Fossil economy

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Published by Beyond Zero Emissions
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First edition November 2014

This document can be downloaded from http://bze.org.au/

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Key findings

Emissions-intensive export revenue will fall short by $100 billion per year by 2030 due to emission reduction efforts by Australia's trade partners.

The Australian Government has projected coal, gas and iron ore exports to grow steadily over the coming decades. Projections by the Bureau for Resources, Energy and Economics (BREE) have failed to consider the impacts of climate change mitigation efforts by other nations expected to consume those exports.

The International Energy Agency has very different projections to the Australian Government.

BREE's most recent projections are significantly higher than the IEAs 'central' New Policy Scenario, and wildly different to the climate mitigation 450 parts per million scenario.

Emissions-intensive commodities account for 44 per cent of all export revenue. Just four countries imports 92 per cent of these commodities.

Australia's export revenue is highly concentrated to China, India, Japan and South Korea. These countries have recently either initiated or announced policies to shift away from fossil fuels, and promoting clean energy and energy efficiency in their countries.

Current energy policy would result in Australia being the source of 16 per cent of the global carbon budget by 2050, up from 4 per cent today.

Exported emissions will increase from 130 per cent of domestic emissions currently to 350 per cent by 2050. Australia cannot continue to increase fossil fuel production unimpeded in a global economy that is reducing fossil fuel use.

Australia will need to decouple from emissions-intensive exports to ensure a stable and prosperous economy in the future.

Australia is at risk of its economy being left behind, our prosperity being a relic of the past – fossilised – as the rest of the world moves to a cleaner future.

Executive summary

The world's major economies, including Australia's key trading partners, are shifting away from fossil fuels to less emission intensive economies. Despite this, Australia continues to develop economic and energy policies that are reliant on increasing fossil fuel exports, and increasing pollution.

Since 2008, the International Energy Agency (IEA) has produced energy projections in-line with the two degree warming limit. The so-called 450ppm scenario projections are updated annually, and highlight the impact of emission reductions on the energy system - the major source of warming emissions. The impact on Australia's emissions-intensive resources is dramatic.

Findings from the IEA 450ppm scenario indicate a shortfall in coal, gas and iron ore export revenue of AU$100 billion per year by 2030 compared with the expectations of the Australian Government; a reduction of almost half.

Australia's current energy policy, the 2012 Energy White Paper, projects coal and gas production will continue to rise to 2050 (the end of the projection period). This would make Australia the source of 16 per cent of the global emissions budget in that year, up from four per cent today. For contrast, Australia is 2 percent of global GDP and just 0.3 per cent of the global population.

With coal, gas and iron ore currently accounting for 44 per cent of export revenue, Australia is highly vulnerable to global climate action to reduce emissions. Heightening this issue is the concentration of these exports (92 per cent) with just four countries: China, Japan, South Korea and India. The prospects of Australia's export income hinges on just four sovereign energy policies. It is not contingent on a global treaty. Each of these trade partners are introducing policies that will reduce their imports of fossil fuels.

The concern is not that Australia's trade partners are reducing coal, gas and other emissions-intensive commodities. This is imperative to limit climate change. The concern is that the Australian Government has been ignoring the impact of these reductions on our own economy, even when information has been readily available.

A broader view must be taken on energy planning with a predominant focus on the influences of climate change. Our energy policy must be consistent with international action to limiting climate change, not opposed to it.

Great expectations

The changing focus of Australia's major trade partners is challenging the familiar narrative of Australia's economic and resource planners. A long period of high demand for Australia's emission-intensive resources was tipped to boost the country's fortunes for decades. The so called 'super-cycle' was different to all other booms, in that the bust that accompanied all previous booms was so far into the future that there was no need to be concerned about it. The emergence of China, India and other large but developing countries was to be bigger and more durable than all previous events.

The development of China and other emerging economies still has a long way to go before they reach the standard of living of developed nations. Despite this, the expectation of ongoing demand for Australia's emission-intensive resources is in doubt. Real world feedbacks are leading

emerging economies to change their approach to development, departing from the post-war model which in the past has well served the world's advanced economies.

The possibility of a downturn has not been considered by the Australian Government's resource planners, let alone the probability of a structural shift in the economy from which we may not recover. The same planners have assumed that Australia's combined domestic and exported emissions can increase from 4% of annual global emissions to 16% of the annual budget recommended by the International Panel on Climate Change by 2050, a position that will be unacceptable to the international community. This narrow field of view provides no opportunity to consider the impact of different outcomes; obscuring the need for a more balanced economic strategy that takes account of the risks and changes that lie ahead.

Despite clear signals of change emerging from the our trading partners expected to drive Australia's 'super-cycle' — China, Japan, South Korea and India — the Australian Government continues to adhere to its original script. Far from being the responsible economic managers the current government claims to be, this 'more of the same' attitude presents an avoidable risk to the stability of the Australian economy.

By continuing to focus on emission intensive resources, industries we will need in the future are being weakened.

Divergent possibilities for emission intensive exports

In order to capture the effect of the changes being signalled by Australia's major trade partners, Beyond Zero Emissions has evaluated recent economic projections from the Bureau of Resources and Energy Economics (BREE), which guide the Australian Government. We compared these with two projection scenarios from the International Energy Agency (IEA). This comparison identifies a significant divergence in anticipated demand for the emission intensive commodities considered, namely gas, thermal and metallurgical coal, as well iron ore as it relates to the emissions intensive process of steel making. We have constructed three trajectory cases (Figure 1) which generally correspond to the reference source projections:

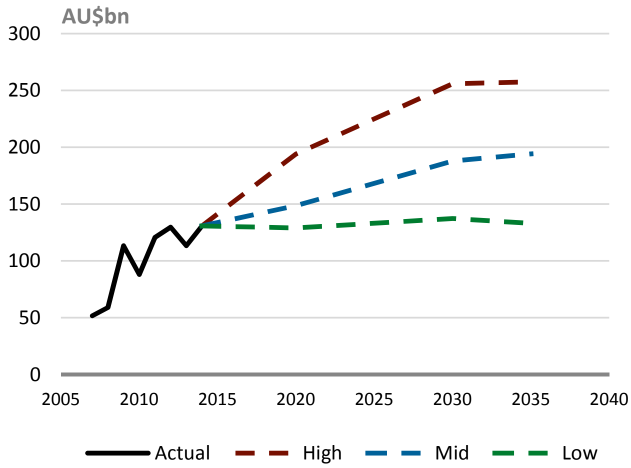
The **high trajectory case** typically corresponds to estimates from BREE and Treasury reference material. This trajectory best reflects the expectations of Australian policy makers.

This **mid trajectory case** most closely reflects the IEA New Policy Scenario, projecting the energy system effects of contemporary policies. This has been augmented with alternative pricing information to account for the effect of over-capacity (which has already eventuated).

The **low trajectory case** generally corresponds to the IEA 450ppm scenario; a projection indicating the effects of meaningful climate change mitigation efforts. This also applies alternative pricing values where appropriate.

We find that the divergence in demand between the high- and low-trajectory cases amounts to shortfalls in gross annual export revenue of $65 billion in 2020 and $120 billion in 2030 (Figure 1).

FIGURE 1 **Comparison of total gross revenue for each trajectory case**



The shortfall associated with the mid-trajectory case is approximately half of this. In terms of net national income, and accounting for foreign claims on export profits, the divergent trend is maintained, though the magnitudes are reduced by approximately 25 per cent.

The commodity most impacted in this comparison is thermal coal. In the low trajectory case, Australian thermal coal exports are expected to decline to one quarter of current export volumes.

The situation for gas exports is less certain. Despite a large variation in projected exports of gas, the opaque nature of the Asian LNG market makes it difficult to determine precisely how Australian exports will be affected. Recent LNG projects in Australia have amongst the highest break-even prices in the market. Competitive pricing will affect the profitability of these projects and erode tax and resource rent revenues.

Demand for metallurgical coal is significantly lower for the mid- and low-trajectory cases corresponding to the IEA scenarios. In the short term, metallurgical coal and iron ore are more likely to be affected by economic issues than emissions policies, resulting in lower demand for steel.

Trade partner perspectives

To gauge which trajectory case best reflects the policies and ambitions of Australia's major trade partners we have reviewed the latest targets and announcements of China, Japan, South Korea and India. Each of these nations is exploring new ways to satisfy their energy needs. The factors driving changes in energy policy vary, but the effect is the same; namely, less demand for Australian resources.

The change in China's position is primarily driven by unacceptable levels of pollution which is negatively affecting the quality of life of its citizens. The change in Japan is primarily economic, aimed at reducing energy imports to reign in an unsustainable trade deficit. Korea is seeking to price energy such that it is more reflective of health and pollution costs. In India, the main driver is to provide the energy to support strong economic growth. This, combined with alleviation of energy poverty, requires a secure, diversified, and affordable energy system.

The policies and targets explored in this paper indicate a structural shift taking place, away from emission intensive energy sources to lower emission sources as well as renewable energy generation. Coal in particular is being targeted by taxes to dis-incentivise its use. At the same time, implementation targets for renewable energy generation are being continually ramped up. This review indicates that, over time, policies are evolving in the direction of the 450ppm scenario provided by the IEA.

Carbon catch 22

A critical problem arises from the above findings. Should Australia's exports follow the high trajectory case, the balance sheet of the country will remain stable in the near term; but the world will significantly overshoot the 2deg C goal that is considered by world leaders to be the threshold to dangerous self-reinforcing climate change. Should the world move to take serious action to avoid dangerous climate change, without Australia taking complimentary action, the local economy will be destabilised. It is not feasible to separate the liability of Australia's exported emissions from domestic concerns on climate change.

As global citizens, Australians should be heartened by effective global action to address climate change. The present structure of the economy, centralising emission intensive resource exports, undermines the enthusiasm with which we should be embracing this transition. So long as policy makers depend on these resources for fiscal recovery or otherwise, any arrangement diminishing their prospects will be met with disdain and antagonism. This is the carbon catch 22 Australians currently face with global de-carbonisation. We will be discouraged to support action in the interests of future generations because of the imperatives of today's policy makers.

Australia's economic stability need not be jeopardised by this transition. Pro-active efforts are required which de-couple the economy from emission intensive resources. Opportunities are available for Australia to achieve continued prosperity on sustainable foundations. De-carbonising economic pathways have been analysed and shown to provide ongoing employment and investment opportunities while respecting economic constraints.

Australias capacity to participate in a global shift to clean energy is being impaired by narrow and shortsighted domestic politics that will leave Australia as a fossil economy.

Australia must prepare for the global shift to clean energy, and offer its potential in one of the greatest commercial opportunities ever.

Introduction

The aim of this report is to raise awareness of the impact to be expected from alternative future developments for Australia's trade in emission intensive commodities. The commodities are gas, thermal coal and metallurgical coal as well as its companion in the dominant steel making process iron ore, though to a lesser degree. We consider a range of plausible futures modelled by different agencies with different policy contexts. The focus is the exports and revenue expected for Australia in each of these modelled circumstances. The analysis within provides visibility to the impacts on Australia's export trade from global efforts to mitigate climate change; a future that we certainly hope prevails even if it does not always feel the most likely. We hope that the findings encourage planners and policy makers to take a more holistic approach to the future development of resources as well as other sectors and provide the public with a fuller picture of future possibilities.

Since the late 1990s Australia has experienced the effects of surging global demand for resources with which our land mass is endowed. The demand driving up prices for commodities brought a doubling down of income to Australia with investors rushing in to take advantage. The course of these events is well documented and has been given credit for much of the prosperity accruing to this country since the mid-nineties[1]. The net effects will continue to be debated as the income from this 'mining boom' has not been distributed evenly and has created distortions in the economy to the disadvantage of many other industries. This will no doubt be the subject of considerable retrospective analysis as to whether the boom was well managed for the long term benefit of Australia's population.

Australia is now grappling with the distortions generated by the sudden surge of resource exports, economic reform inertia, continuing malaise from the global financial crisis, lower than expected demand for resources and increasing pressure to mitigate global warming. These forces are currently manifesting in the domestic economy as an overvalued currency, a growing current account deficit, high costs in the construction sector, meagre business investment, domestic price inflation, growing unemployment and declining affordability of housing.

While there appears to be at least recognition of these problems from the Australian Government, positive actions are slow in forthcoming and consideration of further structural pressures is being denied or ignored. It is fair to say that the recent sudden fall in value of commodities such as coal, iron ore and oil (as it pertains to Australian LNG) was not foreseen by resource planners. Approvals for new production capacity continue apace guided by forecasts indicating ever increasing demand[2]. The current turbulence is regarded as a short-term blip in demand that will ultimately return to the projected trend, justifying unimpeded expansion. The prevailing assumption being that the economies slated to consume these resources have an insatiable demand that will continue "for decades to come"[3].

Unrelenting demand is the only official guidance published by Australia's resource advisors, led by the Bureau of Resources and Energy Economics. It informs the Treasury on macro export revenue expectations, which in turn are used in forming

policies to balance the wider economy. The same guidance informs investors, recognising the commercial opportunities of this anticipated growing demand. Substantial and long lived decisions are made on the back of these forecasts. While authors acknowledge the limitations of projections and give note to influences that may change outcomes, these disclaimers fail to adequately assess the impact of alternative outcomes.

The only certainty is that projections of the future will prove to be incorrect. New developments and complex interactions are beyond the capability of even the most sophisticated model. This makes a single projection accompanied by some qualifications of very limited value. A more robust approach is to consider a spectrum of futures that can be reasonably foreseen and consider them in proportion to the likelihood that they will transpire. This strategy can be more complicated but provides a statistical range of futures to expect, giving a degree of confidence of what is most likely and also indicating the more 'fringe' possibilities; both their impact and their likelihood. We recommend that planners and policy makers take this more rigorous approach to risk assessment not only in resources development but also other sectors.

Australian energy policy

Australia's energy policy is strongly guided by projections of global energy and resource demand provided by the Bureau of Resource and Energy Economics (BREE). The 2012 BREE report, *Australian bulk commodity exports and infrastructure: Outlook to 2025*[4], has significantly underpinned Australia's most recent strategic energy policy documents, including the Federal Government's 2012 Energy White Paper (EWP)[5], as well as the 2014 Energy Green Paper recently released in preparation of a new EWP[6]. Preceding the establishment of BREE this role was filled by the Australian Bureau of Agriculture and Resource Economics and Sciences (ABARES), with projections and research dating back to the early phase of the recent mining boom.

In this most recent work BREE has used the Global Trade and Environment Model (GTEM), developed by ABARES in projecting future global energy demand, and hence demand for Australia's fossil fuel exports. GTEM models the impact of policy changes on different economic variables, including gross domestic product (GDP), prices, consumption, production, trade, investment, efficiency, competiveness and greenhouse gas emissions. Though the model does not *directly* link GHG emissions with economic output, BREE maintains that the effect of GHG emission reduction policies impact economic variables in the model through changes in production, consumption and technology choice.

BREEs 2012 projections indicate significant future demand growth for Australia's fossil fuel exports. Projections of Australia's market share of different energy commodities is provided for low, medium and high market share scenarios influenced by factors such as cost of production and competitiveness with other markets. Despite efforts to identify competition among other exporters and the risk this bears on Australia's market share, only one projection of global demand is provided as the baseline for Australia's share of trade. This single demand baseline provides no indication of the sensitivity of Australian exports which could be plausibly anticipated under conditions other than those assumed by the baseline. Some discussion is provided on the impacts of lower growth or climate change mitigation policies, however this is not quantified in any way which diminishes the value of these observations. It is indicated that the single baseline projection is in accordance with a CO_2 concentration stabilised at 550ppm by the year 2100. This corresponds to a temperature increase of 3-4°C, a significant overshoot of the internationally agreed target of 2°C (450ppm)[7].

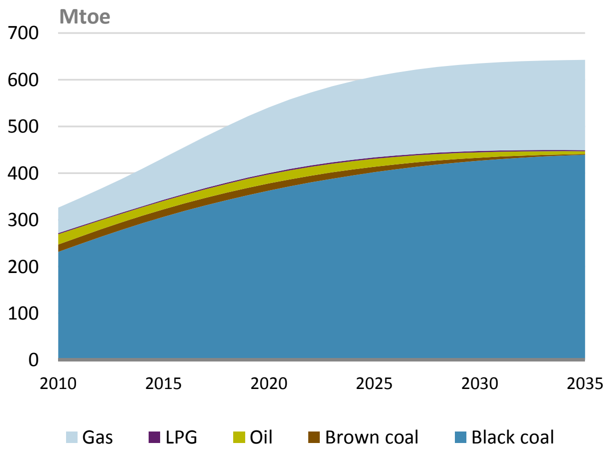
Considering the significance of emission intensive commodities in Australia's external account (48% of trade revenue), the impact of alternative growth and policy developments of trade partners should be more thoroughly explored. Today these commodities are largely depended upon to support Australia's expenditure on imports, which has risen as a result of an elevated currency value during the boom, as well as international debt and equity payments. Sudden and adverse changes in the external account can have damaging consequences on the national economy and financial system.

The general optimism for Australian fossil fuel exports suggested by BREEs 2012 projections is echoed in the strategic energy policies of the former and present federal government.

In 2012, the Federal Government released its

Energy White Paper (EWP), the central policy framework for Australia's energy and energy resource sectors. Policy arguments made in the EWP are underpinned by BREEs 2012 projections. Consequently the EWP listed the expansion of fossil fuel exports as one of its main policy goals. The government aimed to achieve this by streamlining the environmental assessment process across jurisdictions, promoting the development of offshore oil and gas resources, developing a national regulatory framework for coal seam gas (CSG), as well as enhancing the provision of (subsidise) geo-scientific information for the purposes of fossil fuel exploration and extraction. The outlook for Australian fossil energy production as per the 2012 EWP is shown in Figure 2.

