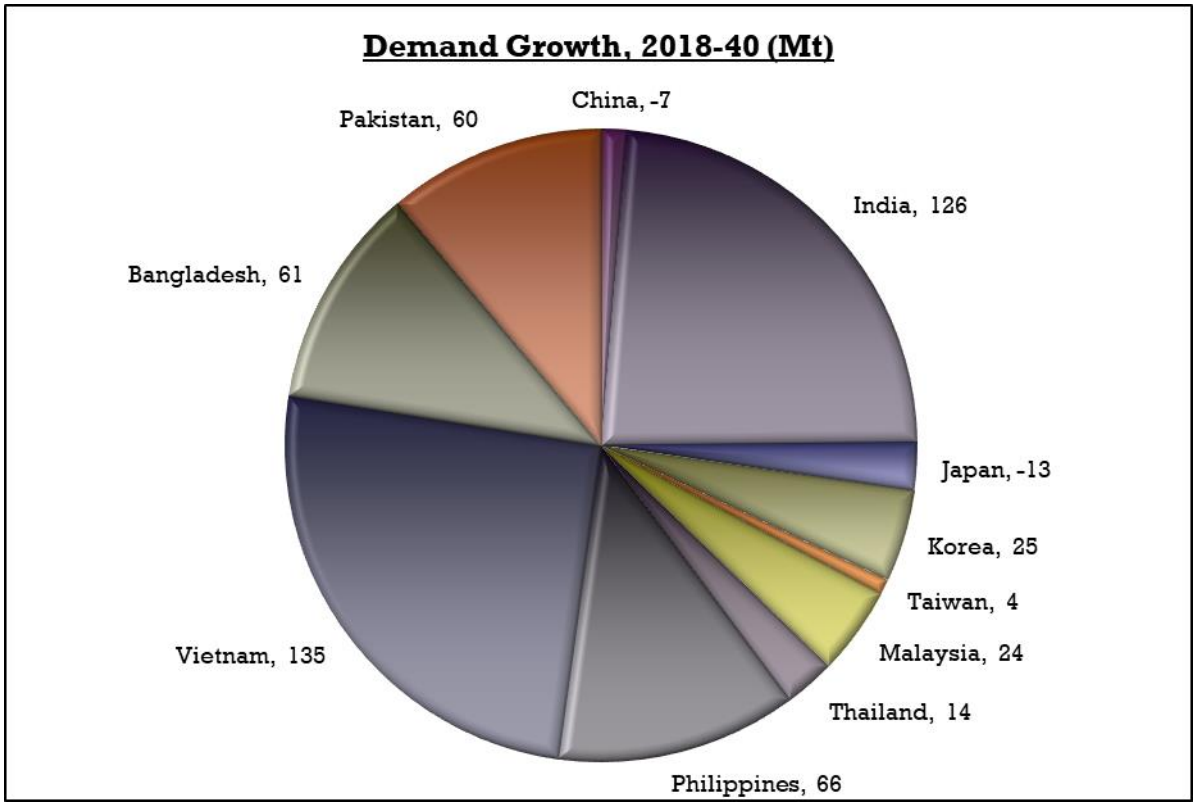
Commodity Insights has estimated thermal coal import demand growth across Asia from 2018-40, based on official government policy targets for coal's share of power generation, population forecasts from the United Nations and electricity consumption patterns. The forecasts presented in this paper are not those of Commodity Insights, but rather estimates based on official government policies across Asia.

Asian thermal coal imports are forecast to grow by almost 500Mt from 2018 to 2040 as tabled below, a CAGR of 2.3% (which is below historical levels). This represents annual growth of 23 Mt, which compares to annual growth of 37Mt from 2007-17.

Country (Imports Mt)	2018	2020f	2025f	2030f	2035f	2040f	Growth
China	207	200	200	200	200	200	(7)
India	161	180	226	262	288	287	126
Japan	140	140	147	134	131	127	(13)
Korea	115	116	125	125	133	140	25
Taiwan	61	63	59	61	63	65	4
Malaysia	34	40	43	50	53	58	24
Philippines	24	27	45	57	71	90	66
Vietnam	23	38	80	100	131	158	135
Thailand	25	25	27	31	34	39	14
Pakistan	14	19	29	40	54	74	60
Bangladesh	2	8	25	44	53	63	61
Total	**806**	**856**	**1,006**	**1,104**	**1,211**	**1,301**	**495**

Source: Commodity Insights.

As charted below, the demand growth is broad-based, with only Japan and China reducing imports across the period (and by small volumes), and strong growth in most other nations.



Source: Commodity Insights

Drivers of this growth include the following:

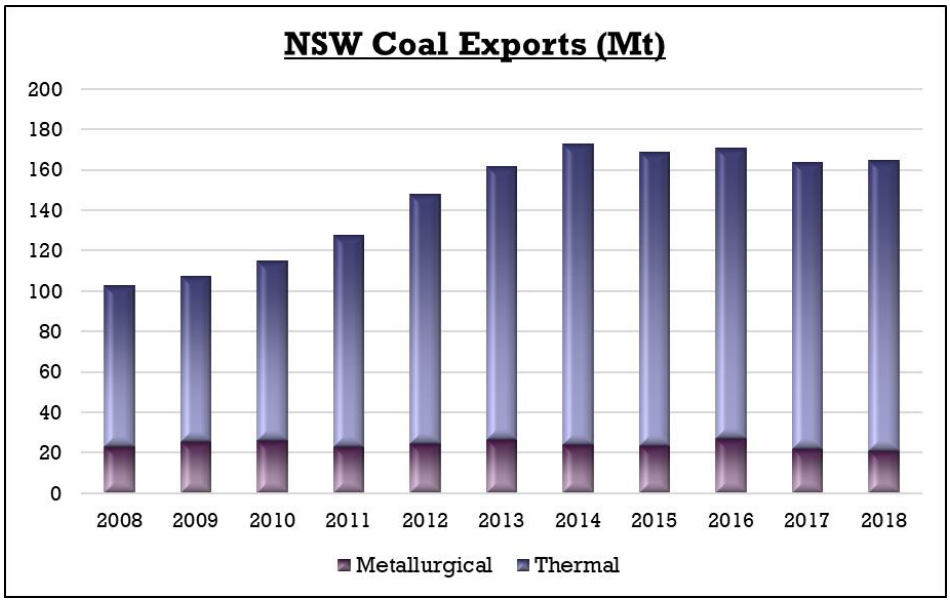
- Policy direction moving away from nuclear power in north Asia (Japan, Korea and Taiwan) following the Fukushima incident in 2011.
- Strong electricity demand growth in southeast Asia and India driven by industrialisation and urbanisation.
- Solid or strong population growth across most regions, except north Asia.
- A move to increase coal's share in the power generation mix in parts of southeast Asia, to diversify away from gas or hydro.

This strong Asian demand growth profile of almost 500Mt presents significant opportunities for New South Wales thermal coal exports, particularly given their favoured position in the market.

Given this strong demand profile, New South Wales thermal coal exports would need to increase to 210Mt by 2040 - approximately half of what Indonesia currently exports – just to maintain market share. There is also the possibility that exports from other key suppliers (particularly Indonesia) may fall over the period, due to a combination of strong domestic demand and declining coal reserves, which may present further opportunities for New South Wales thermal coal exports.