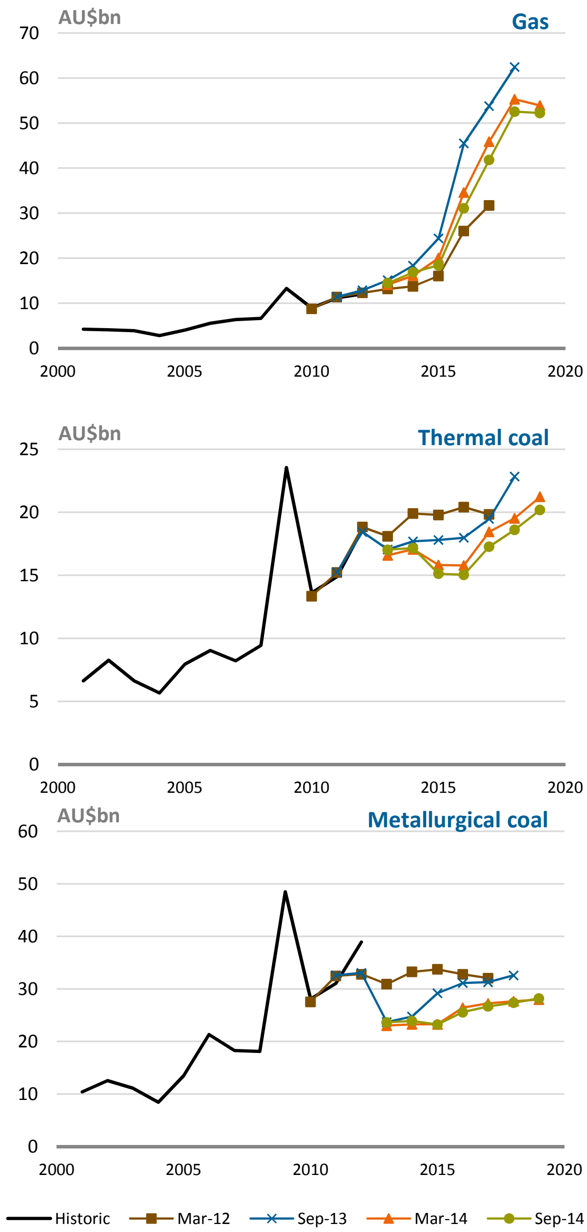
FIGURE 2 Australian Energy White Paper fossil energy production projection



A key objective of the recent Energy Green Paper (EGP) is facilitating a continued expansion of fossil energy exports, reinforcing the same strategy for the next EWP. As part of its ambitions to increase exports, the government also plans to streamline environmental assessment across jurisdictions and improve access to geo-scientific data, as well as encourage skilled migration for the resources and related sectors, address infrastructure bottlenecks and duplication, and assist small and medium sized businesses to integrate into the supply chains of energy resource projects. Indeed the major difference between 2012 EWP and the 2014 EGP is the near complete removal of climate change mitigation and renewable energy.

In 2014, BREE released a report examining the infrastructure required to cater for projected increases in demand for Australian fossil fuel exports. The report, titled *Promoting Australian prosperity: sustaining the boom with export infrastructure*, reiterates the implications of BREEs 2012 projections for fossil fuel export demand, and argues that Australia will need to double its 700 Mt of annual mineral and energy resource exports by 2025 to maintain the resources boom seen over the past decade[8]. The report highlights that the capacity of planned infrastructure projects, such as mines, gas fields, ports and railways, *exceeds* the required capacity indicated in BREEs 2012 projections out to 2025. As such, it appears that Australian exporters will be well placed to capitalise on demand if the BREE projections turn out to be accurate. If demand proves to be lower, as financial markets are increasingly suggesting, then Australian governments and industry may have to manage the financial loss associated with stranded infrastructure.

FIGURE 3 Comparison of export revenue projections from various issues of BREE Resource and Energy Quarterly for gas, thermal and metallurgical coal



Despite considerable changes within the same outlook period from serial forecasts, a singular outlook is provided at each stage to guide policy and planning. This planning formula delivers predictable results and does not allow a robust risk assessment by policy makers or other stakeholders because only one sequence of events is determined to be valid at any point in time.

Since 2011 the Australian resource sector has underperformed the official forecasts, led first by declines in the coal industry. Though the resource sector is not exclusively responsible, the deteriorating profitability of the sector has been a large contributor to taxation revenue write-downs by the Australian Treasury in successive budgets[9]. The fall in iron ore prices since early 2014 will force the government to lower its expectations yet again. Though this revenue downgrading is becoming a repetitive process for the Australian Treasury, the government continues to anticipate a return to forecasts over the mid-term and is ill prepared for a sustained drift.

In this paper we compare the latest guidance from BREE with other sources indicating export volumes, related stabilised prices and therefore revenue. The projections of the International Energy Agency (IEA) were used because the organisation is a respected source and has a thorough view of many international actors. The IEA also formulates one projection series on effective climate change mitigation in-line with the internationally agreed target of 450 parts per million (ppm) of CO2. This is the concentration of CO_2 currently understood to correspond to a 50% chance of limiting global warming to 2°C above pre-industrial levels. Once again, each projection trajectory is sure to prove somewhat inaccurate but this has an important place in setting the range of plausible outcomes to be considered in a thorough risk assessment.

Currently the impacts of substantial climate change mitigation efforts are ignored when it comes to energy policy in Australia. While climate change may be acknowledged as a disruptive factor, no serious consideration of change on the scale associated with the IEA scenario is evident. The narrow field of view guiding Australia's resource and energy policy is irresponsible. There is no visibility to the true scale of impact on this country corresponding to effective global action on climate change. Whether Australia likes it or not we will be affected by the decisions of other sovereign nations. It is out of our control. These decisions will determine the success or otherwise of the domestic resource sector. The only thing Australia can control is how prepared we are for change.

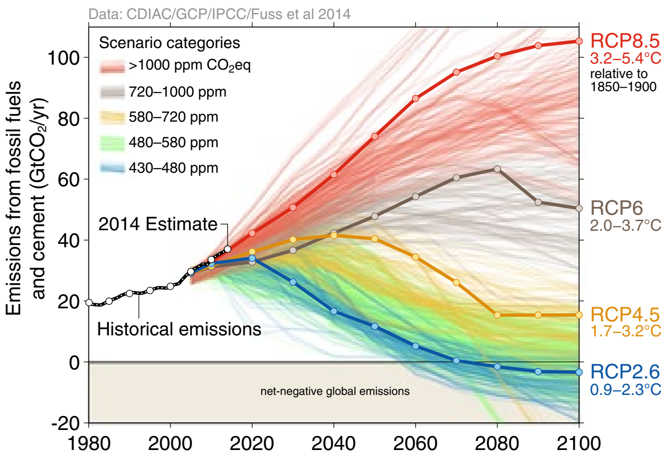
Considering the climate

To bring into focus the relevance of 450ppm, we review the most recent findings of the Intergovernmental Panel on Climate Change (IPCC). The Fifth Assessment Report (AR5) details why the world should be striving for this goal. The purpose of this is to show that the changing climate system is a physical reality and the impacts are already being observed. It is not a social trend that can be reasoned with or negotiated away. Following this we put Australia's energy policy goals into the context of the recommended international targets. We have identified that Australia's annual fossil energy production would rise from 4% to 20% of the annual global emissoin allowance to remain below a 2ºC temperature increase.

Findings from the IPCC Fifth Assessment Report

The climate change projections provide comprehensive information about future emissions or concentrations of GHG, aerosols and other anthropogenic drivers. The Representative Concentration Pathways (RCPs) developed by the IPCC have been published in the Fifth Assessment Report (AR5) 2014. The IPCC Pathways reduce the multitude future emission scenarios to four representative pathways as shown in Figure 4. The pathways are particularly helpful in understanding the possibilities in the future direction of the climate system. RCP2.6 is the most ambitious and the one that is required to limit warming to less than 2ºC.

FIGURE 4 **Representative Concentration Pathways generated by the IPCC AR5. Image courtesy of Global Carbon Project[10]**



The RCP scenarios demonstrate the penalty for delaying a suitable response, requiring more dramatic actions. Presently the emissions trend is in line with the worst case scenario, leading to average temperature increase in the order of 6degC.[7] Such a high temperature increase would continue to alter precipitation patterns, melt glaciers, increase sea-level rise and intensify extreme weather events to unprecedented levels. Further, we could see some 'tipping points' in ecosystems, causing dramatic and irreversible changes to the natural world, effecting all systems and societies.

The Australian region is particularly susceptible to the consequences of a slow response. With the current trajectory, average global sea level in 2100 will be 75-190 centimetres higher 1990 levels, and continue to rise thereafter. This will

displace many people within Australia and our neighbours, requiring the resettlement of climate affected refugees. Days of catastrophic fire danger escalate in many parts of the country, as well as the intensification of both drought and floods. The Great Barrier Reef ecosystem will be in severe danger both due to increased water temperatures, and increased acidification as the ocean absorbs higher levels of carbon dioxide from the atmosphere[11]. Changes in the breeding and migratory patterns of birds, fish and animals, as well as plant species will spread into areas that were previously too cold for them. These consequences already observed in Australia are similar the world over and will have unprecedented effects on the livelihood global society.

The IPCCs latest report confirms and reiterates what was indicated in the Fourth Assessment from 2007; that the warming in the climate systems unequivocal. Observations from 1970-2004 found consistency with the geographic relocation of species and atmospheric warming[12]. Today we are provided with compelling scientific judgement and undeniable evidence of the global warming taking place, and that greenhouse gas emissions from human activity are a major cause. The route to avoiding the worst impacts is by reducing emissions; demonstrated clearly in the RCPs. The IPCC affirmed that the human impact on the climate during this era greatly exceeds that due to known changes in natural processes, such as solar flux and volcanic eruptions. Despite the understanding of climate change consequences and the narrowing time for preventative action, we are still on track with the worst case scenario.

Emissions will continue to grow as economies and population growth worldwide out pace emission reduction with energy intensity. The IPCC measured that total anthropogenic GHG emissions has risen more rapidly from 2000 to 2010 than in the previous three decades.

"Between 2000 and 2010 increased use of coal relative to many other energy sources has reversed a long-standing pattern of gradual de-carbonisation of the world's energy supply. Increased use of coal, especially in developing Asia, is exacerbating the burden of energy-related GHG emissions."[13]

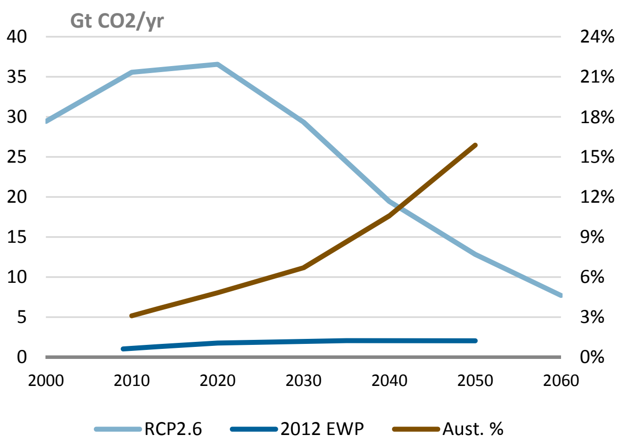
Australia in context

There is an unambiguous convergence of independent and unrelated scientific research that agrees on 2°C as the limit for global temperature increase, and that to push beyond this will result in destabilisation of the climate system. As noted in Beyond Zero Emissions Laggard to Leader report it expresses that limits that can be considered in terms of a 'carbon budget'. Our remaining carbon budget, or the amount of CO_2 in gigatonnes (Gt or billion tonnes) the global community is permitted to release into the atmosphere before this temperature guardrail of 2°C is breached.

Australia's contribution to the carbon budget extends beyond our domestically accountable emissions, which result in the highest per person emissions of any developed nation. The fossil resources exported by Australia, which generate substantial revenue, already outweigh domestic emissions 800Mt to 550Mt. In accordance with projections from BREE, these exports are anticipated to grow substantially over the coming decades.

BREEs 2012 report *Australian Energy Projections to 2049-50,* supports the Energy White Paper and resulting policies initiated in that same year[14]. The combined domestic and exported emissions indicated in this report rise from 1.3Gt today to 2.5Gt of CO_2 in 2050. This approximate doubling of emissions associated with Australia understates the significance in the context of effective global emission reductions. Today's 1.3Gt of CO_2 represents approximately 3.6% of annual global. As shown in Figure 5, by 2050 the projected 2.1Gt of CO_2 represents 16% of the world's annual emissions budget emissions in accordance with the RCP2.6 scenario, rapidly increasing thereafter.

FIGURE 5 Australian combined domestic and export fossil energy emissions based on 2012 Energy White Paper projection compared with RCP2.6 annual emission budget. Proportion of combined emissions (Aust. %) on right axis.



It is incredulous to expect Australia's fossil resources to gain such international prominence when all producing countries will be under pressure from reducing demand. It is irrelevant that the emissions of Australian exports are officially allocated to other nations' domestic emissions accounts. All consumers will be shifting away from fossil fuels and this will impact on Australian producers and the wider economy.

International Energy Agency projections

To provide a meaningful range of possible energy futures we have used International Energy Agency (IEA) projections in addition to official domestic forecasting[2,4,14,15]. The IEA defines three scenarios in its annual World Energy Outlook (WEO) to project future energy trends. The scenarios are the Current Policies Scenario (*CPS*), the New Policies Scenario (*NPS*) and the 450ppm scenario (*450*). These energy trends are commonly used by companies and governments for investment and planning guidance so are an important reference. To fully understand the relevance of the projected scenario findings the input assumptions must be understood. The IEA definition of the *NPS* and *450* scenarios, the most relevant, are provided opposite[16].

Typically the New Policy Scenario is used as a reference case as it most closely reflects the contemporary activities and attitudes of the sector. Due to the obvious uncertainty of estimating future developments, in this case covering the period to 2035, the findings of the *NPS* are flanked by the *CPS* and the *450* scenarios. These additional scenarios are not simply an arbitrary high and low estimate. The *CPS* describes a future in which announced government commitments bearing on the energy sector are not implemented. It is generated to "illustrate the consequences of inaction and makes it possible to evaluate the potential effectiveness of recent developments in energy and climate policy"[16]. The *450* scenario is based on climate change mitigation efforts by individual nations to collectively meet the targeted atmospheric greenhouse gas concentration in an economical way.

Each of these scenarios is at best indicative, but they provide quantified dimensions to the uncertain spectrum of future energy outcomes. Armed with this, governments and investors can weigh the implications of outcomes across this plausible range. With the increasingly compelling physical evidence of climate change and the fitful yet growing attempts of various nations to lower their emission intensity it is wise to investigate and make allowance for this outcome, if only for narrow economic reasons.

New Policies Scenario

"The **New Policies Scenario**, though founded essentially on existing policies and realities, also embodies some further developments likely to improve the energy trajectory which the world is currently embarked. To this end, it takes into account not only existing energy and climate policy commitments but also assumed implementation of those recently announced, albeit in a cautious manner. Assumptions include the phase-out of fossil-fuel subsidies in importing countries and continued, strengthened support of renewables. The objective of the scenario is to provide a benchmark against which to measure the potential achievements (and limitations) of recent developments in energy policy in relation to governments' stated energy and climate objectives."

450 Scenario

"The **450 Scenario** describes the implications for energy markets of a co-ordinated global effort to achieve a trajectory of greenhouse-gas emissions consistent with the ultimate stabilisation of the concentration of those gases in the atmosphere at 450ppm CO_2-eq (through to the year 2200). This scenario overshoots the 450ppm level before

stabilisation is achieved but not to the extent likely to precipitate changes that make the ultimate objective unattainable. The 450 Scenario offers a carefully considered, plausible energy path to the 2C climate target. For the period to 2020, we assume policy action sufficient to implement fully the commitments under the Cancun Agreements. After 2020, OECD countries and other major economies are assumed to set emissions targets for 2035 and beyond that collectively ensure an emissions trajectory consistent with the ultimate stabilisation of greenhouse-gas concentration at 450ppm, in line with what decided at COP-17 to establish the "Durban Platform on Enhanced Action", to lead to a new climate agreement. We also assume that, from 2020, $100billion in annual financing is provided by OECD countries to non-OECD countries for abatement measures."

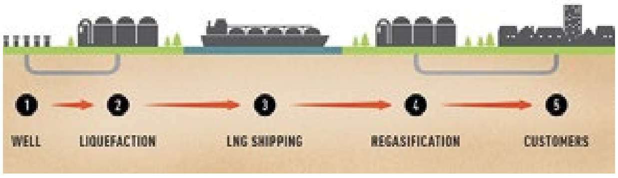
A note on 450ppm

The guiding target for the IEAs 450ppm scenario is an atmospheric CO_2 concentration of 450 parts per million. This has been established as a target corresponding to a 50% chance of achieving the internationally agreed temperature rise limit of 2°C as part of the COP negotiations and IPCC recommendations. The 450ppm level faces strong criticism for still being a dangerously high target given the climate system feedback uncertainties and the consequences of being wrong[17]. A stabilised concentration of 350ppm has been proposed as a more conservative target given the effects currently being observed with CO_2 levels now breaching 400ppm. Considering this, the 450 scenario has been used as a reference in this report not as a suggested target, but merely to demonstrate the implications of a shift corresponding to even this less ambitious goal.

In addition, the *450* scenario features Carbon Capture and Storage (CCS) as a significant source of mitigation from 2020, reducing the emissions from fossil fuel power generation by 2.5Gt CO_2 emissions per annum by 2035. The challenges and uncertainties of applying CCS to electricity generation using fossil fuels have been noted in Beyond Zero Emissions 2014 *Information paper: Carbon Capture and Storage*[18]. It is the view of BZE that CCS is unlikely to be successfully implemented at the scale suggested in the *450* scenario, resulting in fossil based power generation to be overstated by the IEA *450* scenario.

While it is possible some coal demand can be replaced with gas, resulting in lower combustion emissions, the total greenhouse gas impact of this shift is yet to be reliably determined. Fugitive emissions of methane from the many wells required for coal seam gas extraction, for example, are not comprehensively monitored. Natural gas (methane) emissions can occur at any stage of the supply chain (Figure 6). As methane is around 28 times more potent than CO_2 over a hundred year period (84 times over 20 years), relatively small quantities of fugitive methane emissions can significantly increase the global warming impact of gas usage[19].

FIGURE 6 **Reprisentitive LNG supply chain[20]**



In light of these issues with the use of fossil energy in the *450* scenario as well as the complications of nuclear power and its requisite long implementation time, it is our view that an even greater uptake of renewable energy generation will eventuate.

Australia's exposure at a glance

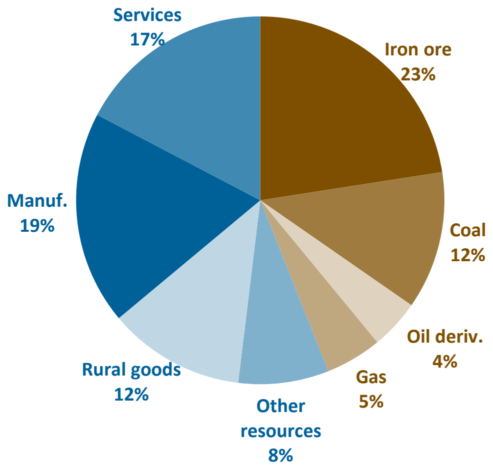
Australia has clear exposures and vulnerabilities through our emission intensive commodity trade.