2. Introduction to NSW Coal Exports

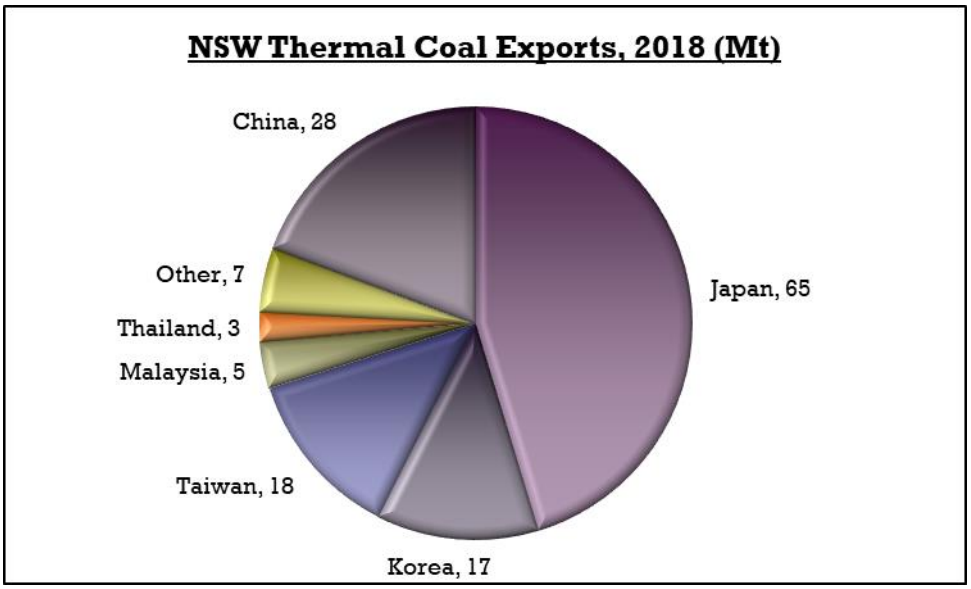
NSW exported 164.6Mt of coal in 2018, an increase of more than 60% since 2008, when exports were 102.5Mt. Most exports are thermal coal, used in power generation, which accounted for 143.4Mt of exports in 2018, and for all the growth over the past decade (see below). The balance is metallurgical coal which is used for steel production.



Source: Commodity Insights

In 2018 NSW accounted for 69% of Australia's total thermal coal exports (207.7Mt). Globally, NSW holds an approximate 15% market share in the seaborne thermal coal market, where volumes reached 960Mt in 2018.

In terms of key markets, Japan, China, Taiwan and Korea accounted for 89% of total NSW thermal coal exports in 2018 as charted below.



Source: Commodity Insights

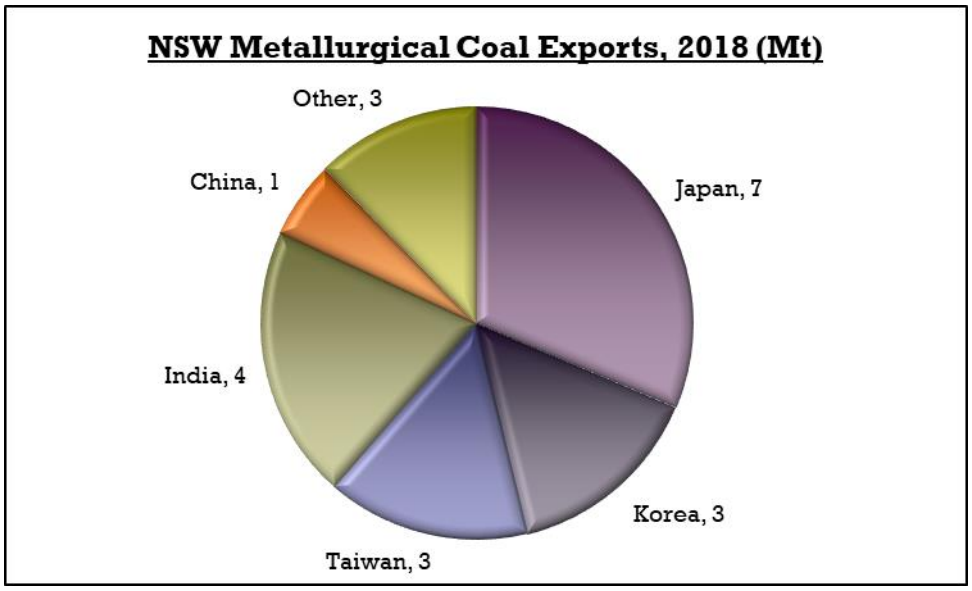
Historically, Japan has been by far the largest importer of NSW thermal coal. This trend continues with Japan accounting for 65Mt (45%) of total NSW thermal coal exports in 2018 (equal to 2017), followed by China 19% (17% in 2017), Taiwan 13% (14% in 2017) and Korea 12% (14% in 2017). Other Asian and Pacific markets account for the balance of NSW thermal coal exports.

The North Asian countries (Japan, Korea and Taiwan) are resource-poor, and rely on energy imports for over 90% of their energy requirements. Japan's dominance is partly due to plant design specifications and traditional behaviour of utilising higher energy coals, together with historical equity positions in NSW coal assets held by various Japanese entities.

China became a net importer of thermal coal in 2009, and is the largest thermal coal importer globally, yet imports are only a small portion of their overall coal consumption.

Further details of government policy and drivers of thermal coal imports for each of these countries is outlined in section 3, along with country import estimates.

In 2018 NSW also exported 21.2Mt of metallurgical coal, accounting for 12% of Australia's metallurgical coal exports (178.2Mt). In terms of key markets, Japan, Korea, Taiwan and India accounted for 82% of 2018 NSW metallurgical coal exports as charted below.



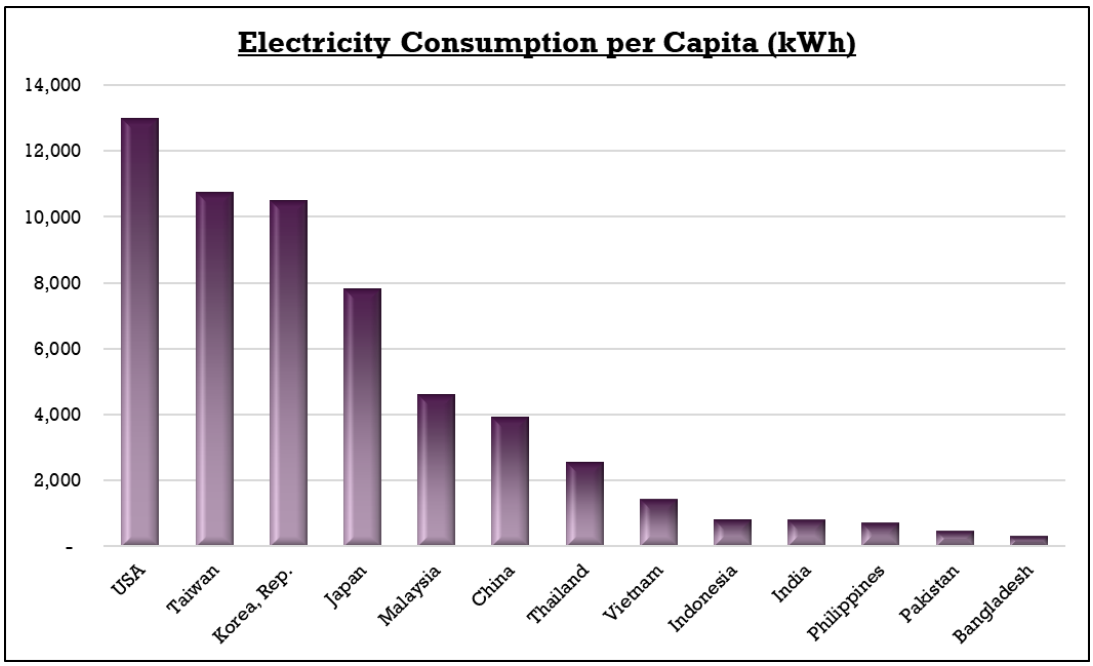
Source: Commodity Insights

Japan is by far the largest importer of NSW metallurgical coal, accounting for 7Mt or 31% of total NSW metallurgical coal exports in 2018 (down from 41% in 2017), followed by India (20%), Taiwan (15%) and Korea (15%). Vietnam was the next largest importer of NSW metallurgical coal with 7%.

3. Seaborne Thermal Coal Demand Forecast

3.1. Asian Electricity Demand

Asia holds around half the world's population (and a significant proportion of forecast population growth according to the United Nations), and has generally low levels of electricity consumption, except for Japan, Korea and Taiwan. Even Japan's level of consumption, around 8,000kWh per capita, is still only around 60% of the level of consumption in the United States, around 13,000kWh per capita (see chart below).



Source: International Energy Agency

The developing regions of Asia, including China, India, Thailand, Vietnam, Indonesia, the Philippines, Pakistan and Bangladesh, all have low-to-average levels of electricity consumption, with the most developed of these – China – only having a consumption level half of Japan's and a third of the USA's. India's per capita consumption level is only one-tenth of Japan's, and Bangladesh's is less than one-twentieth of Japan's!

Along with their substantial populations (Asia contains 8 of the world's 15 most populous nations, including the two behemoths of China and India), these relatively low consumption levels indicate there is massive latent demand for electricity across Asia. For all Asian nations to reach a Japanese level of consumption, massive investment in power generation capacity will be required. While the timeframe of development and growth will vary by country, the latent demand potential for electricity generation in Asia is massive, and while it will be met by a range of fuel types, there is little doubt that coal will provide a key part of the generation mix across Asia as its economic development continues. Indeed, many of the government policies discussed in this paper recognise the importance of coal to the generation mix.

3.2. China

China has been the world's largest thermal coal importer since 2011 when it overtook Japan. Imports were 207Mt in 2018, over 45Mt more than India, the next largest importer. China's thermal coal imports grew rapidly from 2006 (11Mt) before peaking in 2013 (212Mt) and driving seaborne prices up strongly as a result. A slump in imports followed from 2013 to 2015, when levels dropped to 131Mt before recovering strongly in 2016 to 170Mt, as charted below.

Source: Commodity Insights

China's imports are relatively volatile, due to imports being a small proportion of overall consumption (5% in 2017). However, when domestic production is unable to keep pace with demand or domestic prices rise, the market quickly switches to coal imports. That said, the government occasionally imposes import restrictions to balance the domestic market.

Energy and Emissions Policy

In March 2016, China released its 13th Five-Year Plan for Economic and Social Development (2016-20). This was followed in November 2016 by the 13th Five-Year Plan to control greenhouse gas emissions, which reiterated the key climate goal for China: to peak its CO2 emissions by 2030 and make best efforts to peak earlier. Between them, to achieve the key climate goal, the plans have a set of climate and energy targets, including the following:

- A reduction in energy consumption per unit of GDP of 15% between 2015 and 2020.
- A reduction in carbon dioxide emissions per unit of GDP of 18% between 2015 and 2020.
- Increase non-fossil fuels contribution to primary energy consumption to 15% by 2020, up from 12% in 2015.
- A reduction in coal's share of power generation from 64% in 2015 to 58% in 2020.

The 13th Five-Year Plan for Energy was released in January 2017 by the National Energy Administration and confirmed the goals above in relation to coal.

In 2018 coal accounted for just over 64% of all power generation in China followed by hydro (17%), renewables (9%), nuclear (4%), gas (3%) and other thermal.

The 14th Five-Year Plan (2021-2025) is set for endorsement by the National People's Congress in March 2021.

Forecast

Commodity Insights has estimated China's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

China	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	7,092	7,727	8,985	9,766	10,658	11,387

Source: Commodity Insights.

China has significant plans for additional coal-fired generation capacity (circa 100GW) scheduled for construction between 2019-2023. In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2018, the actual figure of 64.1% has been applied.
- For 2019-2020, the share of coal in the generation mix has been gradually reduced (factoring in the new generation capacity) to the government target of 58% in 2020.
- From 2021-2040, coal's contribution to the electricity mix has been gradually reduced to 40%. This is consistent with the IEA World Energy Outlook 2018, New Policies Scenario.

In recent years, Chinese thermal coal imports have been influenced by government intervention, with various coal quality and port restrictions being imposed, particularly towards the end of the year. In 2019, the government has (again) stated a desire that overall coal imports into China should not exceed the level of 2018. Despite this, thermal coal imports have still risen in 2016, 2017 and 2018, and year-to-date figures for 2019 indicate another small rise.

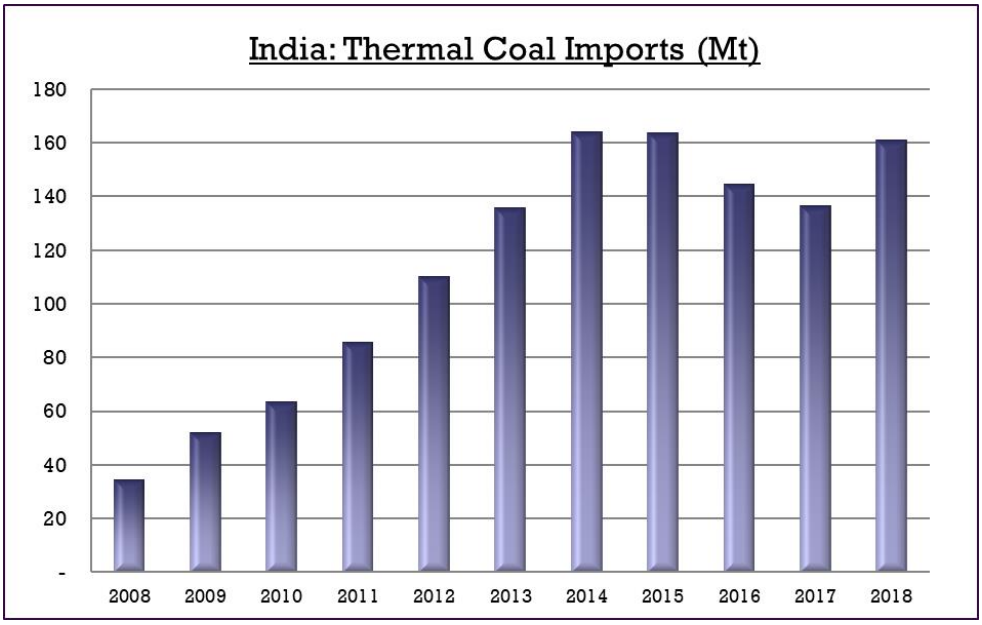
The import estimate below takes the recent government stance into account, and caps thermal coal imports into China at 200Mt across the period, slightly lower than the actual 207Mt imported in 2018. Government policy aside, imports have increased every year over the last decade except 2014 and 2015, so the forecast could be viewed as conservative, particularly if government policy is relaxed.

China	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	207	200	200	200	200	200

Source: Commodity Insights.