The sizable shift in the global energy system associated with the 450ppm scenario will impact on different energy system participants in different ways depending on the particulars of each trade arrangement. Generally speaking, exporters of fossil energy will experience reduced demands and revenues. Energy importers may find higher or lower cost alternatives and increased energy security, albeit with the requirement of substantial infrastructure investment. Factors such as traded commodity emissions intensity, producer productivity, trade partner portfolio diversity, commodity substitutability, importer resources (material or financial), developmental status and geopolitical influences will all have a bearing on the final impact.

Australia is a significant participant in the global fossil energy trade and will undoubtedly be affected by a shift away from these greenhouse gas producing energy sources. The investigation herein identifies the Australia specific impacts of the 450ppm scenario relative to the New Policy Scenario

and Australia's Domestic projections. Before examining the specific implications associated with these varying projections, the general resilience or otherwise of Australia's fossil energy trade is reviewed.

FIGURE 7 **Source of Australian export revenue 2013-14**



Trade product diversity

Australia has a high degree of exposure in its external account to a limited number of emission intensive commodities. In 2013-14, Australian resource exports represented approximately half of all trade receipts with fossil energy being a significant component (Figure 7). Gas (LNG), thermal coal, metallurgical coal as well as its counterpart iron ore accounted for 44% of all export revenue[21]. Australia is increasingly a net importer of oil based energy products. For this reason oil trade has been excluded from this study.

Trade partner diversity

Compounding this concentration of export commodities is the concentration trade partners in Australia's portfolio. This situation indicates the vulnerability of Australia to emission reduction efforts or the policy changes of very few nations. Four nations – Japan, China, Korea and India – account for approximately 92% of Australia's export of these key emission intensive commodities (Figure 8) [22,23]. This shifts to 85% considering only energy commodities (Figure 9).

FIGURE 8 **Destination of combined gas, coal and iron ore**

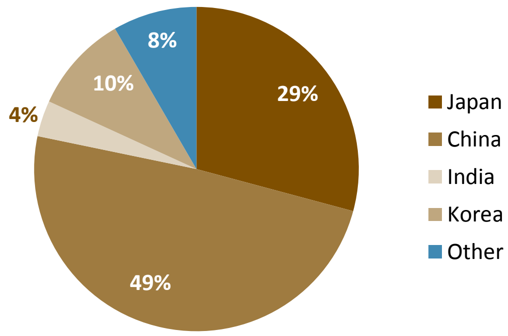
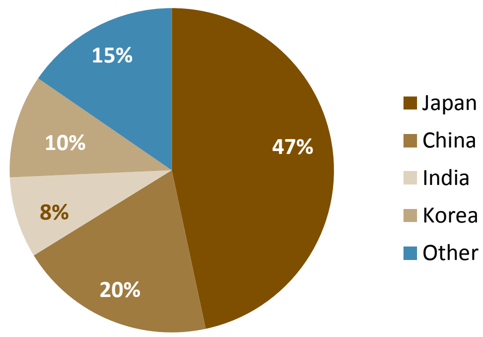


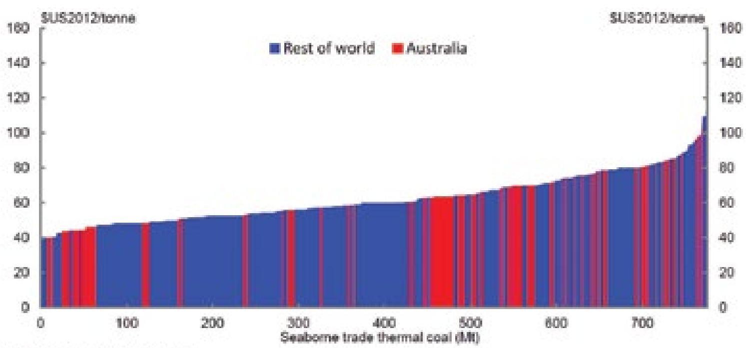
FIGURE 9 **Desination of combined gas and coal**



Competitiveness

Many Australian producers are at the high end of the supply market. The competitiveness of traded commodities is an important factor determining the impact of demand changes on suppliers. While all producers are impacted by prices, those at the high end of the cost curve are the most exposed to financial losses or closure as a result of a downturn in demand. Australian thermal coal producers are spread throughout the cost curve however the bulk of producers are in the higher cost half of tradable suppliers (Figure 10). Australia's recent gas developments are among the highest cost producers in the LNG market.

FIGURE 10 **Australian and Rest of World volumes identified in the seaborn thermal coal cost curve (May 2014)**



Source: Wood Mackenzie.

Commodity substitutability

With the rapid development of renewable energy technologies, substitutability is another element of exposure. Energy resources which are primarily used for electricity supply are vulnerable to the substitutability of both utility scale and, increasingly, distributed renewable energy generating and storage options. Applications with lower substitutability such as transport fuels or key production materials are more resilient. Thermal coal and gas for electricity production will compete directly with renewable energy and energy efficiency alternatives which are already cost competitive and have the advantage of domestic provision.

Trade partner resources

The resources of Australia's major trade partners, both material and financial is another important factor. Both Japan and Korea have extremely limited domestic energy or material resources and are highly dependent on imports. Despite this both nations have substantial resource intensive industries. The high productivity and wealth of these nations allows them to bear high prices for commodities however recent price surges have put this ability under pressure. China and India by comparison have lower per capita wealth but substantial domestic material resources. Both are largely self-sufficient for energy resources however the demand resulting from their economic expansion has outpaced the domestic supply. Lower than expected economic expansion or increased domestic productivity could bear on each nations demand for resources.

Trade partner development status

The stage of development of Australia's trade partners is also a factor to be considered. Korea and Japan are both mature developed economies. Japan enjoys high energy productivity and has subdued expectations for future growth. Korea currently has an energy intensive industrial sector and the economy is forecast to grow. India is in the early stages of resource and energy intensive development. This has historically been characterized by wide-spread construction and heavy industry. India has the opportunity to leap-frog a number of fundamental technologies and infrastructures to reduce the resource intensiveness of this period. China is in between these two states of economic growth as it transitions from the resource intensive investment based growth to a service and consumption focus. This will feature reduced resource intensity for each percentage point of incremental economic growth.

The historic development profile of today's wealthy economies is not an entirely reliable guide for the development of today's emerging economies. Advances in technology allow different infrastructures to underpin large economies; infrastructures that allow higher productivity, with less energy and less environmental impact. Energy efficient buildings, distributed electricity generation, smart and micro-grids with storage as well as autonomous transport are all opportunities to leap-frog the less efficient solutions which were available half a century ago when most of the developed world infrastructure was being implemented. These possibilities must be kept in mind when projecting the economic development of emerging economies in the future. Extrapolation of historic trends has merit but increasingly inaccurate.

Detailed analysis of scenario projections

Australia's resource trade is sensitive to changes in international demand. In this section we quantify the effect on Australia's commodity exports corresponding to the different scenario projections provided by the IEA and the Australian Government. Projected export volumes and prices have been consolidated into high, mid and low 'trajectory cases'. Each trajectory case is a composition of different references as no single reference source provided complete information covering all commodities or time periods. Refer to Appendix A for detail regarding each trajectory case composition.

The **high trajectory case** typically corresponds to estimates from BREE and Treasury reference material. This trajectory best reflects the expectations of Australian policy makers.

The **mid trajectory case** most closely reflects the IEA New Policy Scenario. This has been augmented with alternative pricing information to account for the effect of over capacity which has eventuated.

The **low trajectory case** generally corresponds to the IEA 450ppm scenario and also applies alternative pricing values where appropriate.

Export revenue range

The commodities considered are gas, thermal coal, metallurgical coal and iron ore. Iron ore is considered in this analysis as it is both a significant contributor to Australian export revenue and because it is used for steel making which consumes emissions intensive metallurgical coal with current production methods. The resulting gross revenue trajectories are given in Table 1.

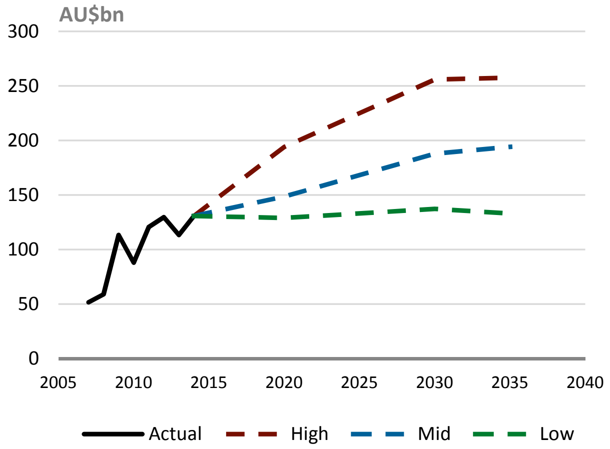
Table 1 shows that the gross revenue of the high trajectory case increases from the current level of $131 billion to $194 billion by 2020 and $256 billion by 2030. These figures indicate the future revenues anticipated by Australian government decision makers when considering future budgets, resource infrastructure investment and other structural adjustments to Australia's international trade and payments. The low trajectory case indicates a negligible change in gross revenues from the commodities investigated. The difference in trajectories translates to a reduction in anticipated revenues of $65 billion in 2020 and $119 billion in 2030 resulting from international efforts to reduce GHG emissions in line with a 2°C temperature rise. The divergence of revenues according to the three trajectory cases is shown in Figure 11 for all four commodities.

TABLE 1 Trajectory case commodity revenue

	2014	2020			2030			2035		
		Low	Mid	High	Low	Mid	High	Low	Mid	High
Gas	16	36	38	52	44	56	101	42	61	100
Coal (th)	18	11	16	24	3	18	27	5	19	29
Coal (met)	22	18	21	29	18	24	37	18	24	39
Fossil energy	56	65	75	105	65	98	165	64	104	167
Iron ore	75	64	73	89	72	90	90	69	90	90
Total	**131**	**129**	**149**	**194**	**137**	**188**	**256**	**133**	**194**	**258**

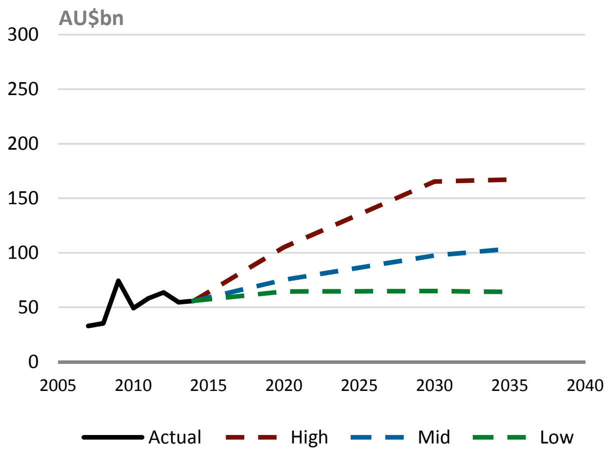
It is clear that Australian export revenue will be heavily impacted by global efforts to address climate change.

FIGURE 11 Comparison of total gross revenue for each trajectory case



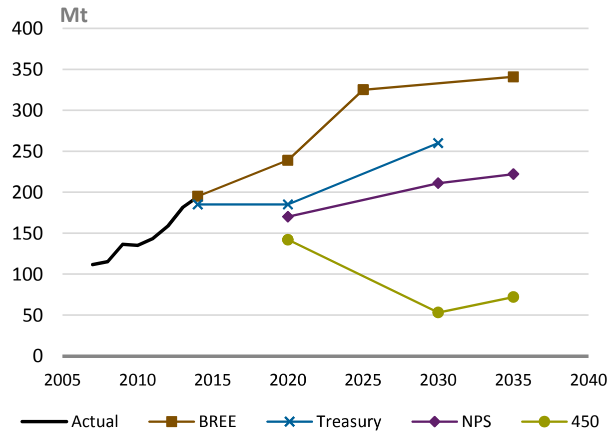
The divergence of high and mid trajectory cases indicates the misalignment of Australian expectations and the IEA's New Policies Scenario reference case. Figure 12 shows the gross revenue trajectories from the fossil energy resources, namely gas, thermal and metallurgical coal. The effect is a $30 billion and $40 billion reduction in 2020 gross export revenue, relative to the high trajectory case, for the mid and low trajectory cases respectively. This variance increases to $67 billion and $100 billion by 2030. These changes in fossil energy export revenues bear directly on Australia's trade balance.

FIGURE 12 Comparison of fossil energy gross revenue for each trajectory case



The difference in high and mid trajectory cases is mostly attributable to significantly lower production volume estimates by the IEA compared with BREE. The disparity is illustrated for thermal coal in Figure 13. Considering that the recommendations in the IEA World Energy Outlook are intended to indicate an economically efficient level of production from different nations to match expected global demand, this may be an indicator of uneconomic capacity. The IEA's global energy model takes into consideration the relative production and investment costs to determine the most streamlined capacity investment world-wide in order to ensure attractive returns while keeping energy costs low. Overshooting this indicates that Australia may have gone beyond a prudent strategy for resource and associated rail and port infrastructure investments relating to the New Policies Scenario projection.

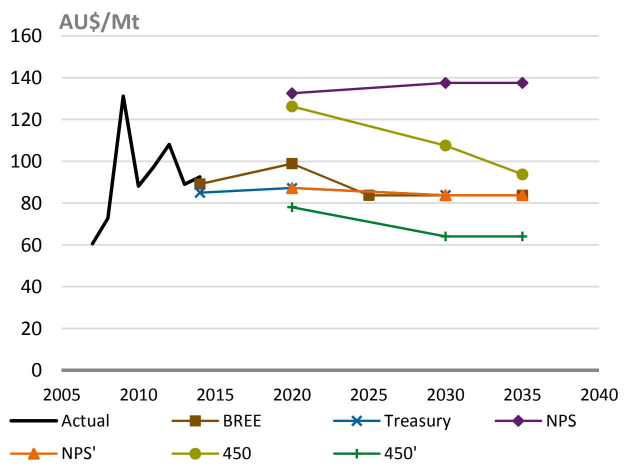
FIGURE 13 Thermal coal export volume projections



The increased divergence between the high and low trajectories illustrates the potential impact of climate change mitigation efforts by the international community – particularly Australia's trade partners. In this *450* scenario the IEA recommends an economically efficient level of production from nations to balance the changed demand for emission intensive energy commodities. At a global level the *450* scenario features a substantial reduction in consumption of all fossil fuels relative to the New Policies Scenario and an absolute reduction in the consumption of thermal coal. This is likely to result in a dramatic restructure of the thermal coal trade in particular as surplus domestic capacity is newly available for export. This supply glut will introduce unprecedented competitive pressure to producers supplying a consumer market experiencing terminal decline.

At times when supply and demand diverge dramatically, commodity prices experience volatile movements. This was witnessed between the years 2000 to 2011, with the surge in demand from China outstripping the available supply capacity resulting in very elevated prices. The commodities being analysed here are currently experiencing an unprecedented drop in prices as demand proves to be lower than the expanded supply capacity built in response to the previous surge. Bearing this imbalance in mind, the commodity price projections of the IEA must be treated with caution. These prices were determined based on a rational and efficient development of energy resources, neatly traversing supply cost curves to the appropriate marginal producer. Development has not transpired in this way. Competition to win market share has resulted in supply over-capacity with demand tracking lower than anticipated. Considering this, alternative commodity price references have been investigated to find a more representative value of marginal supply price in cases of oversupply. Projected price estimates for thermal coal are shown in Figure 14.

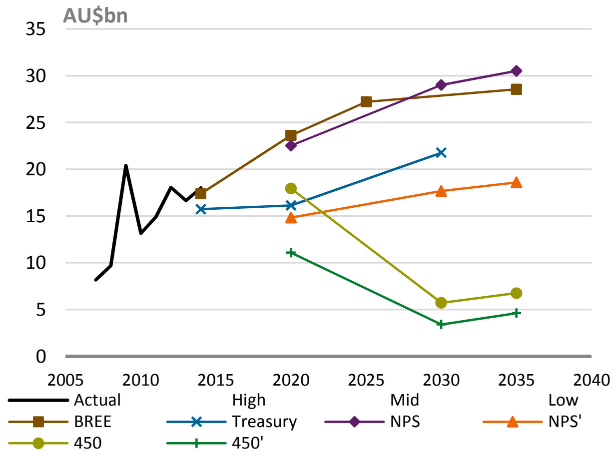
FIGURE 14 **Seaborn thermal coal price projections**



The resulting gross revenue for each source is shown in Figure 15. This also demonstrates the composition of high, mid and low trajectory cases which have been constructed for the case of thermal coal.

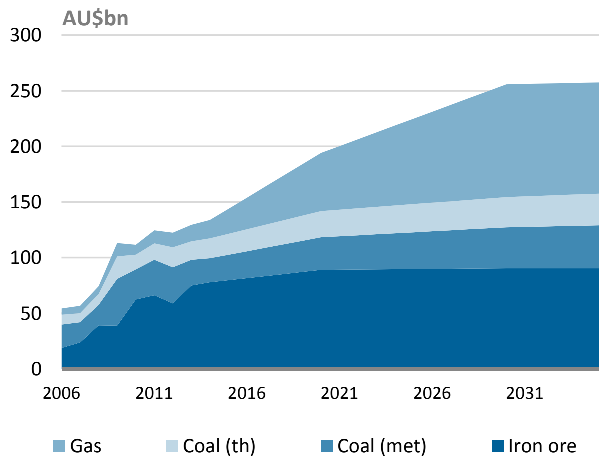
As the Figure 15's thermal coal charts suggest, the aggregated view hides some significant imbalance among the various commodities under consideration in different trajectory cases. To consider this we can view the commodity breakdown separately for each trajectory case. These are shown in Figure 16, Figure 17 and Figure 18.

FIGURE 15 **Thermal coal export revenue projections and trajectory cases**



As can be seen in the high trajectory case, all commodity export revenues grow out to 2035, with gas being the most significant rise. In the low trajectory case, a smaller increase in gas export revenues largely replaces the revenue from coal products, particularly thermal coal which all but disappears. The result is a negligible change from current aggregate revenue. A summary of projected commodity volumes and prices used to construct the three trajectory cases is presented in Figures 24–35*.

FIGURE 16 **High trajectory case commodity revenue**



* NPS' indicates alterations based on NPS information. See Appendix A for details. 450' indicates alterations based on 450 information. See Appendix A for details.