3.3. India

India's thermal coal imports grew rapidly from 34Mt in 2008 to 164Mt in 2014, driven by new coal-fired generation capacity and the inability of domestic supply to meet demand growth. India briefly became the world's largest importer of thermal coal in 2015 before China overtook it in 2016. India was the 2nd largest importer of thermal coal in 2018, following a recovery from reduced import volumes in 2016-2017.



Source: Commodity Insights

India is a very price-sensitive market for thermal coal imports. Due to this, and the fact that Indian power generators have historically used low energy coal supplied domestically, Indian importers tend to generally import low energy coals from the seaborne market.

Energy and Emissions Policy

India is heavily reliant on coal-fired power generation, which accounted for over 74% of electricity generated in 2018, followed by hydro (9.6%) and renewables (9.3%), with the remainder from gas and nuclear.

India's Central Electricity Authority (CEA) released a National Electricity Plan for Generation in January 2018. While this document does not provide targets for the electricity generation mix, it does provide insights to the new capacity being developed in India:

- It does expect that from 2017-22 some 47,855MW of new coal-fired capacity will be added to the Indian grid, with a further 46,420MW from 2022-27.
- India also plans significant investment in renewable energy. The Indian government has set an installed capacity target of 175,000MW of renewable sources by 2022, consisting of 100,000MW of solar, 60,000MW of wind, 10,000MW of biomass and 5,000MW from small hydro. This will bring the installed capacity of renewables to around 33% of the entire installed capacity by 2022.

Forecast

Commodity Insights has estimated India's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

India	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	1,643	1,846	2,467	3,276	4,321	5,653

Source: Commodity Insights.

In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2018, the actual figure of 74.7% has been applied, as reported by the Central Electricity Authority.
- From 2018-40, coal's contribution has been gradually scaled down by 0.5% per annum. This is to account for the significant investment in renewable energy capacity (noting that there is also significant coal-fired capacity being commissioned over the period).

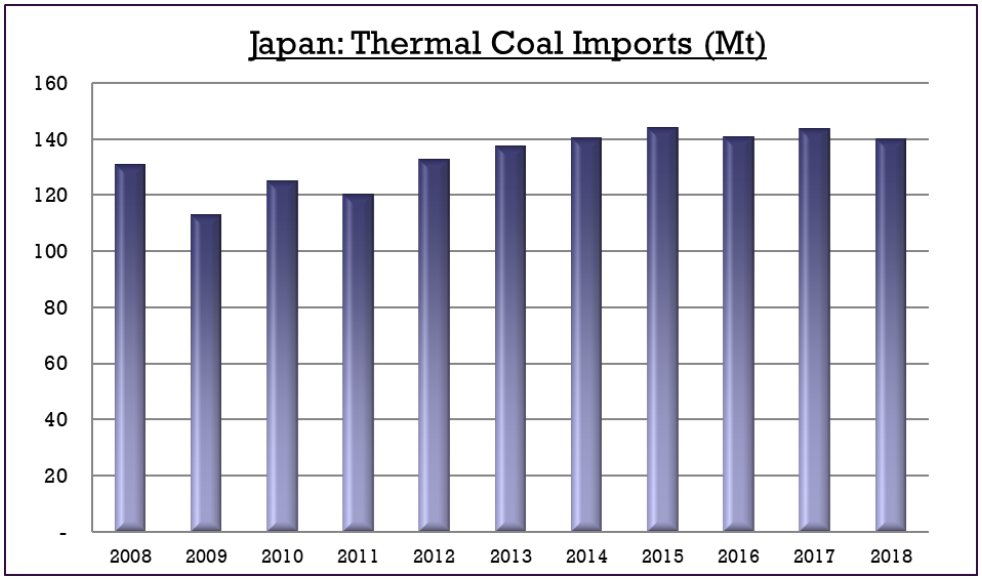
Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for India:

India	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	161	180	226	262	288	287

Source: Commodity Insights.

3.4. Japan

In 2018, Japan was the 3rd largest importer of thermal coal globally, importing 140Mt. Over the past decade, Japan's imports of thermal coal have ranged between 120-144Mt per annum, except for a GFC-induced dip in 2009. Since the Fukushima nuclear disaster in early 2011, thermal coal imports have grown strongly.



Source: Commodity Insights

Energy and Emissions Policy

In 2018, the Government of Japan released the 5th Strategic Energy Plan aimed at realising the long-term energy supply and demand outlook ("energy mix") to 2030 as announced by the Ministry of Economy, Trade and Industry (METI) in 2015. This document outlined three energy targets for Japan by 2030:

- Raise the self-sufficient energy rate from a very low 6.4% (2014) to 'about 25%'. This would be achieved through leveraging renewable and nuclear energy;
- Lower energy costs from current levels. This would be achieved through utilising nuclear and coal-fired power generation, both relatively inexpensive sources of energy;
- Set CO2 reduction targets comparable with the EU and the US, through utilising renewable and nuclear energy, optimising the efficiency of coal-fired generation, and leveraging LNG generation.

From these broad energy targets, METI has a projected 2030 energy mix of LNG 27%, coal 26%, renewables 14%, nuclear 20-22%, hydro 9% and oil 3%. However, there are several challenges for Japan in achieving these targets:

- Prior to Fukushima, Japan had 54 nuclear reactors. Since Fukushima, 21 reactors have been slated to be decommissioned. Of the remaining 33 reactors, only 9 reactors were operational as at July 2019, accounting for around 11GW of capacity. The government's target of reducing coal's share in the electricity mix to 26% is partly dependent on the realisation of the 20-22% nuclear target mix, which may be challenging given the ongoing delays to nuclear plant restarts. Accordingly, the increased use of alternate fuel sources may be required, including coal.

- Deregulation (in 2016) and retail competition in the Japanese electricity market has resulted in an additional emphasis on electricity cost, where coal has a competitive advantage in Japan. Along with uncertainty around the future of the nuclear fleet, this has resulted in a surge of investment into coal-fired power generation capacity.

Forecast

Commodity Insights has estimated Japan's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Japan	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	1,102	1,106	1,084	1,056	1,025	992

Source: Commodity Insights.

Japan has considerable new coal generation capacity additions (circa 10GW) currently under construction and scheduled for commissioning from 2019-2023. In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2018, the actual figure of 30.9% has been applied.
- For 2019-2030, coal's share has been gradually reduced (factoring in the new generation capacity) to the 2030 government target level of 26%.
- From 2031-2040, the coal contribution to electricity output has been retained at the 2030 government target level (26%).

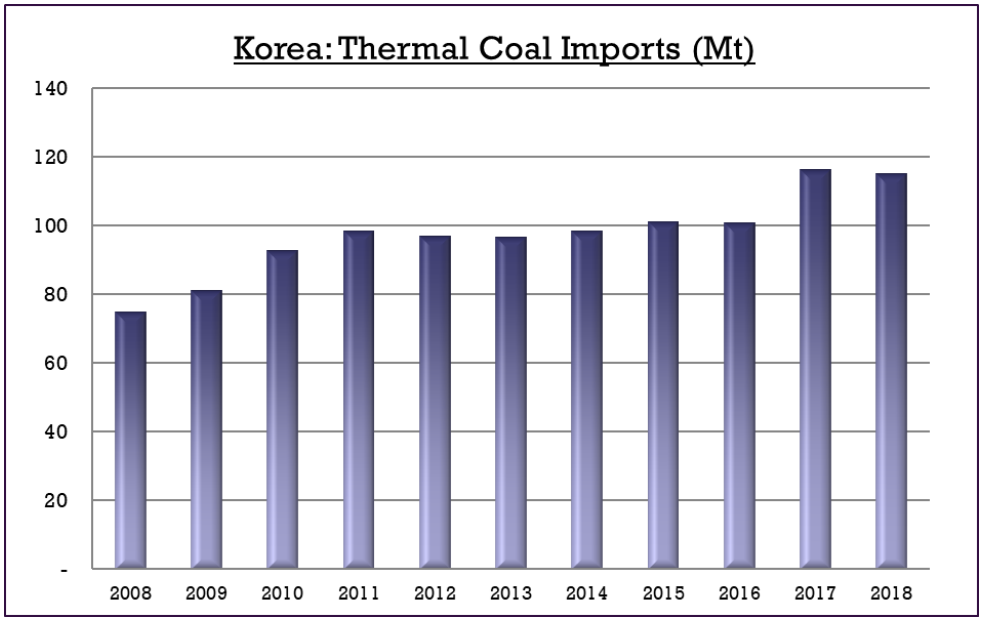
Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Japan:

Japan	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	140	140	147	134	131	127

Source: Commodity Insights.

3.5. Korea

In 2018, South Korea (Korea) was the fourth largest importer of thermal coal globally, importing 115Mt. Korean imports have grown strongly from 66Mt in 2007, driven by the addition of new coal-fired capacity. Between 2011-16, imports levelled out between 97 and 101Mt, but then jumped again in 2017 due to a surge of new coal-fired capacity.



Source: Commodity Insights

Energy and Emissions Policy

In December 2017, the Korean Ministry of Trade, Industry and Energy (MOTIE) released a Draft of the 8th Basic Plan for Long-term Electricity Supply and Demand. Under this plan the government is targeting the stable and economic supply of electricity together with reduced fine dust pollution through establishing a more balanced electricity generation mix by 2030.

This plan is to be accomplished through a greater share of generation from renewables and a shift in consumption tax reducing cost effectiveness away from coal and towards LNG. Electricity generation from renewables is targeting 20% in 2030 (up from 5% in 2017), together with a lower share from coal (36% versus 43% in 2017) and slightly lower shares from nuclear (23.9% due to safety concerns around nuclear generation) and LNG (18.8%).

Between 2017 and 2030, the installed capacity of renewables (predominantly solar and wind) is planned to increase to 58.5 GW (from 11.3 GW). Installed LNG plant capacity is to expand to 47.5 GW (from 37.4 GW), and coal-fired capacity to increase to 39.9 GW (from 36.8 GW). Installed capacity of nuclear power generation would contract to 20.4 GW from 22.5 GW.

The 9th Basic Plan for Long-term Electricity Supply and Demand was not released at the time of writing.

Forecast

Commodity Insights has estimated Korea's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Korea	2017	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	553	581	627	673	718	760

Source: Commodity Insights.

Korea has around 5GW of new coal fired generation capacity scheduled for commissioning from 2019-2023. In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2017, the actual figure of 43.1% is applied.
- From 2017-2030, coal's share in the generation mix has been gradually reduced (factoring in the new generation capacity) to the 2030 government target level of 36%.
- From 2031-2040, the coal contribution to electricity output has been retained at the 2030 government target level (36%).

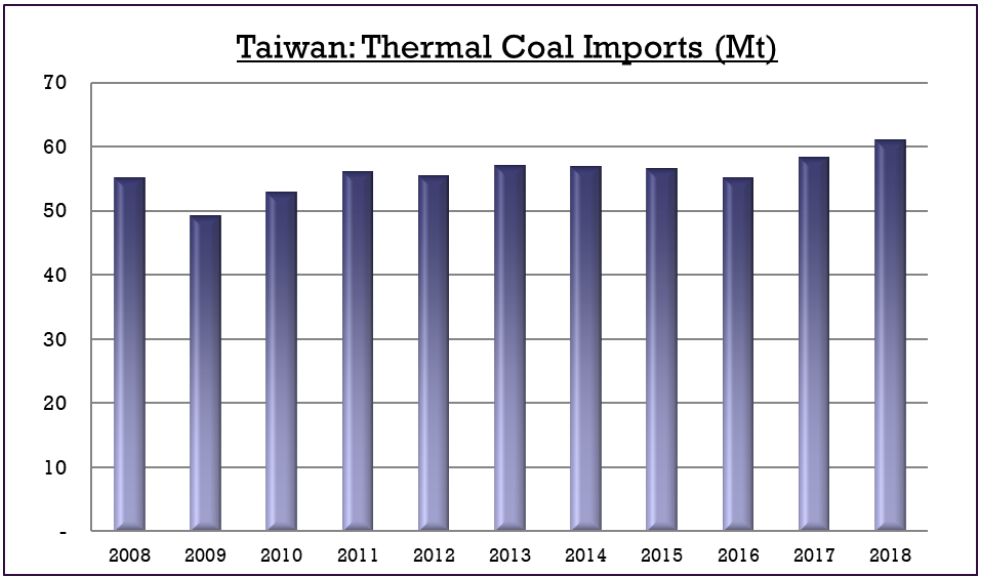
Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Korea:

Korea	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	115	116	125	125	133	140

Source: Commodity Insights.

3.6. Taiwan

In 2018, Taiwan was the fifth largest importer of thermal coal globally, importing an estimated 61Mt. Over the past 10 years, Taiwanese imports have ranged between 49-61Mt, with very little new coal-fired capacity commencing over the period until 2017-18, when the commissioning of several new units resulted in a jump in thermal coal imports.



Source: Commodity Insights

Energy and Emissions Policy

In 2018, the Bureau of Energy and Ministry of Economic Affairs announced three key policy outcomes underpinning development of the electricity sector as 1) nuclear free, 2) stable power supply and 3) reduced pollution. Accomplishment of these will involve the increased use of HELE equipment, renewable generation and LNG generation.

Also, in 2018, the Bureau of Energy and Ministry of Economic Affairs announced the targeted 2025 electricity generation mix of renewables 20% (from 4% in 2017), LNG 50% (from 34% in 2017), coal 30% (from 46% in 2017) and nuclear down to zero generation by 2025.

Forecast

Commodity Insights has estimated Taiwan's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Taiwan	2017	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	276	287	317	334	350	363

Source: Commodity Insights.

Taiwan has minimal coal generation capacity additions (800 MW) scheduled for commissioning from 2019-2023, with the emphasis for new generation capacity focused on LNG and renewables. In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2017, the actual figure of 46.6% was applied.
- From 2017-2025 the share of coal in the generation mix has been gradually reduced (factoring in the new generation capacity) to the 2030 government target level of 30%.
- From 2026-2040, the coal contribution to electricity output has been retained at the 2030 government target level (30%).