FIGURE 17 **Mid trajectory case commodity revenue**

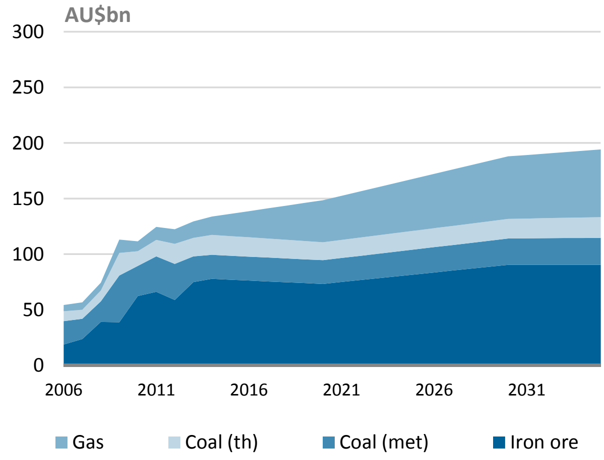
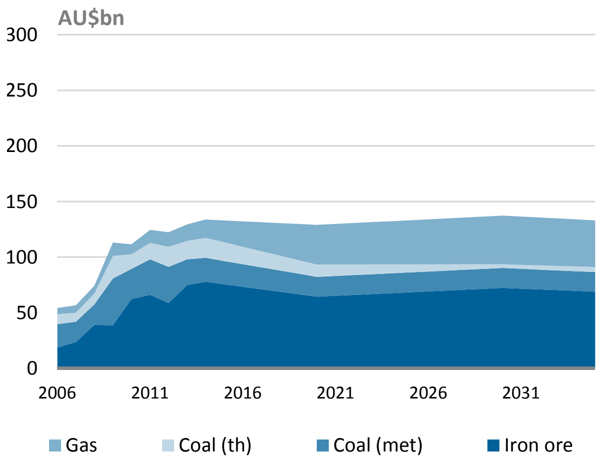


FIGURE 18 **Low trajectory case commodity revenue**

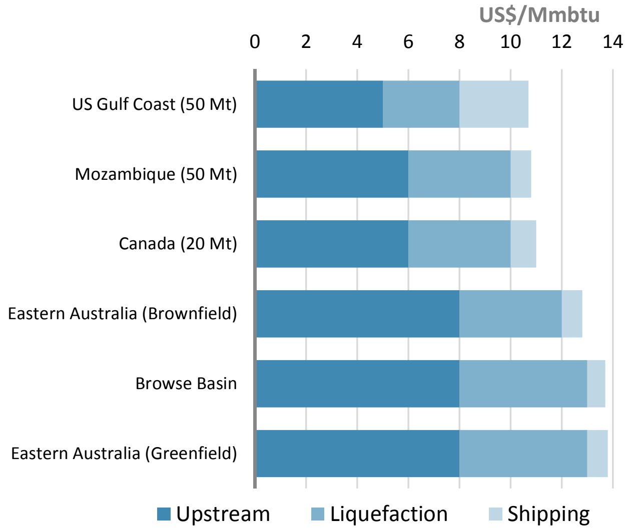


Gas exports

The variation seen in projected volumes of gas is dramatic, even between the IEA reference *NPS* case (mid trajectory case) and the estimates of Australian policy makers (high trajectory case). Exactly how gas export volumes might be affected remains unclear as the Asian LNG market is not transparent and open. A high proportion of gas is sold in accordance with long term contracts with varying price indexation. This provides some insulation to exporters from market volatility. What can be pointed out is that LNG produced from new Australian projects result in some of the highest cost gas available to Asian consumers. This makes contract renegotiations a possibility as lower cost suppliers become available and will likely result in the progressive exclusion of the highest marginal cost producer as more and more volume is traded on spot price terms after contract periods wind up (circa 2020). The decline in Asian LNG import prices in 2014 may be indicative of this[24].

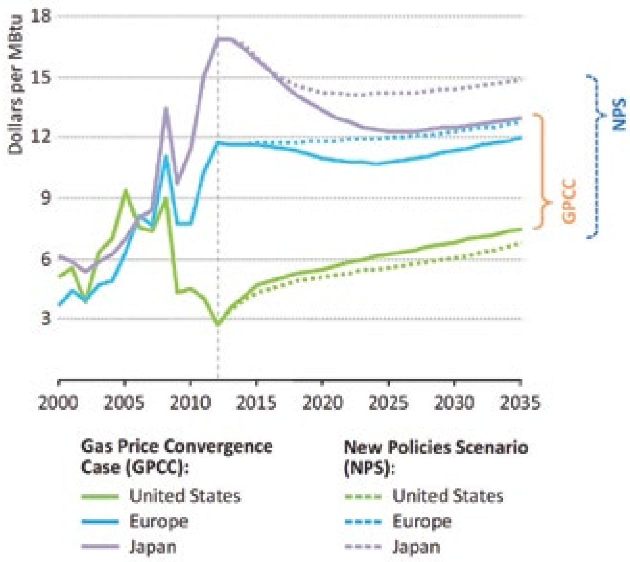
The projects currently committed have been primarily justified on the basis of export economics, with local demand likely to decline as domestic gas prices double to equalise with export netbacks (international price minus shipping and liquefaction). LNG liquefaction, storage and transportation requires specialized and expensive infrastructure. Including development costs, LNG supply cost estimates to the Asia Pacific region for green and brownfield developments in Australia are estimated to be higher than supply from competing regions such as the US Gulf Coast, East Africa and Canada (Figure 19)[25]. The existing projects will need to compete with new suppliers such as the US on price, as their contracts expire. Australian LNGs higher break-even cost to supply to Asia put profitability and hence taxes, rents and dividends, potentially at risk.

FIGURE 19 **Supply cost estimate for new LNG developments. (Reproduced)** [25]



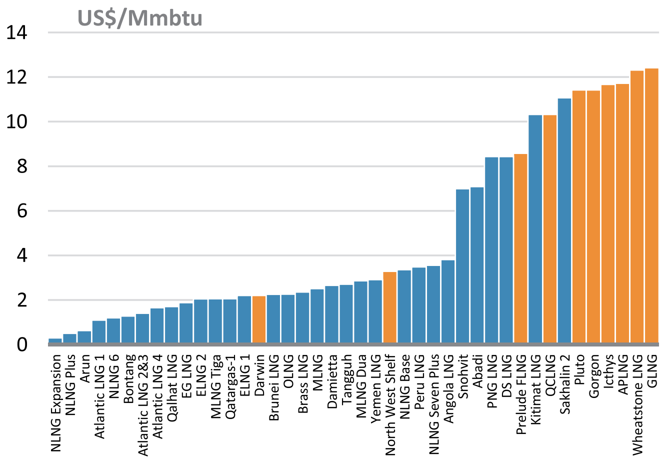
A Gas Price Convergence Case was produced as part of the he IEAs 2013 World Energy Outlook (Figure 20). It showed that differential pricing in regions narrows as a result of increased LNG export capacity. The high cost of transporting and shipping gas, which varies depending on the shipping distance, accounts for the differences in *converged* prices shown below. In this scenario, prices achieved in Japan (Asian market) are lower than those in the New Policies scenario. This strengthening of the buyers' hand in pricing negotiations will have a negative pricing effect on Australia as the seller.

FIGURE 20 **Regional gas prices in the New Policies Scenario and Gas Price Convergence Case**[15]



Another pressure point for Australian LNG exports is the substantial Russia-China eastern gas pipeline deal. This new dimension is problematic as China is expected to represent the largest incremental demand for gas in the next decade. The price of the Russia pipeline gas has been estimated to be between US$10-12 per Mmbtu[26], below the breakeven point for many of Australia's new LNG projects (Figure 21). This issue will only be further exacerbated by the addition of a western pipeline which is currently being negotiated, doubling the pipeline supply volume[27].

FIGURE 21 **LNG project F.O.B. break-even costs (2013). Australian projects indicated in orange. (Reproduced)**[28]



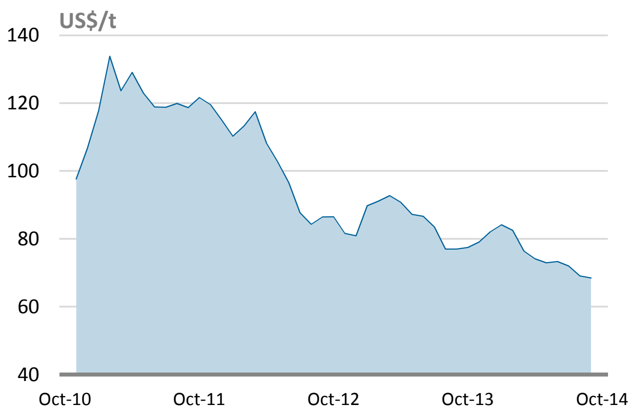
With the current trade structure, economic outcomes for consumers may take longer to be realised than in an open market but pressure will be present to achieve more competitive outcomes, i.e. lower prices. This will materialise in reducing operating margins of Australian producers and eventually shutting out high cost producers as recently seen in coal and iron ore production.

For domestic gas supply in eastern Australia, price rises will be driven by the linking of the eastern Australian gas market to the global LNG market through the completion of three LNG export facilities at Gladstone. This is a result of the introduction of Coal Seam Gas (CSG), which has increased potential gas production to levels that have justified construction of LNG facilities. Hence gas supply for domestic use will only be available at a price competitive with the netback from exporting that gas. Any domestic shortages of gas will be "resolved in the market through increases in price"[29]. The cost of this domestic price increase to the wider economy has been estimated to substantially outweigh the benefits anticipated from exports[30].

Coal exports

Thermal coal forecasts vary widely, with projections for volume ranging from +70% (high trajectory case) to -70% (low trajectory case) by 2030. Thermal coal makes a minimal contribution in the low trajectory case, with prices reducing by 25% from 2014 levels. Even in the high trajectory case, thermal coal is the lowest contributor to revenue, mainly due to an expected price reduction of 10% as a result of limited demand. Australian thermal coal has decreased in price by around 45% from its high in early 2011, with a continuing consistent downward trend (Figure 22).

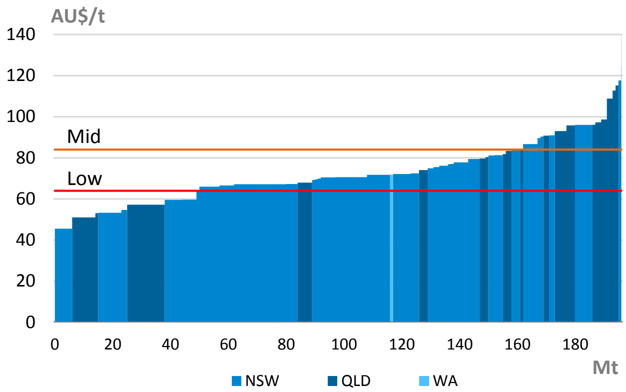
FIGURE 22 **Newcastle spot thermal coal F.O.B. price history**



Thermal coal represents the lowest financial contribution to Australian emission intensive exports and the highest revenue risk, with the average Australian thermal coal mine currently

operating at only cash break-even levels. Coal is also the greatest contributor to greenhouse gas accumulation. Another concerning attribute of Australia's coal producers is the concentration of high cost mines located in the state of Queensland. One third of current thermal coal export production in Queensland operates at cash costs above the estimated mid trajectory case prices of AU$85 per tonne (Figure 23). The low-trajectory price estimate of around AU$65 per tonne would exclude 70% of current thermal coal export production. Metallurgical coal will be less affected however those mines currently under pressure are unlikely to be offered relief.

FIGURE 23 Australian export thermal coal cash cost curve by state (Sept 2014)[31]



As with thermal coal, metallurgical coal has experience a substantial reduction in value from the highs of 2009. This is now reflecting the cost of marginal supply and all three trajectory cases indicate prices to remain similar. The volumes projected by the IEA scenarios, constituting the mid and low trajectory cases, are markedly lower than the guidance of BREE and Treasury forming the high trajectory case. This is so even with the IEA acknowledging Australian thermal coal representing half of all seaborn trade in the New Policies Scenario, suggesting a substantially smaller market for the commodity in future than Australian Government expectations.

Forecasts assume that metallurgical coal remains an essential input to steel production. With substantial efforts to reduce carbon emissions, the steel sector will eventually be placed under pressure to make changes. Steel is a core commodity supporting many industries and is not easily replaced by alternative materials. When the penalty for emitting greenhouse gases reaches critical levels, increasing the cost of steel produced by blast furnace, lower emission production processes will be considered. These include gas based Direct Reduced Iron , bio-mass coke, Electric Arc Furnace production and storage or use of captured carbon emissions. These are already in limited use but are not favoured due to economics. Revenue from iron ore, also used for steel production, is projected to remain fairly steady relative to current levels. Demand for both of these commodities is closely related to global steel demand.

Iron ore exports

Efforts to mitigate climate change may affect iron ore indirectly via the emission intensive nature of blast furnace steel production employing coking coal (or metallurgical coal). This pressure is expected to develop in the middle period of de-carbonisation after the lower hanging fruit of transitioning the power generation system is well underway.

In the nearer term exports of iron ore have already been placed under pressure by lower than expected demand. As more scrap steel becomes available recycling will become an increasing factor. The short fall is largely driven by economic factors in China. A steel intensive period of investment driven growth featuring extensive infrastructure and residential construction has begun a transition toward more domestic consumption and services. This so called 'rebalancing' has exposed some inefficient past investment which contributed to high expectations for future demand for iron ore. With China accounting for the bulk of the growth in iron ore demand over the past decade, this shift has resulted in a global oversupply of iron ore and depressed prices which are presently attracting significant attention.

The *450* scenario provided by the IEA does not specify the impact on iron ore demand, only a relatively minor reduction in demand for metallurgical coal, citing a lack of a large scale substitute. It has been assumed in the low trajectory case that this small decline in demand for metallurgical coal corresponds to a proportional small decline in demand for steel and iron ore in turn. The stabilised iron ore price level for the low trajectory is assumed to be unchanged from the mid trajectory case price provided by Treasury estimates. This is due to the decline in volume being relatively small and remains in a very flat position on the marginal supply cost curve.

This analysis does not consider the other economic factors currently bearing on the iron ore market, only the additional pressure assumed to result from the *450* projection. The economic factors would be expected to substantially outweigh the *450* scenario effects.

Gas projections

FIGURE 24 Comparison of projected gas export volumes by BREE and the IEA New Policies Scenario and 450ppm scenario

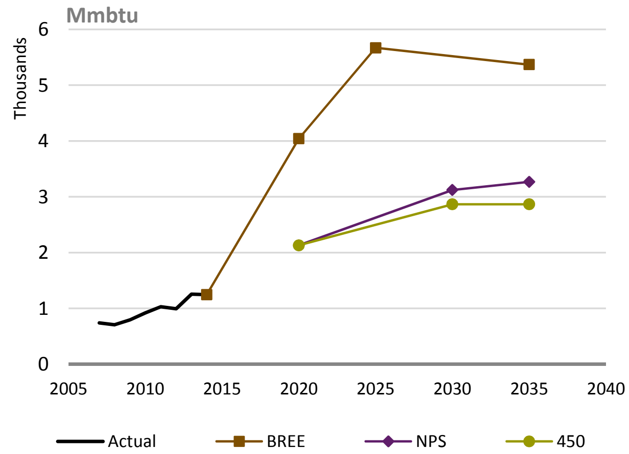


FIGURE 25 Comparison of projected gas export volumes by BREE and the IEA New Policies Scenario, Gas Price Convergence Case and 450ppm scenario

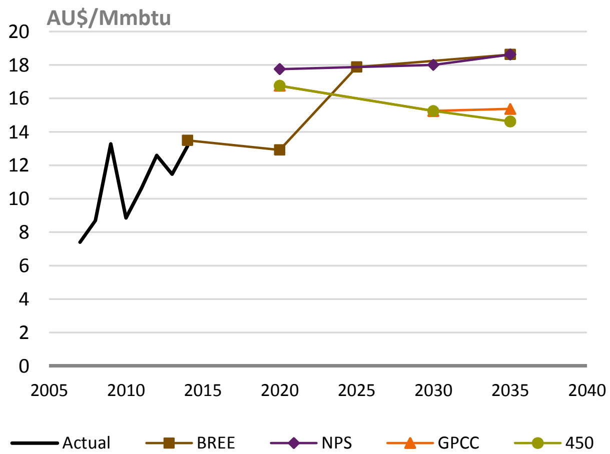
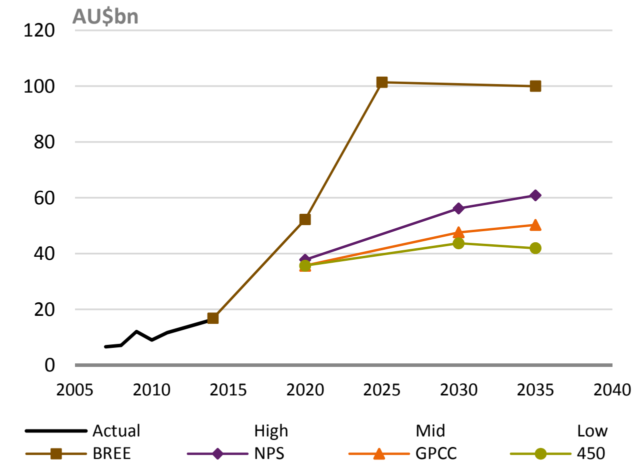


FIGURE 26 Comparison of trajectory cases with projected gas export revenues by BREE and the IEA New Policies Scenario, Gas Price Convergence Case and 450ppm scenario



Thermal coal projections

FIGURE 27 Comparison of projected thermal coal export volumes by BREE, Treasury and the IEA New Policies Scenario and 450ppm scenario

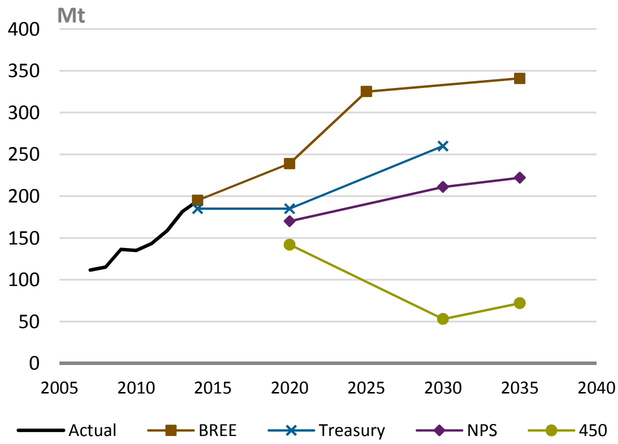


FIGURE 28 Comparison of projected thermal coal export prices by BREE and the IEA New Policies Scenario, and 450ppm scenario