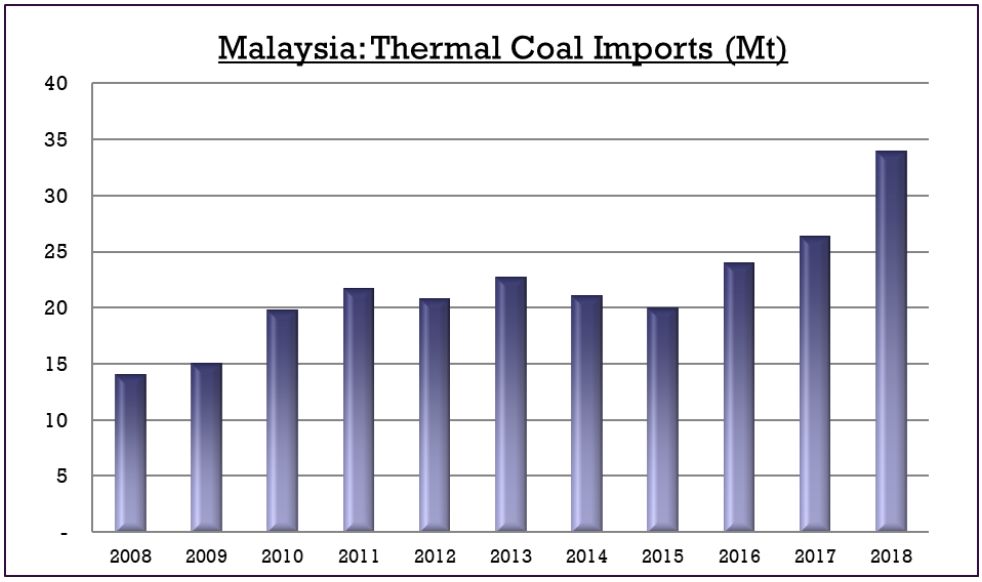
Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Taiwan:

Taiwan	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	61	63	59	61	63	65

Source: Commodity Insights.

3.7. Malaysia

In 2018, Malaysia imported an estimated 34Mt of thermal coal. Since 2010, Malaysian imports have grown steadily from 20Mt, due to new coal-fired capacity being commissioned.



Source: Commodity Insights

Energy and Emissions Policy

The Malaysia Electricity Supply Outlook 2017 was published by the Energy Commission of Malaysia. This document includes clear projections of generation mix for Malaysia out to 2026, including:

- A reduced dependency on natural gas, primarily due to the retirement of gas plants, will result in the gas share of generation falling from 41% in 2016 to 32% in 2026.
- Renewables will double their generation share from 2% in 2016 to 4% in 2026. Hydro will remain steady at 5%.
- The target for coal rises from 53% in 2016 to 56% in 2026, peaking at 57% from 2018-23 inclusive.

Forecast

Commodity Insights has estimated Malaysia's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Malaysia	2017	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	166	178	217	251	281	313

Source: Commodity Insights.

Malaysia has 2GW of coal generation capacity additions scheduled for commissioning from 2019-2023. This compares to almost 5GW of gas fired capacity over the same period and 0.9GW of hydro.

In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2016, the actual figure of 53% is applied.
- From 2017-26, the target figures from TNEB's Malaysia Electricity Supply 2017 are applied, which results in coal's share increasing to 57% in 2018 and ending the forecast period (2026) on 56%.
- From 2027 to 2040, coal's contribution is held at the 2026 level of 56%.

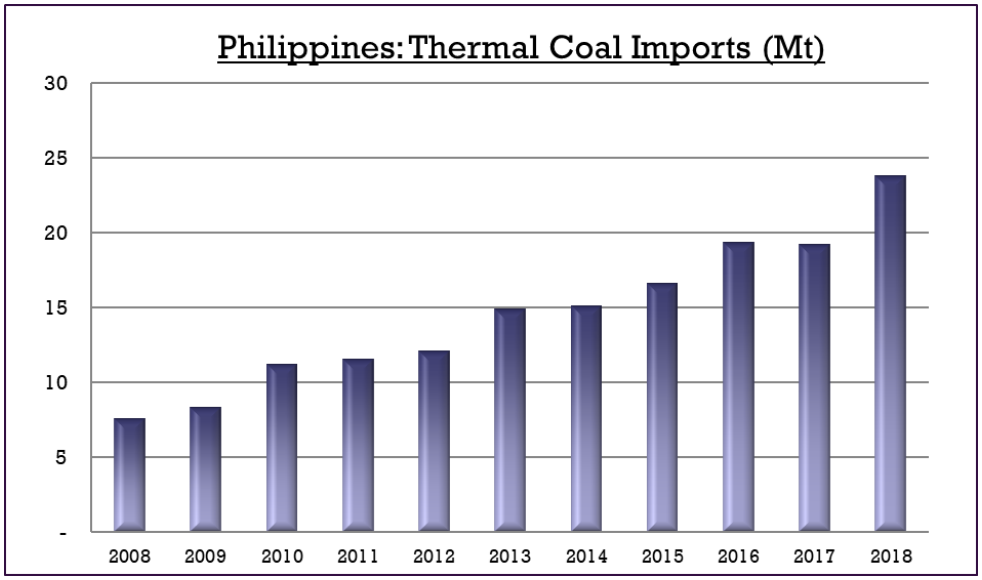
Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Malaysia:

Malaysia	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	34	40	43	50	53	58

Source: Commodity Insights.

3.8. Philippines

The Philippines imported an estimated 24Mt of thermal coal in 2018, having more than doubled from 8Mt in 2008.



Source: Commodity Insights

Energy and Emissions Policy

The Philippines Energy Plan 2017-40, developed by the Department of Energy, was released in 2017 and is focused on ensuring energy security. This document supports the Transmission Development Plan 2016-40, which is developed by the National Grid Corporation of the Philippines (NGCP) and includes the following targets for installed capacity mix:

- Coal's share of the capacity mix (not the same as power generation mix) is expected to rise from 35% in 2016 to 43% in 2030.
- Also expected to increase their share of installed capacity are solar (from 3% to 7%) and wind (2% to 6%). At the same time, the share of installed capacity will fall for natural gas (16% to 14%), geothermal (9% to 4%) and diesel/oil (17% to 9%).
- The power generation mix forecast for 2040 is coal 48.6%, natural gas 21%, geothermal 13.8%, hydro 10.2%, other renewables 3.6%, oil 2.9%.

Forecast

Commodity Insights has estimated the Philippine's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Philippines	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	100	113	153	208	279	371

Source: Commodity Insights.

The Philippines has approximately 9GW of coal generation capacity additions currently under construction and scheduled for commissioning from 2019-2023.

In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2018, the actual figure of 58.1% is applied.
- From 2019-2040 the share of coal in the generation mix has been gradually reduced (factoring in the new generation capacity) to the 2040 government forecast level of 48.6%.

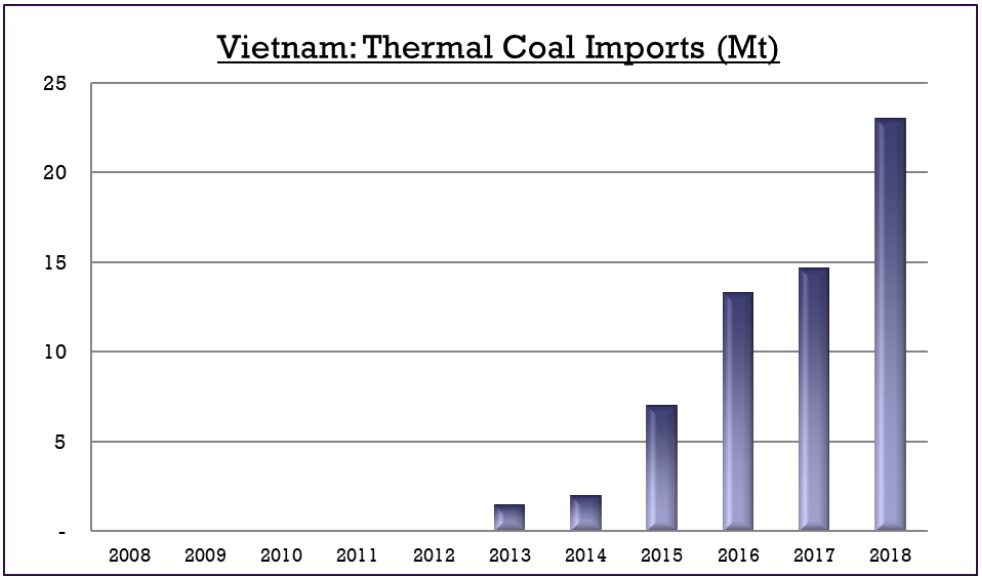
Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for the Philippines:

Philippines	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	24	27	45	57	71	90

Source: Commodity Insights.