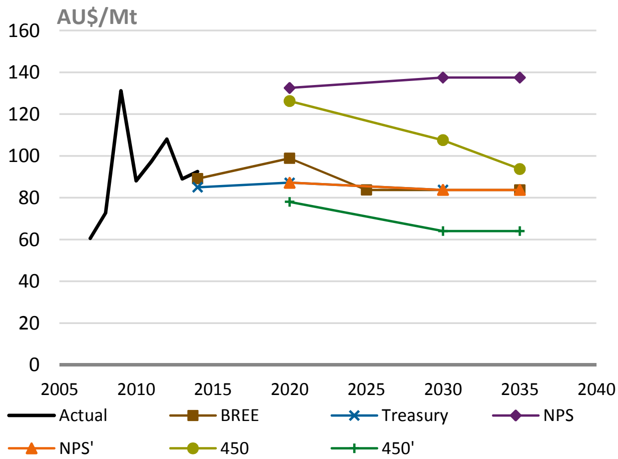
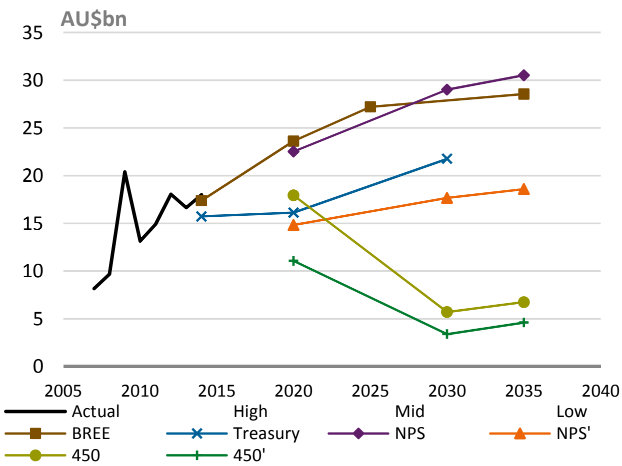


FIGURE 29 Comparison of trajectory cases with projected thermal coal export revenues by BREE, Treasury and the IEA New Policies Scenario, and 450ppm scenario



Metallurgical coal projections

FIGURE 30 Comparison of projected metallurgical coal export volumes by BREE, Treasury and the IEA New Policies Scenario and 450ppm scenario

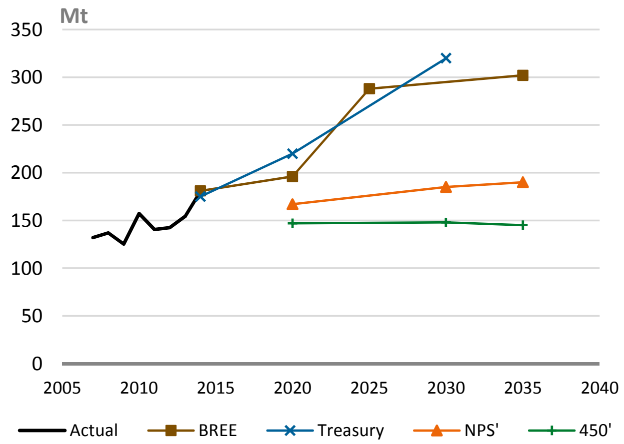


FIGURE 31 Comparison of projected metallurgical coal export prices by BREE, Treasury and the IEA New Policies Scenario and 450ppm scenario

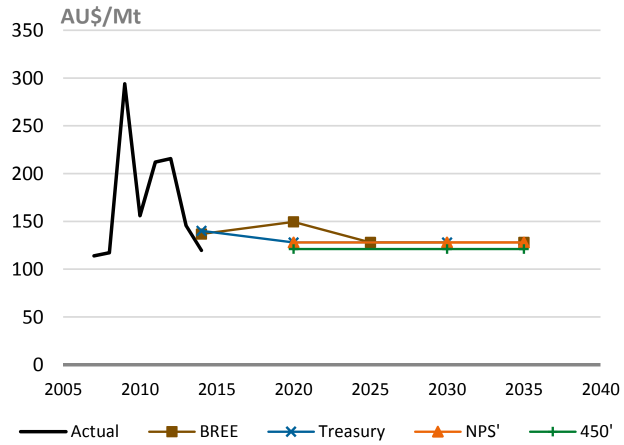
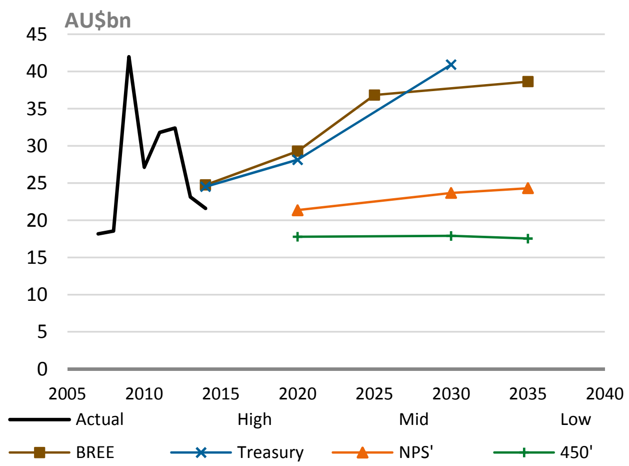


FIGURE 32 Comparison of trajectory cases with projected metallurgical coal export revenues by BREE, Treasury and the IEA New Policies Scenario, and 450ppm scenario



Iron ore projections

FIGURE 33 Comparison of projected iron ore export volumes by BREE, Treasury and an adjustment corresponding to the IEA 450ppm scenario

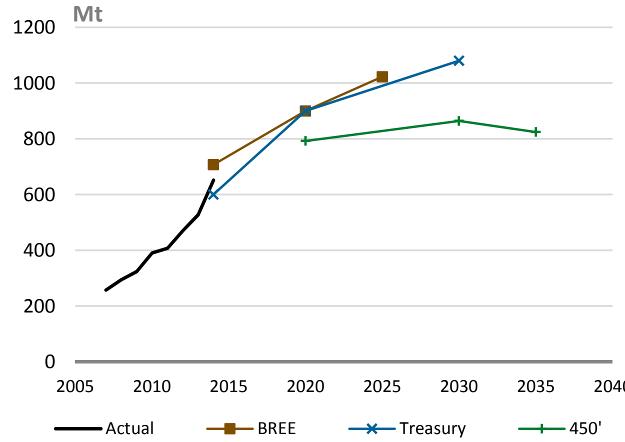


FIGURE 34 Comparison of projected iron ore export prices by BREE, Treasury and an adjustment corresponding to the IEA 450ppm scenario

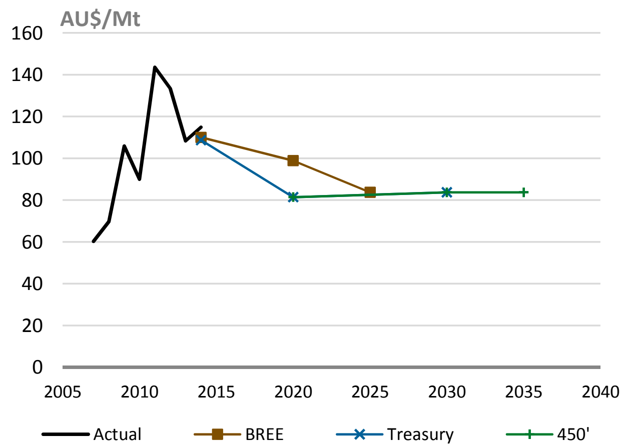
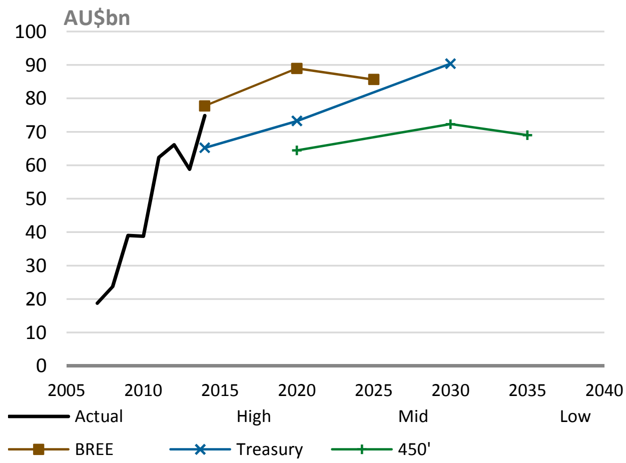


FIGURE 35 Comparison of trajectory cases with projected iron ore export revenues by BREE, Treasury and an adjustment corresponding to the IEA 450ppm scenario

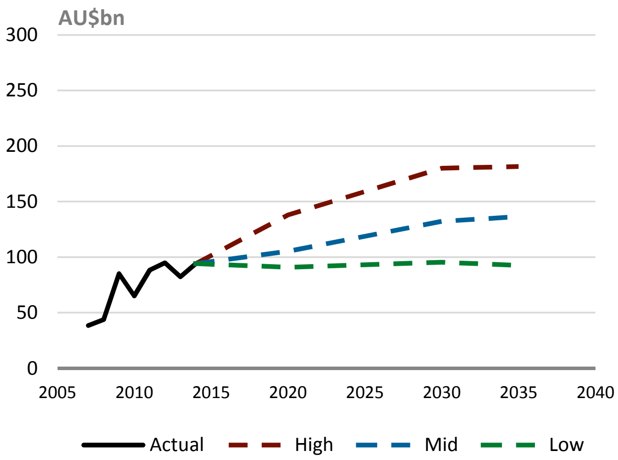


Net national income

The magnitude of estimated revenues is moderated to a degree when net national income is considered, that is the portion of gross export revenue retained by Australia. In this instance, the profits allocable to foreign stock holders is subtracted from gross revenue in proportion to equity share holdings. This issue is important because foreign holding are in the range of 70-80%. Factoring this provides a more indicative estimate of the impact on Australia's broader balance of payments which considers not only the net trade flows but also the net capital flows (debt and equity) between Australia and other nations*. The results are shown in Figure 36 for all four commodities and Figure 37 for the three fossil energy commodities.

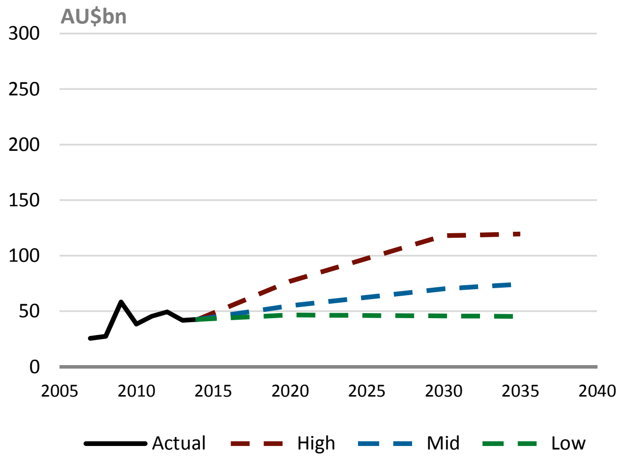
The change in net national income relative to the high trajectory is a $24 billion and $30 billion reduction in 2020, for the mid and low trajectory cases respectively, increasing to $50 billion and $77 billion by 2030. Although this diminishes the magnitude of variation between each trajectory case by around 25%, the trend is maintained. Shortfalls in the balance of payments in the order of tens of billions of dollars would be a significant problem should future developments follow the low or even mid trajectory cases indicated.

FIGURE 36 **Comparison of trajectory case total net national income**



* The proportion of foreign held stock cannot be determined precisely due to limited disclosure as well as the multi-national operations of companies resource companies. Net national income is also dependent on taxable profits. Historic tax contributions have been employed for estimating this but this is not necessarily reflective of future performance. See Appendix A for details of assumptions.

FIGURE 37 **Comparison of trajectory case fossil energy net national income**



Trade partner perspectives and policies

The factors driving changes in energy policy are varied among each of Australia's major trading partners, but the effect is the same; namely, slowing demand growth for Australian resources. China, Japan, Korea and India are all at different stages of economic development and have varying capacities for changing their energy policy, but each of them recognise change is in their best interest. The change in China is primarily driven by unacceptable levels of pollution which is negatively affecting the quality of life of citizens. The change in Japan is primarily economic, aimed at reducing energy imports to reign in an unsustainable trade deficit. Korea is seeking to price energy such that it is more reflective of the true cost to its citizens; this includes the costs of health and pollution. In India the main driver is providing energy to support strong economic growth combined with alleviation of energy poverty, requiring a secure, diversified and affordable energy system.

The view from China

China is now the world's second largest economy and is predicted to overtake the United States as the world's largest in the coming decade. This phenomenal growth has been built upon increasing demand for fossil fuels, principally coal, with China now the world's largest energy user. China has relied on resource exporters, such as Australia, for much of its raw materials and some fossil fuels above and beyond its vast domestic coal resources.

China's energy landscape is changing. Energy policies are increasingly being influenced by issues of pollution, water scarcity, security as well as climate change. Policies are being shaped to support energy efficiency and cleaner energy sources through measures such as a favourable Feed-in-Tariff and an expanding Emissions Trading Scheme (ETS). Employment and investment opportunities are also a key priority, with China aiming to drive technology leadership in many rapidly emerging low carbon sectors. These abrupt changes have been deemed necessary for the well-being of Chinese citizens despite causing demographic difficulties in coal producing regions. China has the largest coal reserves in the world yet it is moving away from this as an energy source due to the accompanying environmental and social costs.

Environmental drivers

POLLUTION

Pollution of land, water and atmosphere is an increasingly salient issue in China. At the local and national level, pollution has become an impediment to daily life, to economic activity, and to future prosperity. The increase of local environmental protests in the last five years demonstrates the high levels of public concern related to the environment. Outdoor air pollution is estimated to contribute to 1.2 million premature deaths per year, while it is estimated that 90 percent of urban water bodies are polluted (Cohen et al, 2005), and that 10 million hectares of farmland are contaminated nationally (Chen, 2009)[32].

The necessity of reducing pollution levels has been acknowledged in China's 12th Five Year Plan (FYP12), issued by the National People's Congress in 2011[33]. FYP12 aims for "inclusive growth" – rebalancing the economy to spread benefits more equally, as well as alleviating social inequality, reducing pollution and protecting the environment. This rebalancing of objectives corresponds to a reduced target GPD growth of 7 percent, down from the 10 percent average achieved during the previous FYP[32]. FYP12 sets binding targets covering energy use, carbon dioxide and other emissions, power industry investment and decreased energy intensity of GDP. Principle targets are highlighted in Table 2.

Coal use has been targeted by an array of changes implemented by FYP12, primarily to mitigate air pollution resulting from industrial and electricity sector coal usage. FYP12 specifically limits coal to 65% of primary energy consumption by 2017, a decline of 4% from its current share of the energy mix.

TABLE 2 Key binding targets in the 12th Five-Year Plan (2011-15)[34]

Indicator		% change
Water usage reduction per unit of industrial added value		-30
Non-fossil fuel consumption vs total primary energy consumption		+3.1
Energy reduction per unit of GDP		-16
CO_2 emissions reduction per unit of GDP		-17
Emissions reduction of key pollutants:	COD	-8
	SO_2	-8
	Ammonia nitrogen	-10
	NOx	-10
Forest coverage		+1.3

Recent deterioration in air quality has prompted even more aggressive measures for reducing coal consumption. September 2013 was a watershed moment in Chinese energy policy, after a series of heavy smog experiences throughout that year was met with the 'Action Plan for Air Pollution and Control'[35]. The Plan takes aim at three key economic regions; Beijing-Tianjin-Heibei, the Yangtze River Delta and the Pearl River Delta, with mandatory reductions in fine particle (PM2.5) air pollution. This plan recognised that achieving these outcomes requires transformation of the energy system which has been the source of the increasing pollution. The plan features a ban on new conventional coal-fired power plants in these regions, reductions in coal consumption and steel production as well as introduction of Euro 5 vehicle fuel efficiency standards. Coal has been recognised as the main offender and the plan is targeting a peak in coal consumption in these regions by 2017.

As well as this, FYP12 aims to reduce sulphur dioxide emissions by 8%, and ammonia nitrogen and nitrogen oxide emissions by 10%; the majority of which come from China's coal dominated industrial sector. Overall, pollution control measures through FYP12 and the Air Pollution Control Action Plan are expected to have significant depressing impacts on coal usage.

Water

Water scarcity remains one of the biggest problems faced by China. Contamination of water sources combined with exponential growth of urban centres now sees over 400 cities experiencing water shortages[36]. In order to respond to demand pressures, water intensity, defined as the water consumed per unit of industrial added value, is set to be cut by 30% by 2015[34] with water quotas issued to every province in 2013[37]. With the coal sector currently responsible for 17% of water withdrawals nationally[38], increased coal washing coupled with increased power plant efficiency is expected to place downward pressure on coal demand and therefore imports into the future.

The Green Economy

The shift in China's industrial strategy in FYP12 transfers focus onto promotion and prioritisation of new 'strategic and emerging' industries. Renewables and clean energy vehicles are replacing the 'old' state-owned strategic pillar industries such as coal, defence and oil. These industries will benefit from state support in the form of research and development funding, low cost capital and supportive market reform. The transition, shown in Table 3, represents 50 years of industrial development from one five year plan to the next and indicates China's shift to sustainable development.

TABLE 3 Comparison of seven priority industries from FYP11 (2006-10) and FYP12 (2011-16)[34]

	FYP11	FYP12
1	National defence	New energy
2	Telecom	Energy efficiency and environmental protection
3	Electricity	Biotechnology
4	Oil	New materials
5	Coal	New IT
6	Airlines	High-end manufacturing
7	Marine shipping	Clean energy vehicles

FYP12 outlines a shift in the direction of the Chinese economy. New policy instruments will drive this transition and promote the development of a green economy. Progress to date is evidenced by the massive investment in clean energy and energy efficiency, with China emerging as a global leader in the sector. GDP contributions from the seven priority industries are expected to increase from 2% to 8% by 2015.

Clean energy

The growth of the clean energy industry in China outpaces total growth in capacity for the rest of the world. Political support for the expansion of clean energy is driving China to the forefront of the global clean energy industry and acting as a depressive influence on Chinese coal demands as the share of renewables in China's energy mix increases.

Ambitious renewable energy goals continue to be upgraded due to a higher than anticipated rate of expansion. In 2006 China's renewable energy planning was targeting an installed capacity of 30GW of wind and 2GW of solar PV by 2020. Installed wind capacity had already reached 80GW by 2009 and in 2010 targets were increased to 150GW of wind and 20GW of solar PV by 2020. The DRC Energy Research Institute is now suggesting installed capacities of over 200GW of wind and 150GW of solar PV by 2020[39].

China's ambitious wind target established in 2011 under FYP12 aimed to have connected 100GW of wind capacity to the grid by 2015 and 150 GW by 2020[40]. Due to faster than expected expansion of the sector, targets have since been revised up to 140GW of installed capacity by 2015[32]. Hydro power is also being dramatically increased with a target of 420GW of capacity by 2020[33]. This is double the capacity in 2011 with 31GW having been commissioned in 2013-14[41].