3.9. Vietnam

Vietnam is a relative newcomer as an importer of seaborne thermal coal, with its first cargoes delivered in 2013. Since then imports have grown rapidly to 15Mt in 2017 and 23Mt in 2018 as shown below.



Source: Commodity Insights

Energy and Emissions Policy

Energy policy in Vietnam is driven by the Revised Power Development Plan version 7, which was issued by the Ministry of Industry and Trade in March 2016. The plan is quite prescriptive in terms of the targeted generation mix, including the following targets for coal-fired generation:

- By 2020, to reach 49% of total power generation.
- By 2025, coal is forecast to reach 55% of total power generation, which will then ease slightly to 53% by 2030.

The PDP7 (revised) also forecasts thermal coal imports for Vietnam to reach 102Mt by 2030.

Forecast

Commodity Insights has estimated Vietnam's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Vietnam	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	209	248	379	574	860	1,114

Source: Commodity Insights.

Vietnam has over 15GW of planned new coal generation capacity additions scheduled for commissioning from 2019-2023, which is the largest coal-fired generation capacity development of all the countries covered in this report outside China and India.

In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2016, the actual figure of 36% is applied.
- For the remainder of the forecast period, the targets from the revised Power Development Plan 7 are applied (i.e. 49.3% by 2020, 55% by 2025 and 53.2% by 2030). Beyond 2030, the ratio for 2030 (53.2%) is applied.

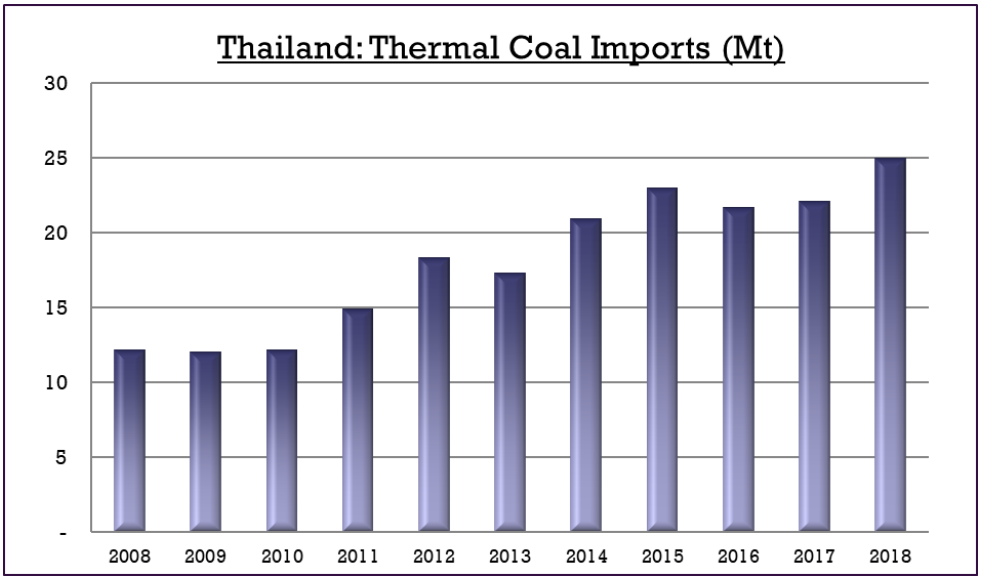
Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Vietnam:

Vietnam	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	23	38	80	100	131	158

Source: Commodity Insights.

3.10. Thailand

Thailand's imports of thermal coal have more than doubled in the last decade from 12Mt in 2008 to 25Mt in 2018, as shown below.



Source: Commodity Insights

Energy and Emissions Policy

In April 2019 the Thai Ministry of Energy published the Thailand Power Development Plan 2018-37, also known as PDP2018. Supporting headline goals around energy security, economy and ecology, the plan also outlined estimated targets for power generation for 2037. These are as follows:

- An additional 56GW of generation capacity to be added to the grid, taking total generation capacity to 77GW by 2037
- Gas is forecast to account for 53% of power generation in 2037, up from the previous plan of 37% in 2036.
- Coal is forecast to account for 12% of power generation in 2037, down from the previous plan of 23% in 2036.
- Renewables will account for 20% (same as the prior plan), imported hydro power 9% (down from 15%) and nuclear will be zero (down from 5%).

Forecast

Commodity Insights has estimated Thailand's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Thailand	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	189	212	283	358	433	520

Source: Commodity Insights.

Thailand has 1800MW of planned new coal generation capacity additions currently under construction and scheduled for commissioning from 2019-2023.

In terms of coal's share of electricity generation, the following assumptions have been made:

- For the base year of 2018, the actual figure of 17.5% was applied.
- From 2018-2037, a steady reduction is applied to the 2037 government target of 12%.
- From 2037 to 2040, coal's contribution is held at the 2037 level of 12%.

Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Thailand:

Thailand	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	25	25	27	31	34	39

Source: Commodity Insights.

3.11. Pakistan

Pakistan is a relative newcomer as an importer of seaborne thermal coal, and in 2018 imported 14Mt, up from 6Mt in 2016. Coal supply to Pakistan is predominantly from South Africa and Indonesia due to geographic proximity.

Energy and Emissions Policy

Details regarding the energy and emissions policies in Pakistan are not particularly transparent, however, the Pakistan Vision 2025 includes goals to increase electricity generation capacity by 25,000 MW by 2025. As of June 2017, coal accounted for 3% of the installed generation mix with plans to increase this to 19.5% by June 2025.

Pakistan has 4.3GW of planned new coal generation capacity additions currently under construction and scheduled for commissioning from 2019-2023.

Forecast

Commodity Insights has estimated Pakistan's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Pakistan	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	146	182	283	451	706	1,057

Source: Commodity Insights.

Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Pakistan:

Pakistan	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	14	19	29	40	54	74

Source: Commodity Insights.

3.12. Bangladesh

Bangladesh is also a relative newcomer to thermal coal imports, and imported 2Mt of thermal coal in 2018. Coal supply to Bangladesh is predominantly from Indonesia due to geographic proximity.

Energy and Emissions Policy

Details regarding the energy and emissions policies of Bangladesh are not particularly transparent, however, the Power System Master Plan 2016 vision to 2041 includes a target of 35% of power generation from coal (up from around 3% at present).

Bangladesh has 5.6GW of planned new coal generation capacity additions currently under construction and scheduled for commissioning from 2019-2023.

Forecast

Commodity Insights has estimated Bangladesh's electricity generation growth to 2040 (tabled below), based on population growth forecasts from the United Nations and per capita electricity consumption forecasts.

Bangladesh	2018	2020f	2025f	2030f	2035f	2040f
Electricity Generation (TWh)	64	76	121	182	263	377

Source: Commodity Insights.