The Feed-in-Tariff (FiT) is the principal policy driver of wind farm growth whereby generators receive a fixed purchase price higher than the price for coal-fired electricity. Growth of renewable capacity is also supported by China's Renewable Energy Law, which promotes renewable energy by combining mandated targets, market-based incentive and direct subsidies[42].

Energy efficiency

FYP12 contains strong energy efficiency commitments. Under FYP11 (2006-2010), significant investments were made in industrial energy efficiency which resulted in a 19% fall in energy per unit of GDP[43]. For the first time, under the FYP12, China has established a target under the Copenhagen Accord and submitted it to the United Nations Framework Convention on Climate Change (UNFCCC) to reduce carbon intensity per unit of GDP by 40-45% by 2020, compared to 2005 levels[44]. A total closure of 72.1GW of inefficient power and industrial facilities during the FYP11 contributed to a marked decline in energy intensity[45]. The deeper cuts to inefficient energy use outlined in the FYP12, will contribute significantly to a reduced demand for coal.

Coal is the dominant fuel in China's industrial sector, with the steel and iron industry accounting for 50% of industrial coal usage and cement production accounting for 20%. Industrial coal demand grew strongly over the period 2002-2011 averaging 9.5% per annum. Growth in industrial coal demand has now slowed to 1.9% per annum and is expected to peak before 2020 as the Chinese economy begins to transition away from heavy industries. Industrial demand is then expected to fall away from this peak at a rate of 0.9% per annum, significantly depressing overall Chinese coal demand and price.

Emissions Trading

After operating six pilot Emissions Trading Schemes (ETS), beginning with Guangdong province in 2013, the National Development and Reform Commission (NDRC) recently announced China's intention to introduce a national ETS by 2016[46]. The resulting carbon market is expected to encompass 3-4 billion tonnes of CO_2 by 2020; around six times Australia's annual emissions. The expected value of the carbon market (AU$11-73 billion) suggests a carbon price of between AU$4-18 per tonne. With the emissions intensity of China's industrial sector more than three times that of Europe, a given price on carbon emissions there will be more potent than in advanced economies[47].

Implications

These policy measures have been translated into a trajectory of primary energy demand for comparison with the projected IEA scenarios. This has been guided from announcements of the government's objectives by the Director of the Development Research Centre (DRC) of China's State Council[48]. Specified proportional energy targets for coal, from 67% (2012), to 60% (2020) and below 50% (2030); gas from 5% (2012), to 10% (2020) and 15% (2030); and non-fossil energy (renewables plus nuclear) from 9% (2012), to 15% (2020) and 25% (2030). These targets were augmented by further insights recently presented by a director of Energy Research Institute (ERI) from the National Development and Reform Commission[39]. The resulting trajectory to 2020 is shown in Table 4.

TABLE 4 Chinese energy demand and composition in 2011 and projected for 2020 according to announced targets*

Resource	2011		2020	
Coal	1866	68%	1882	60%
Oil	446	16%	550	17%
Gas	110	4%	418	13%
Hydro	60	2%	106	3%
Nuclear	23	1%	123	4%
Wind & solar	21	1%	105	3%
Bio energy	216	8%	213	7%
Total		**2743**		**3185**
Intensity				
Energy mtoe/GDP		0.653		0.428
Emissions kT CO2/GDP		2.066		1.33

* Conflicting proportions for 2011 table values and noted 2012 values is attributable to differing definitions of the IEA and the National Bureau of Statistics of China (NBSC).

Comparing this outlook with the IEA projected scenario range gives an indication of which scenario is more consistent with the continuing development of Chinese energy policy. The projection for coal demand is shown in Figure 38. Both of the scenarios provided by the IEA indicate a dramatic change in the pattern of coal use taking place in China. The *NPS* projection indicates demand plateauing shortly after 2020 after a decade of 10% annual growth. What is shown however is the most recent targets stated by the Energy Research Institute suggest demand for coal will track very closely to the *450* projection provided by the IEA, declining in absolute terms prior to 2020.

Looking at demand for gas in China, Figure 39 shows very little difference in the *NPS* and *450* scenario projections provided by the IEA. The goals provided by the ERI indicate a much higher demand for gas to 2020. How this will unfold for Australian LNG exporters is unclear as China has entered a substantial supply deal with Russia, with more being negotiated, and is constructing a pipeline network for international transportation[27]. This volume is estimated to be valued lower than the breakeven price of Australian LNG projects putting profitability, therefore rents and company tax revenue which is the main remaining revenue stream for Australia, in doubt.

The IEA outlook for renewable sources of energy in China are similarly underestimated compared with the stated goals from the ERI. Figure 41 shows the *450* scenario diverges from the *NPS* scenario around 2020 with a rapid increase. The goals of the Energy Research Institute bring this divergence to the present year, climbing faster than the *450* projection.

Overall, it is clear that, as the IEA states, "a small shift in China's supply and demand balance could have a large impact on global trade"[15]. Given China's political will to deal with pollution-related health and greenhouse gas issues, as well as its huge domestic fuel resources, it is likely that China's appetite for imported fossil fuels could disappear, resulting in global supply exceeding demand and suppressing global prices.

FIGURE 38 China coal primary energy demand. Comparison of historic consumption, IEA projections and NDRC targets.

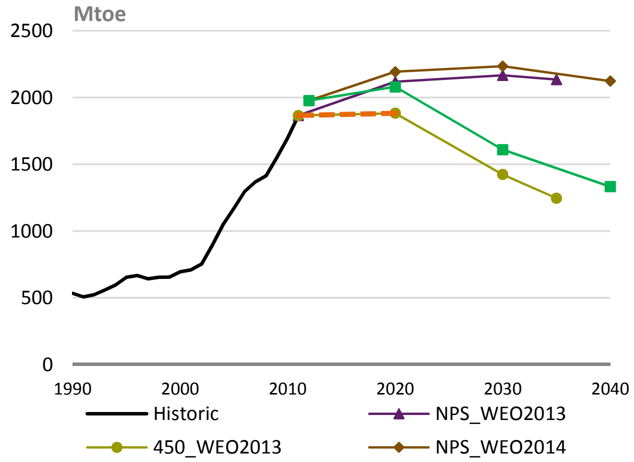


FIGURE 39 China gas primary energy demand. Comparison of historic consumption, IEA projections and NDRC targets.

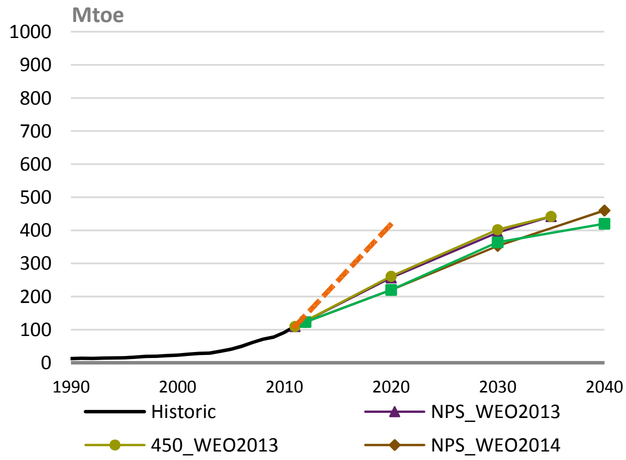


FIGURE 40 China nuclear primary energy demand. Comparison of historic consumption, IEA projections and NDRC targets.

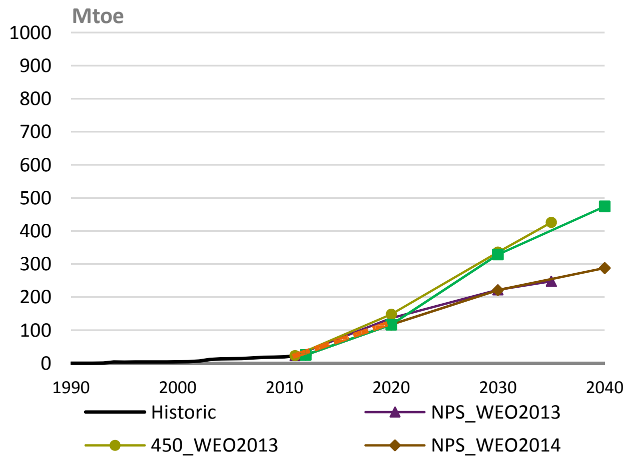
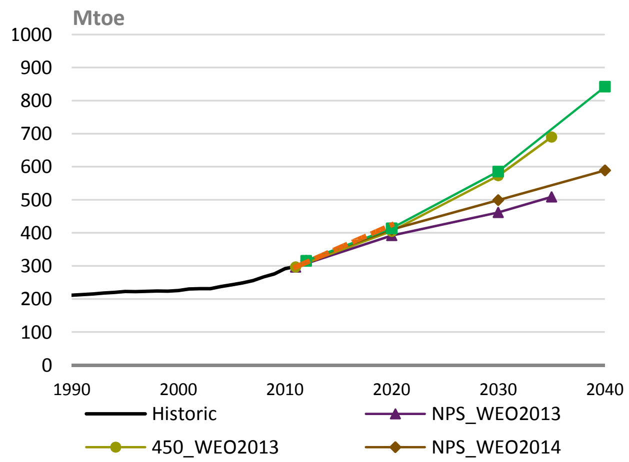


FIGURE 41 China renewable primary energy demand (incl. hydro, biomass, wind and solar). Comparison of historic consumption, IEA projections and NDRC targets.



Japanese efficiency

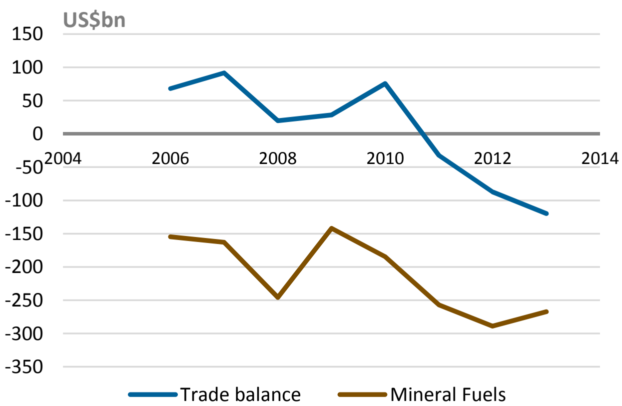
Long after the immediate destruction of the 2011 Fukushima Daiichi nuclear disaster, the Japanese energy system has been under stress and a drag on the national economy. Observing the vulnerability of its nuclear generators the Japanese leadership swiftly turned off its reactors, until safety audits and necessary upgrades had been completed – a process still ongoing. The disruption to the energy system required both demand management as well as substitution with fossil fuels to fill the energy void. The substitution of domestic nuclear generation of electricity with imports, primarily high priced LNG, has caused an imbalance in Japan's trade balance, leading to a growing trade deficit. This unsustainable economic situation has spurred an energy efficiency drive throughout Japan to reduce this liability.

The nuclear shutdown removed 30% of Japan's power system from service requiring the country to secure a supply of energy in the midst of turbulent market prices[49]. Natural gas, the preferred substitute for Japan following the disaster, was ramped up quickly, but the cost has become problematic. The Asian gas market is experiencing the highest prices internationally following a divergence in US, European and Asian markets coinciding with the 2008 Global Financial Crisis (GFC). The price of gas to Asia has traditionally been linked to the oil price which has remained high since the GFC.

Japan's energy deficit

The high cost of imported gas is causing record losses among Japanese utilities, undermining the competitiveness of energy intensive industries and contributing to a mounting trade deficit. This issue was featured strongly in Japan's 2014 Energy Annual Report. The report pointed to the fact that the country is more reliant on non-nuclear fossil energy today (88%), than before the damaging oil shocks of the 1970s (80%). In 2010, prior to the Fukashima disaster, coal, oil and gas constituted 62% of Japan's primary energy mix[50]. In the wake of the oil shocks Japan's economy suffered. The leaders of the country are anxious about their present vulnerability to commodity market volatility. The increased imports of gas, oil and coal to fill the nuclear void have been one of the major causes of a growing current account and trade deficit (Figure 42).

FIGURE 42 Japan's annual expenditure on mineral fuel imports and aggreagate trade balance



This situation is regarded by officials as unsustainable for Japan. Their most recent energy policy, the Strategic Energy Plan (SEP), targets this problem of import exposure as well as regarding energy security as a central issue[51]. The SEP calls

TOP RUNNER ENERGY EFFICIENCY PROGRAM[54]

Japan's Top Runner Program establishes standards for a wide range of energy consuming products such as domestic appliances, home air conditioners, vehicles and lighting. The program was initiated in the 1998. Standards for product energy efficiency are defined by the product on the market with the highest energy efficiency. Taking this product as a benchmark, standards are established that aim to meet an efficiency goal in a given timeframe.

In 1999 standards were established for passenger vehicles; a fuel economy improvement of 22.8% was targeted for 2010. The race to the top caused by the Top Runner Program saw the goal being met 5 years early in 2005. The program promotes market competition amongst Japanese manufacturers, fuelling innovation and best practice whilst creating a market for the most energy efficient products through information campaigns and energy efficiency labeling. Adoption of increasingly energy efficient consumer goods has allowed Japan to reduce household energy usage considerably. The Top Runner program saw the efficiency of household air-conditioners increase by 67% in 7 years. Japanese experience with the Top Runner Program shows how ambitious policy that matches market conditions as well as technological conditions can work very well to achieve remarkable energy efficiency gains.

for reinstatement of limited nuclear capacity, the ultimate volume to be considered on the basis of: "a stable energy supply, cost reduction, global warming and maintaining nuclear technologies and human resources."

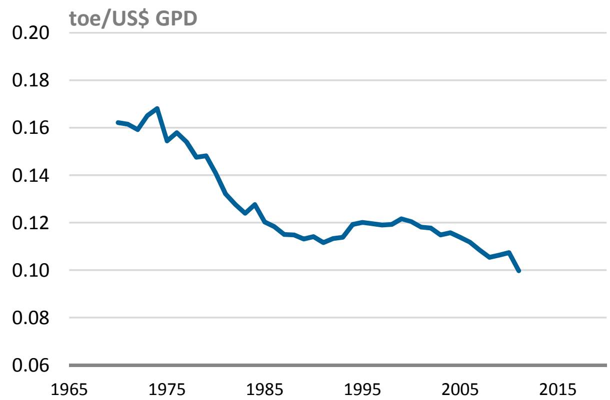
Without a domestic source of fossil energy and while a limited reinstatement of nuclear power slowly progresses, Japan is addressing this problem from two angles.

Efficiency drive

Knowing that the lowest cost energy is that which is not used, Japan has embarked on a broad energy efficiency agenda. A variety of national measures including public relations campaigns, advisory projects, workshops and conference events were launched to educate the nation on energy saving practices. Born out of the power cuts following the Tohoku earthquake and tsunami with the popular 'Setsuden' (saving energy) campaign, these emergency measures have proved to be lasting solutions offsetting a substantial amount of the lost nuclear capacity[52]. Simple yet concerted actions such as switching off appliances, 'thinning' lighting and reducing air conditioner use were immediately effective and commercial facilities were audited for energy savings opportunities. Japan's renowned Top Runner efficiency program was extended in 2013 (see box above), strict building energy efficiency codes have been implemented and some energy intensive industries are being phased out[15].

The Strategic Energy Plan notes that in response to the oil shock in the 1970s, Japan reduced its energy intensity by 40% through a number of initiatives and regulation. Emulating this past success, the Government of Japan is pursuing new energy efficiency policies targeting buildings, appliances, vehicles, industry as well as demand management strategies. The Institute for Energy Economics and Financial Analysis calculates that energy efficiency has reduced electricity demand per unit of real GDP by 15% over the three years to 2014[53].

FIGURE 43 Reduction in Japan's energy intensity following the 1970s oil shock



Solar energy drive

In addition, Japan has been installing solar PV at a rapid rate, aided by a generous Feed-in Tariff (FiT). Introduced in 2012, the FiT scheme requires utilities to purchase electricity from renewable generators. The scheme has overseen the installation of 8.7 GW of solar capacity with a further 72GW of solar approved but yet to be installed[55]. Though the scheme has progressively been wound the FiT for solar projects, the Japanese government has increased the tariff for wind projects with the intention of diversifying the renewable energy portfolio[56]. This will continue to offset demand for fossil fuels, both coal and gas, and steadily reduce the country's energy import liability.

As Japan reduces its natural gas demand it will be in a stronger negotiating position with suppliers. Australia, being a high cost producer of LNG, will be in an uncomfortable position when contracted volumes have expired and they must compete with the international market.

Energy demand flattening

At this point in time no specific targets have been issued for future energy volumes or proportional mix of sources. Considering the projections from the IEA it can be seen that future demand for coal and gas in Japan is expected to remain relatively flat in the case of the New Policies Scenario, even a gradual decline in demand for coal after 2020 (Figure 44 and Figure 45). For the *450* scenario, a moderate decline in demand for gas is indicated with coal demand reducing by half over the projection period.

The supply of nuclear power is expected to rebound in both scenarios, plateauing in the vicinity of pre-Fukashima disaster levels (Figure 46). Also significantly increasing in both scenarios is the supply of renewable energy, rising at an accelerating rate over the next decade and continuing to climb thereafter (Figure 47).

Despite the uncertainty of these projections, the outlook for total energy demand in Japan appears to be relatively stable. The cost burden of importing fossil energy will no doubt result in a phase out of these sources of energy as the domestic sources, nuclear and renewables, are progressively brought online.

FIGURE 44 Japan coal primary energy demand. Comparison of historic consumption and IEA projections.

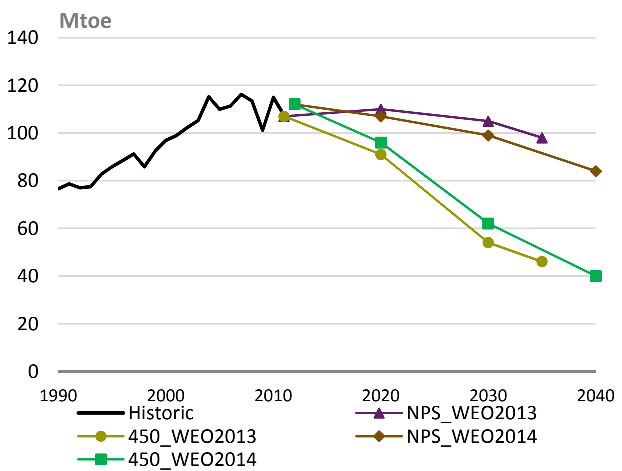


FIGURE 45 Japan gas primary energy demand. Comparison of historic consumption and IEA projections.