Combining the government's projected energy mix with the electricity generation forecast results in the following thermal coal import forecast for Bangladesh:

Bangladesh	2018	2020f	2025f	2030f	2035f	2040f
Thermal Coal Imports (Mt)	2	8	25	44	53	63

Source: Commodity Insights.

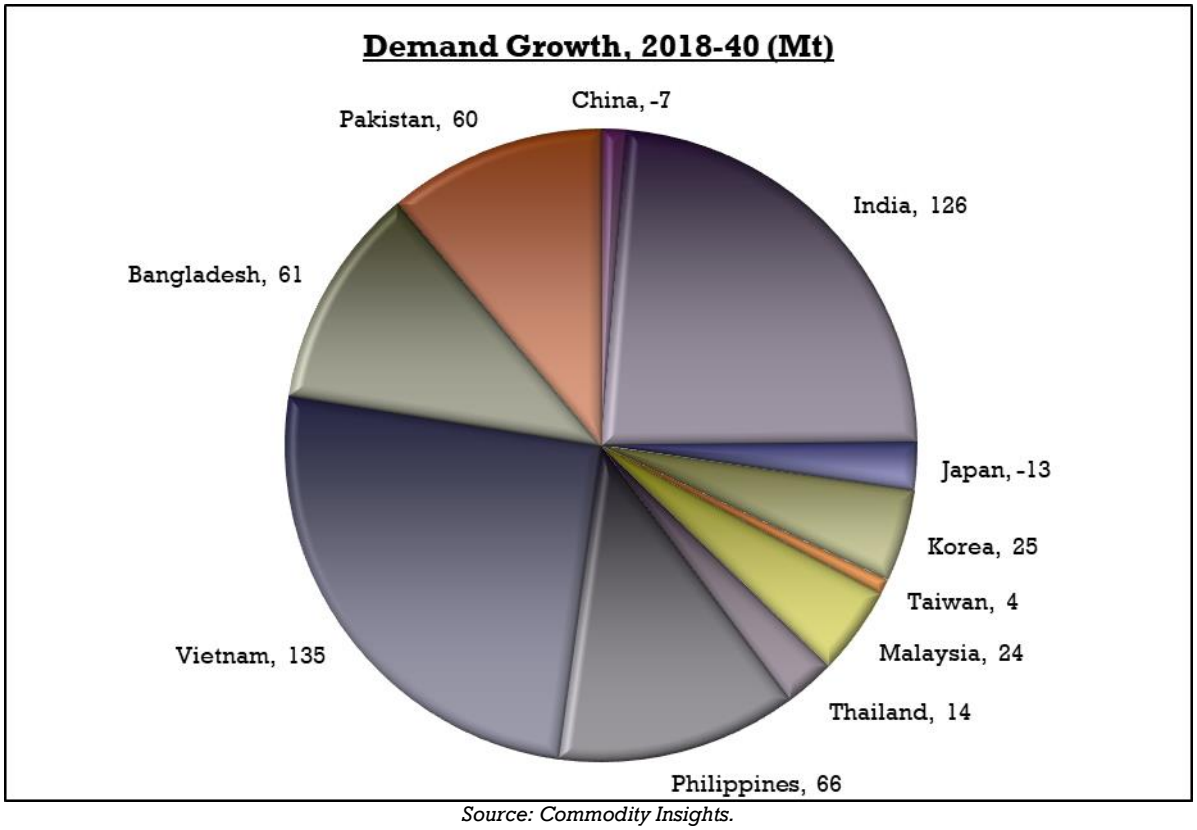
3.13. Demand Summary

Based on the government energy policies across Asia and the resulting estimates in the preceding sections, the overall forecast of Asian thermal coal import demand is tabled below. Imports are expected to grow by almost 500Mt from 2018 to 2040, a CAGR of 2.3% (which is below historical levels). This represents annual growth of around 23 Mt, which compares to annual growth of around 37Mt from 2007-17.

Country (Imports Mt)	2018	2020f	2025f	2030f	2035f	2040f	Growth
China	207	200	200	200	200	200	(7)
India	161	180	226	262	288	287	126
Japan	140	140	147	134	131	127	(13)
Korea	115	116	125	125	133	140	25
Taiwan	61	63	59	61	63	65	4
Malaysia	34	40	43	50	53	58	24
Philippines	24	27	45	57	71	90	66
Vietnam	23	38	80	100	131	158	135
Thailand	25	25	27	31	34	39	14
Pakistan	14	19	29	40	54	74	60
Bangladesh	2	8	25	44	53	63	61
Total	**806**	**856**	**1,006**	**1,104**	**1,211**	**1,301**	**495**

Source: Commodity Insights.

Importantly, the import growth is not reliant on one or two importing countries but is rather widely spread across Asia, as charted below.



Source: Commodity Insights.

The demand growth profile presented in this report is a potentially significant opportunity for New South Wales thermal coal exporters. Even half the growth estimated (circa 250Mt) is still substantial and significantly more than total Australian thermal coal exports in 2018 (207Mt). The growth opportunities may be greater if Indonesian exports slow or decline due to domestic demand pressures, which would further widen the demand-supply gap in Asia.

New South Wales thermal coal is already very well positioned into the Asian seaborne market for the following reasons:

- Coal quality and end user design dependency.
- End user mine equity.
- Take or pay contracts.
- Industry infrastructure ownership/control.
- Key off-take market stability.
- Geographic proximity

New South Wales thermal coal export supply is also very stable and dependable, regardless of the state of the market (unlike Indonesia, for example, which can experience large fluctuations in supply volumes based on market prices), which is very important for customers in the power sector who need long-term, stable supplies of thermal coal.

4. Appendix A – Government Energy Policy Documents

The following documents were utilised in this report to assist in estimating coal's share of power generation for each country across the forecast period.

Country	Document	Release Date
China	13th Five-Year Plan for Economic and Social Development (2016-20)	2016
India	National Electricity Plan for Generation	2018
Japan	5th Strategic Energy Plan	2018
Korea	8th Basic Plan for Long-term Electricity Supply and Demand (Draft)	2017
Taiwan	General announcements by the Bureau of Energy and Ministry of Economic Affairs	2018
Malaysia	Malaysia Electricity Supply Outlook 2017	2017
Philippines	Philippines Energy Plan 2017-40	2017
Vietnam	Revised Power Development Plan version 7	2016
Thailand	Thailand Power Development Plan 2018-37	2019
Pakistan	Pakistan Vision 2025	2014
Bangladesh	Power System Master Plan 2016 vision to 2041	2016

5. Appendix B – Commodity Insights' Forecasts

In June 2018, Commodity Insights published a report for the Minerals Council of Australia, titled Market Demand Study: Australian Export Thermal Coal. The report was made publicly available. It forecast Asian demand growth for thermal coal imports between 2017 and 2030, estimating growth of 407Mt over the period, which equates to approximately 31Mt of growth per annum on average.

This report attracted criticism from some quarters and was derided for being too optimistic in its outlook (i.e. demand forecasts were too high).

However, data is now available for the first year of the forecast in the MCA report (2018) and it shows over 60Mt of Asian thermal coal import growth. Year-to-date growth in 2019 is also up, increasing 4% which annualises to over 30Mt for 2020.

While acknowledging that demand growth is not a linear process, on current observations the forecasts were not only directionally correct (i.e. demand is growing), but if anything, they may be conservative in terms of volumes.

The forecast in this NSWMC report applies the same methodology for forecasting Asian thermal coal import demand as was utilised in the MCA report.

Attachments included with submission

NSW Minerals Strategy, Department of Planning and Environment, February 2019