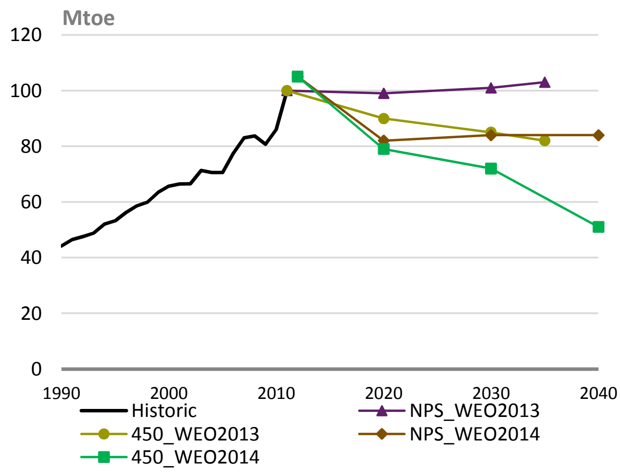


FIGURE 46 Japan nuclear primary energy demand. Comparison of historic consumption and IEA projections.

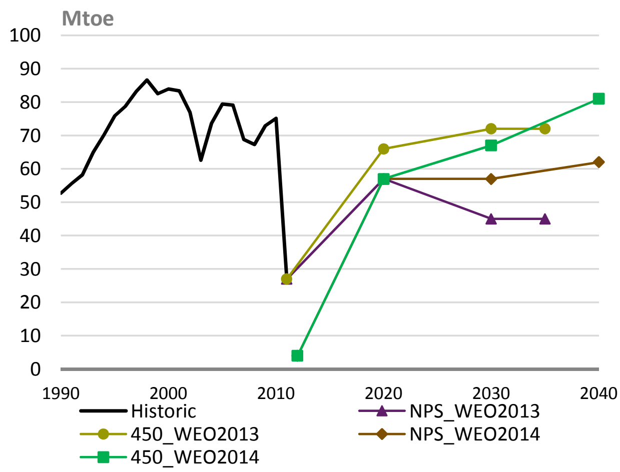
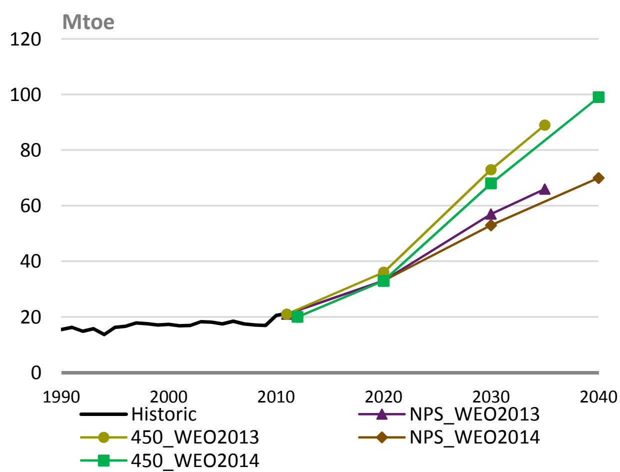


FIGURE 47 Japan renewable primary energy demand (incl. hydro, biomass, wind and solar). Comparison of historic consumption and IEA projections.



Going Green in Korea

Over the past two decades Korea has emerged as a key industrial nation in the Asian region. Energy consumption has rapidly increased in step with successful heavy industries and is now among the most emissions intensive in the OECD group of advanced economies[23]. With the recent push for a 'Green Growth' model in Korea, the trend in the energy sector has been recognised as contrary to the nation's ambitions. Past subsidisation of emission intensive energy sources such as imported coal and gas has promoted their use with poor environmental and economic outcomes. With a mission to take account of the full social, environmental as well as financial cost of energy, Korea is introducing substantial taxes on coal and an extensive emission trading scheme to shift the balance towards low carbon technologies.

Korea is one of the fastest growing economies in the world and has undergone massive development in the past couple of decades. The country has enjoyed 8.6% average annual GDP growth, placing it as Asia's fourth largest economy in 2010. This in turn led to unprecedented demand for electricity supply, rising from 33 TWh in 1980 to 499 TWh in 2011[57].

Korea currently relies on fuel imports for 97% of its energy demand, placing it in the bracket of low resource countries such as Japan and Germany. However there is a clear difference between the situation of Korea and other energy-poor countries. For Japan, Germany and France, energy consumption is decreasing, not increasing, and therefore the need for infrastructure investment is higher for Korea[58]. Korea is currently the world's second-largest importer of LNG, the fourth-largest importer of coal, and the fifth-largest net importer of oil products[59]. Currently Korea relies exclusively on tanker shipments of LNG and crude oil, as it has no international oil or natural gas pipelines. While the government has goals to offset the nation's imports, encouraging Korean oil and gas companies to explore offshore investment opportunities, there is also an emerging focus on domestic renewable energy. As part of Korea's new economic model of 'green growth', renewables satisfy energy security goals, whilst also addressing environmental and social concerns.

Role of nuclear

Nuclear plays a strategic priority for Korea's energy security as it provides a low carbon and relatively low cost source of energy when compared to the costs of imports. Currently Nuclear accounts for one third of Korea's electricity supply, with 23 reactors around the country[57]. The government originally planned to increase the share of nuclear in providing energy over the next 20 years, increasing capacity by 59% to 32.9GW by 2022. However this increase has been at the centre of much public resistance since Japan's 2011 Fukushima disaster.

In the most recent energy policy paper, it is made clear that Korea will be seeking to limit its reliance on nuclear in the long term. Korea is seeking to diversify its energy portfolio to meet energy consumption, whilst also attending to the social and environmental costs of consumption. This has pushed the government to implement pricing on imports and to pursue renewable technology.

Korea Energy Master Plan

The 2014 Korea Energy Master Plan outlines the main principles and objectives up to 2035, which are highly conducive with the "3 Es" which were established in their First Master Energy Plan in 2008, Energy Security, Efficiency, and Environment. The Major tasks until 2035 are[58]:

1. Make the transition to energy policies focused on demand management, with an objective of reducing electricity demand by 15%, achieved through energy tax rates, improved electricity rate systems, and establish a demand management system based on communication technologies.
2. Build a distributed generation system, which will supply more than 15% of power from distributed generation.
3. Strike a balance with environmental and safety concerns, applying the latest GHG reduction technology to new power plants, which will in turn strengthen climate change response and enhance nuclear safety.
4. Enhance energy security and energy supply stability, involving the development of overseas resource capacity and achieving a renewable energy deployment rate of 11%. This will be done through reinforcing public resource development enterprises, expanding renewable energy deployment and enhancing international co-operation.
5. Establish a stable supply system for each energy source. Here Korea will look to secure stable supply of conventional energy sources, oil and gas. Achieved through diversifying supply routes, expanding domestic stockpiling capacity etc.
6. Shape energy policy to reflect public opinion, with an objective to introduce an "Energy Voucher System" in 2015. The main task will be to improve welfare and respond pro-actively to energy related controversies.

Coal tax and emissions trading scheme

Korea announced in its energy master plan that it will be enforcing a tax on coal in order to more fully account for the cost of using this energy source. A distortion in energy consumption has been recognised and that energy prices are not reflective of the environmental and social costs of power generation[58]. Even though coal emits more GHG and pollutants than gas, gas is taxed at a rate of 16% while coal is currently not taxed. The tax will in turn encourage a lower consumption of coal as an energy source and also incentivise renewables and non-carbon intensive energy sources in Korea. The ministry of finance has announced in a statement that as of July 1 2014 there will be a tax imposed on coal of 19 won per kilogram with a net calorific value above 5,000kcal/kg (AU$20/t); 17 won per kilogram (AU$18/t) for lower calorific value coal[60]. It also announced that other energy sources that are less GHG intensive will have their respective taxes reduced.

Korea is currently Australia's second largest importer of coal, accounting for 19% of all Australian exports[22]. The dampening effect of the introduction of a tax will further ease global demand for Australia's coal production.

Adding to the disincentive of the coal tax, Korea is planning to enforce caps on CO_2 emissions for utilities and industry at the beginning of 2015 as part of an emission trading scheme. When the scheme is launched it will be the second largest in the world after Europe (until the commencement of China's national ETS) and will reinforce Asia as an emergent hub for carbon trading[61].

Changing pace of Korea's energy mix

The development of Korea's primary energy supply mix is projected in the Master Plan for the period to 2035. It is not possible to compare these targets with the estimates of the IEA scenarios as Korea is aggregated into the OECD Oceania group along with Australia, New Zealand and Japan. The projections from the Master plan (Table 5) have been charted in relation to the historic energy demand to give an indication of the change expected to take place in Korea in the near future. The misalignment of the two data sources is assumed to be due to differing accounting protocols.

TABLE 5 Korea Energy Master Plan primary energy mix targets

Source	2011	2025	2030	2035	Annual growth (%)
Coal	83.6	100.2	107.7	112.4	1.24
Oil	105.1	111.0	107.1	101.5	-0.15
Gas	46.3	64.8	69.8	73.3	1.93
Hydro	1.7	1.7	1.9	2.0	0.70
Nuclear	32.3	59.6	65.3	70.0	3.28
Renewable & other	6.6	16.8	18.0	18.8	4.44
Total	**275.7**	**354.1**	**369.9**	**377.9**	**1.32**

Over the past two decades Korea saw a rapid increase in demand for coal, increasing four fold. Almost all was imported. The Master Plan maintains expectation for growing consumption of coal however at a much slower pace (Figure 48). This will no doubt be influenced by the policies and price signals previously discussed.

Projections for both gas and nuclear energy approximately follow the historic trend although nuclear development appears to have stalled in the last five years (Figure 49 and Figure 50). After starting from a low base, renewable energy is expected to grow over the next decade with the growth petering out after 2035 (Figure 51).

FIGURE 48 Korea coal primary energy demand. Comparison of historic consumption and Korea Energy Master Plan targets.

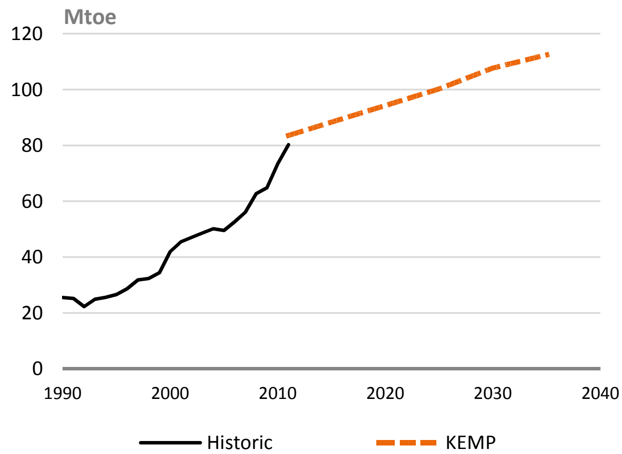


FIGURE 49 **Korea gas primary energy demand. Comparison of historic consumption and Korea Energy Master Plan targets.**

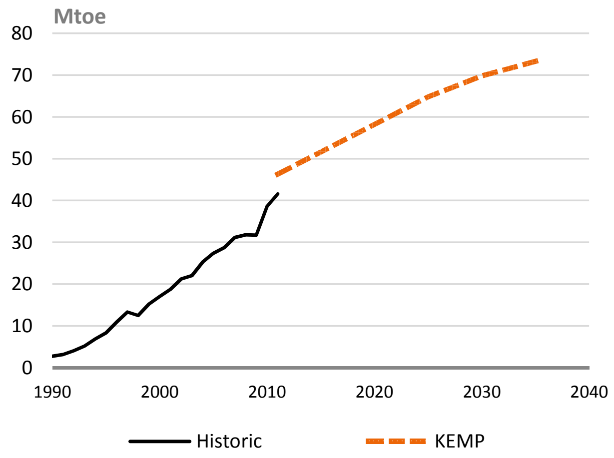


FIGURE 50 **Korea nuclear primary energy demand. Comparison of historic consumption and Korea Energy Master Plan targets.**

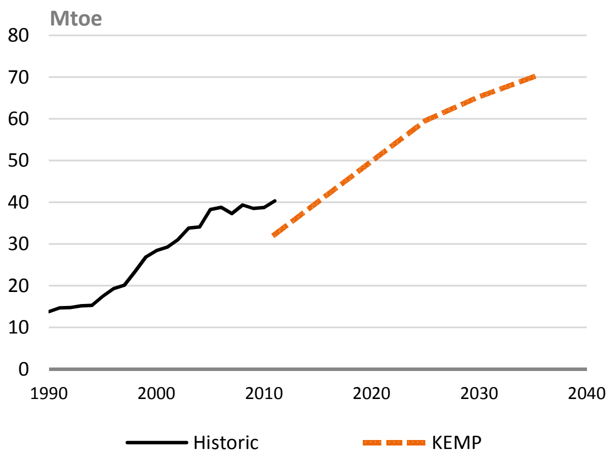
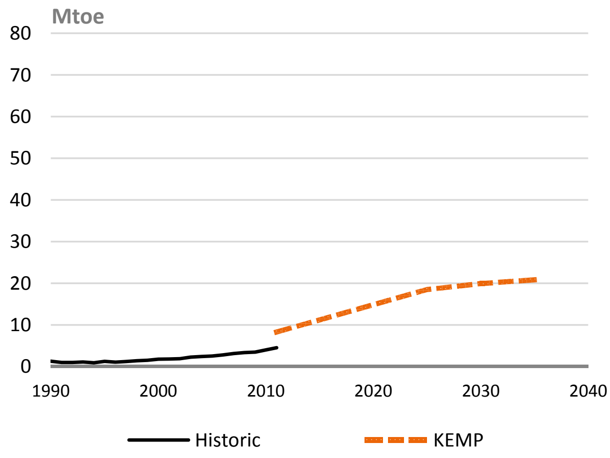


FIGURE 51 **Korea renewable primary energy demand (incl. hydro, biomass, wind and solar). Comparison of historic consumption and Korea Energy Master Plan targets.**



Developments in India

The challenges facing the Indian energy sector are large and multi-faceted. Demand is set to soar as India enters an energy intensive phase of development, whilst the electricity demands of a booming, urbanised, middle class rise exponentially. Meanwhile, a huge segment of the Indian population is disconnected from the national grid whilst remaining reliant on biomass and other inefficient fuels for their primary energy needs. Expansion of India's energy sector is hampered by inefficiencies within the electricity sector regulators, utility operators and their main provider of fuel, the domestic coal industry. India's new government is signalling a "paradigm shift" in the energy sector. Guided by the principles of access to energy, energy security and climate change mitigation, a new energy strategy is being developed. This strategy aims to maximise its domestic coal industry in order to cease imports, a 'Saffron Revolution' using solar power to provide electricity to all Indians as well as a national power grid.

Current state of affairs

India has the fifth largest power generation portfolio worldwide and is the world's fourth largest energy consumer after China, the United States and Russia[15]. Over the last 20 years the Indian power sector has seen huge transformation. In the period from 1990 to 2009 electricity generation has more than tripled with India now having 211 GW of installed electricity generation capacity – mostly in coal-powered plants.

Nonetheless, a significant portion of the Indian population still lack access to modern energy services. It is estimated that 45% of population are not on the commercial energy grid and that 290 million Indians (or nearly 25%) live without any access to electricity[62]. Energy poverty within India is recognised as a barrier to economic development. Consequently, bringing electricity to those suffering from energy poverty is a high priority in Indian energy policy. Annual energy use per capita in India is currently well below the OECD average, at 0.6 tonnes of oil equivalent, and low even relative to developing countries.

Although delivering electricity to 1.24 billion people is a monumental challenge in itself, it only represents one of the many challenges facing the Indian energy sector. Energy demand in India is set to soar as the population heads towards 1.5 billion[63] and the economy enters an energy intensive phase. This will feature investment in infrastructure and heavy manufacturing to provide the basis for a sophisticated industry and improved standard of living. Consequentially, energy demand in India is increasing, however meeting current energy demands is proving to be challenge enough, let alone meeting projected future demands.

A changing energy strategy

The change of government in April 2014 is ushering in a paradigm shift in India's energy strategy. Promising a "Saffron Revolution", the new Prime Minister, Narendra Modi, declared that the government would harness the sun to deliver power to all of India's citizens. The goals are a major departure from the previous government approach.

In 2006, India's Planning Commission released an Integrated Energy Policy (IEP)[64]. Until recently, this was the core energy policy to guide intermediate stages of planning to meet the country's growing

energy needs. The IEP provided energy supply targets to 2032 as well as policy strategies. A key direction of the IEP was the long-term dominance of coal in the energy mix as the primary energy demand was projected to more than triple.

In accordance with the Integrated Energy Policy, the previous government pursued an expansion of the power sector through its Five Year Plans (not to be confused with China's FYPs). FYP12, ending in 2017, targets a 42% increase in generation capacity coming mainly from coal. Achieving these aims of expanded coal power has so far proved difficult for India, falling short of the targets set in FYP11, and with scandals surrounding the previous government's allocation of permits to develop coal deposits. What first appeared to be an affordable and relatively simple option is increasingly recognised not to be the case.

Currently, bottlenecks in production and transportation of coal as well as other fuels have led to serious energy shortages, while transmission and revenue collection losses continue to undermine margins and efficiency. As a result of insufficient fuel supply and inefficiency in the generation, transmission and distribution of electricity, the country suffers from a severe shortage of electricity and rolling blackouts. As a result, a major restructuring of the Indian power sector is required in order to fully meet current and future electricity demand.

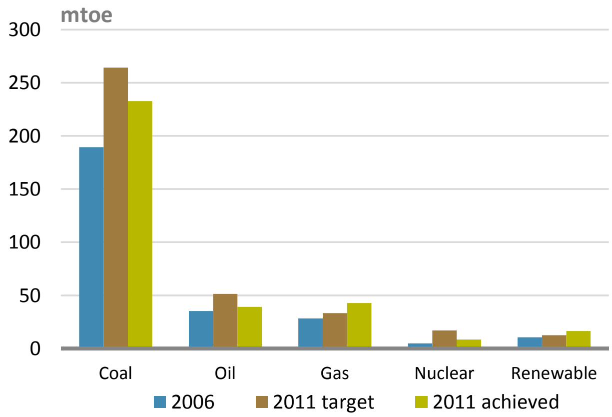
Led by Modi, the new Bharatiya Janata Party (BJP) government has recognised the necessity of a new energy strategy, making it central to their 2014 election policy platform. A formal energy policy has yet to be issued, but a series of public statements and pilot initiatives give texture to the intentions of the new government: ambitious goals for solar energy, large scale solar farms, winding back fossil fuel subsidies, domestic coal sector reform, oil and gas exploration; all to the effect of increasing energy security. Most recently the energy minister, Piyush Goyal, indicated India's intention to cease imports of coal within 2-3years.

The fossil fuel option

India has the world's third largest hard coal reserves, after the United States and China[65]. Even given the inefficiencies of the Indian coal sector, India is the world's third largest coal producer after China and the United States, and is expected to surpass the United States by 2025[15]. A number of factors may inhibit further expansion of domestic coal production.

Two state-owned companies maintain a duopoly of India's coal production, representing a share of almost 90% and leaving little room for competition to drive productivity. If Coal India (CIL) and Singareni Collieries Company Ltd (SCCL) fail to achieve production targets, there is no reliable alternative source to make up the losses other than imports[63]. Domestic coal production has been stagnating in recent years and failed to achieve the production targets of FYP11 (Figure 52).

FIGURE 52 India FYP11 energy targets and achieved energy growth compared with 2006 benchmark



Geography has presented a major barrier to increasing domestic coal production. The dysfunctional transmission system has required the physical transportation of coal from mines to generators near high demand markets. The new government has made nationally integrated transmission system one of its top priorities. This will allow electricity to be transmitted to any location on the grid from its physical source, be that coal or renewable generators.

The bureaucratic process for obtaining approval for a new coalmine or generation facility also creates considerable delays in the expansion of domestic capacity. The official timeframe to obtain environmental and forestry clearance permissions is 150 to 210 days, but commonly takes two to six years, resulting in delays of project implementation and further shortfalls in coal production. This delay is largely a result of hard fought land use conflicts. With India under severe population stress, coal deposits coinciding with farms and villages face the protestations of local residents. The defence of forests and areas of ecological value also attract substantial support.

A recent scandal surrounding the improper allocation of coal development permits, colloquially known as 'Coalgate', has generated public outrage. Uncompetitive tendering resulting in cut price access to the country's natural resources was rejected by India's Supreme Court, ordering the

cancellation of 214 of 218 allocations awarded since 1993[66]. The allocations which have since been developed are facing fines while others are subject to retendering; both results adding cost pressure to domestic coal extraction.

Considerable reform of the coal sector, major infrastructure investment, and increased bureaucratic efficiency is required in order to overcome these barriers. Given the scale of India's coal reserves, there is little doubt that India will attempt to exploit this domestic resource, maintaining coal as a feature of India's energy mix. As a democracy though, political leaders in India will face increasing difficulty and cost in forcing through new developments at the expense of local populations.

IMPORTS

The failure of domestic coal production to meet demand has seen Indian coal imports increase dramatically during the decade. The growth of coal imports is now outpacing domestic production by 86 Mt annually. Coal imports now equal 13% of total coal consumption[67]. Oil is an even greater problem with imports accounting for around 75% of consumption[63].

While imports may appear to be the solution to India's energy challenges, the country's capacity for imports, especially of coal, is subject to a number of barriers.

There exists a considerable disparity between domestic and international coal prices, with imported coal considerably more expensive than domestic coal. Indian electricity generators, transmission companies and distributors are subject to a rigid tariff system aimed at maintaining affordable electricity prices for citizens. Consequentially, generators are therefore unable to pass on the additional cost of imported coal to consumers. In effect, the rigid pricing regime places a ceiling price on coal imports. Passing this ceiling would mean losses for generators.

Another concern for India is the trade deficit which has grown substantially over the past decade, approaching US$200 billion in 2012-13. Energy is a major contributor to this trade imbalance, principally petroleum, but coal has been increasing. This has been a drag on the country's economic development rather than a boost. Exports have underperformed and the resulting deficit devaluing the local currency is deterring investment needed to boost productivity. Oil is the bigger contributor on a value basis however coal imports have attracted criticism from the Government in light of the domestic resource and unproductive local industry. At a macro level, the capacity for India to increase its imports of coal will be constrained by the performance of exporters and the productivity gains within the economy.

Alternatives

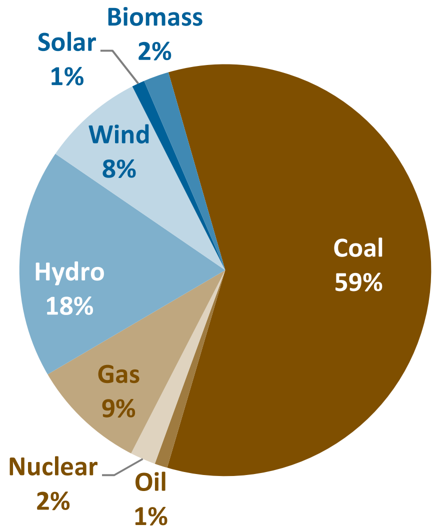
Awareness is high within the Indian political sphere of the dangers in continuing with a business-as-usual energy path. Indian leaders are learning from the experience of China, now dealing with the adverse environmental and health impacts of a rapid ramp up in fossil fuel use. Successive Indian governments have enacted legislation aiming to curb the fossil fuel intensity of growth, increase energy efficiency and increase the share of renewables in the energy mix. Since 2010 coal use has been taxed at a rate of 50 rupees per tonne (AU$0.93/t); in 2014 the tax was doubled[68]. The proceeds of this tax are directed to the National Clean Energy Fund and used to finance renewable energy projects.

RENEWABLES

Renewables are already an essential part of India's energy mix, and are an attractive option to enhance energy security, provide universal energy access to the population, as well as to mitigate global warming (Figure 53).

As of May 2014 India had 31.8GW of installed renewable energy capacity, making up 12.5% of India's energy mix, up from 8% in 2008 and above the aspirational goal of 30GW of non-hydro renewables given in the Integrated Energy Policy[69,70]. Including hydro power brings the renewable generation capacity to 72.4GW (29.5%).

FIGURE 53 India's installed electricity generation capacity by source as of May 2014



Renewables are no longer seen as an alternate energy source to fossil energy, but as a solution critical to meeting basic energy needs, especially in rural and remote areas[71]. The distributed nature of renewable generation is advantageous in India where the costs of localised renewable generation compare favourably to extending network and fuel supply infrastructure to population centres not yet serviced.

India's 2008 National Action Plan on Climate Change (NAPCC) established a target of 15% renewable electricity generation by 2020[72].

Since issuing the NAPCC the deployment of wind power has kept pace with ambitious expectations during both FYP11 and FYP12 periods. Around 21GW of capacity is now installed, up from 7GW at the outset of FYP11, with the current rate of deployment between 2-3GW per year. Building on this success, the government is working to strengthen the wind sector with a National Wind Mission employing supportive policies and regulations, emulating the success of the National Solar Mission introduced with the NAPCC.

The roll out of the solar powered "Saffron Revolution" is becoming a powerful force in the Indian power sector. The incremental policy developments that have been introduced since the change of government in April have dwarfed the previous expectations for solar power. According to Piyush Goyal, India's Minister of State for Power, Coal and New & Renewable Energy:

"It will be much, much larger. I think for India to add 10,000MW a year [of solar] and six, or seven or eight of wind every year is not very difficult to envisage."[73]

Large scale utility installations are driving down solar costs in India bringing about some of the lowest power supply contracts seen anywhere in the world. Recent tenders of around 5.3 rupees per kWh (AU$0.10/kWh) are making solar power competitive with coal power derived from imports[74]. New projects of the "ultra mega" scale (500-1,000MW) are being encouraged by the government with the aim to install 25GW within five years[75]. Small scale distributed solar is also regarded to offer substantial potential[76]. Beyond the benefits associated with new found access to electricity, the roll out of small scale systems is being viewed as an extensive employment opportunity.

The Modi led BJP government's new energy strategy is expected around the end of 2014. While fossil energy is still expected to feature strongly, it is anticipated that the goals for renewable energy will mark a substantial change from the previous expectations and targets indicated in the 2006 IEP.

FIGURE 54 The Charanka solar park in Gujarat has an installed capacity of 224 MW

ENERGY EFFICIENCY

A growing focus on energy efficiency forms a major component of India's energy policy. The IEA predicts that a combined 42% of emission reductions in India during the period 2010-50 will come from energy efficiency improvements in power generation, end-use fuel and electricity consumption[63].

Spearheading efficiency improvements is the National Mission on Enhanced Energy Efficiency (NMEEE) which emanated from the NAPCC. Modelling from NMEEE has estimated that savings of coal, gas and petroleum products will equate to 23Mtoe by the end of the 2014/2015 financial year, while electricity savings will avoid over 19GW of capacity addition[63,77].

The centrepiece of NMEEE is the Perform, Achieve and Trade (PAT) scheme, which aims to improve energy efficiency in energy intensive industry through market-based, cost-effective mechanisms. Under the PAT scheme, eight energy-intensive industries, including power, iron & steel, cement, fertilizer and aluminium, will have mandatory participation in the first phase, with an expected reduction of energy consumption by energy intensive industries in three years[78]. The NMEEE also features an energy-efficiency financing platform focusing demand-side management (DSM) programs in all of the selected sectors by capturing energy savings.

The Ministry of New and Renewable Energy also sanctioned an 'Energy Efficient Solar/Green Buildings' scheme to be implemented during the 2013-14 financial year and run for the rest of the FYP12 period[78].

Provisional energy goals

In anticipation of the new government's energy strategy the goals indicated in the IEP and resulting FYP12 are considered provisional. Here they are compared with the two IEA scenarios. Again, the misalignment of base year values is assumed to be the result of differing accounting protocols. The goals from FYP12 exceed the New Policies

Scenario projection for all sources of energy. This is mainly due to higher estimates of GDP growth assumed India's central energy guide, the 2006 Integrated Energy Policy (IEP) compared with IEA expectations[63]. Though dated, the 2006 IEP provides the guidelines for subsequent five year plans until the new energy strategy is finalised.

In the case of coal, all projections pre-date the recent coal allocation fiasco and it is unclear how this will impact on these figures. In the *450* projection India's demand for coal plateaus by 2020 at a level which domestic supplies are expected to meet (Figure 55).

India is exploring many options to increase the availability of gas for use in the country. As well as sounding out many producers of LNG in search of diverse and affordable import arrangements, the government is also looking to a gas pipeline to central Asian supplies. This has been controversial in the past considering the need to traverse Pakistan which has historically presented diplomacy issues for co-operation. A concerted effort is being made to overcome any barriers in light of the pressure for secure access to energy. The goals in FYP12 indicate a much more rapid uptake of gas than the *NPS* and *450* scenarios which are more or less equivalent (Figure 56).

Both nuclear and renewable historic energy goals are consistent with the IEA projections (Figure 57 and Figure 58). The most interesting feature of these two energy source projections is the divergence of the *450* after the year 2020 and the sharp increase anticipated for renewable energy in the later years of the projection period. Considering the push by the new BJP government we will observe how effective their energy strategy is at achieving this increase in earlier years.

FIGURE 55 India coal primary energy demand. Comparison of historic consumption, IEA projections, Integrated Energy Policy scenario 5 targets and .FYP12 targets.

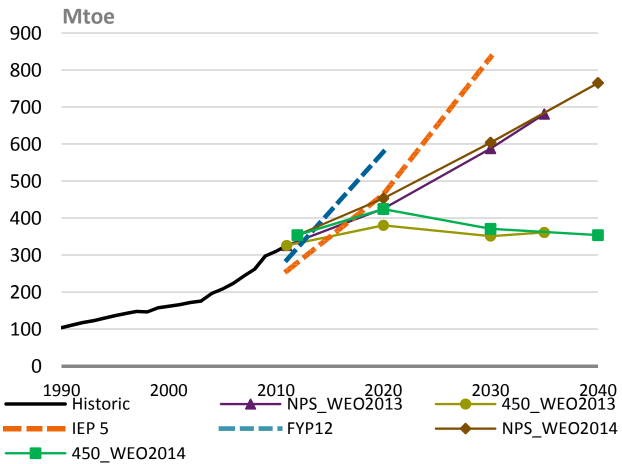


FIGURE 56 India gas primary energy demand. Comparison of historic consumption, IEA projections, Integrated Energy Policy scenario 5 targets and .FYP12 targets.

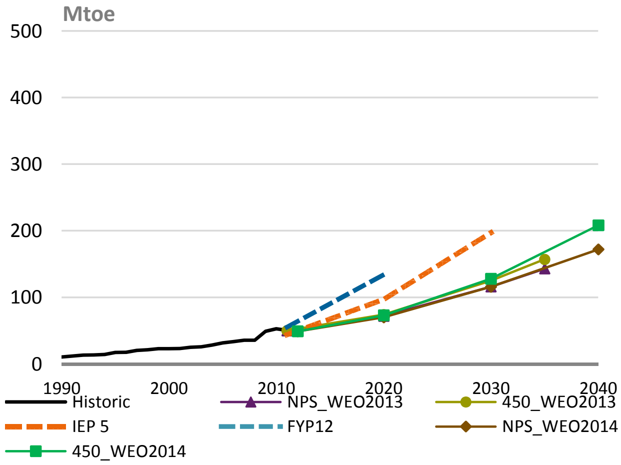


FIGURE 57 India nuclear primary energy demand. Comparison of historic consumption, IEA projections, Integrated Energy Policy scenario 5 targets and .FYP12 targets.

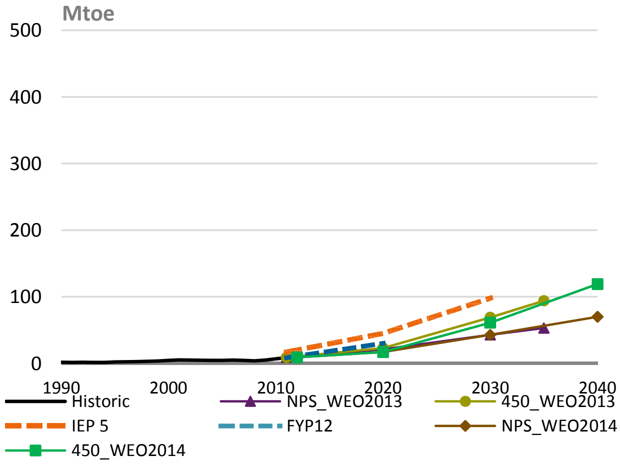
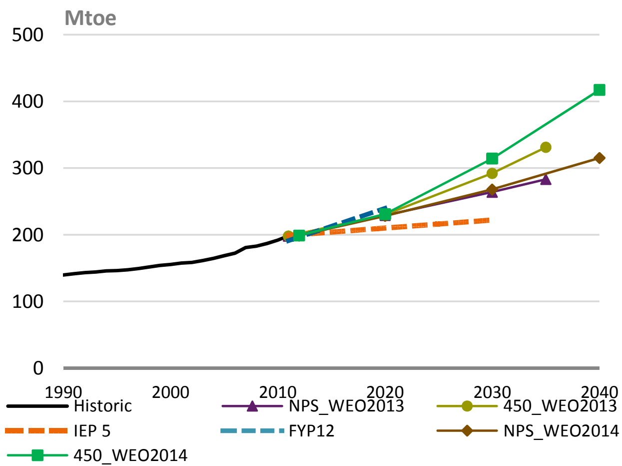


FIGURE 58 India renewable primary energy demand (incl. hydro, biomass, wind and solar). Comparison of historic consumption, IEA projections, Integrated Energy Policy scenario 5 targets and .FYP12 targets.



Insights

Each of the trajectories discussed in this analysis are based on multiple forward looking models which are at best only ever indicative. Smooth and economically rational outcomes are rarely observed and are influenced by a countless factors which are difficult to model with any accuracy. The value of these economic models is to indicate what would be the rational trajectory based on input assumptions which are belived to capture the context of future development. The results of the models then indicate a reasonable reference point for policy makers and investors to make best use of. As is the case of all models, they are only as reliable as the assumptions embedded in them.

In the case of resource forecasting, where infrastrucutre and other investments are of such great magnitude it is important to provide a reliable reference. Because of the inherent uncertainty it is sensible to simulate a range of plausible scenarios in a way which reflect the uncertainty. This is common practice in financial appraisals and other modelled future developments which have economic functions at their core. It is the basis for a robust risk analysis. Armed with this knowledge the impact of baseline assumptions proving to be innacurate can be determined. Is the effect large or small? In some cases projections might see negligable risks when a plausable set of alternative assumptions are tested, providing low risk (high confidence) in the reference case. Or the reference case might be highly sensitive to plausible variations. In this case the risk profile is very high and the reference can be considered with a significant margin for error.

In this report we have compared three trajectory cases. The context of the high trajectory case is continued high and resource intensive growth in developing countries underpinning the BREE estimates. The mid trajectory case considers more globally rational projections from the IEA captured by their New Policies Scenario, arguably independent from competitive opportunism. The low trajectory case characterises a measured course of development which de-carbonises the energy system in accordance with the 2°C threshold. All of these trajectories are plausible future scenarios which could materialise in this long projection period – each with their respective consequences. With the information provided by this report, the approximate impact on Australia's emissions intensive resource exports can be observed for each outcome. It is clear that a considerable variation in revenues can be expected from this small collection of plausible scenarios. As a result the wider Australian economy is exposed to the energy and environmental policy developments of our trade partners. This is not necessarily a problem so long as the possibilities are sufficiently understood and the economy is prepared to adapt in response to change.

Australia's economic policy development throughout the resource boom has not been constructed in this way. At each stage of planning, the government has been steered by a narrow view of the future. This narrow view has assumed the future can be extrapolated from the past; that China will boom for decades, that India will follow suit and Australia will enjoy untold riches so long as we keep pace. This narrow field of view has been blinkered to the implications of real world feebacks such as pollution, technological innovation, economic constraints and climate change mitigation.

Investment in infrastructure associated with the exporting of emission intensive commodities can

require decades to fulfil returns. Investments to generate alternative sources of income also require significant lead times and accomodating policy. As remarked by Ross Garnaut in his book on the receding boom, Dog Days: “You cannot fatten the pig on market day.” If a reference case is acted upon with absolute confidence, adjustments to alternative future developments can be time and capital consuming, as well as economically destabilising. Should the demand for these commodities play out in accordance with the mid or low trajectory cases, the shortfall in revenue expected from the high scenario cannot be immediately filled from another sector.

In 2012, Beyond Zero Emissions published the Laggard to Leader report which focused on the issue of Australia’s exports[80]. In this report it was identified that Australia was in a position to drive a faster shift to clean energy by unilaterally curtailing our fossil energy exports. The logic was that this would cause clean energy to be more attractive by constraining the availability of fossil fuels and demand a higher price. In its place Australia could endeavour to provide clean energy solutions. This suggestion was overlooked in the ‘super-cycle’ exuberance. Investments continued to flow into increased supply capacity. Many of investments following the 2011 peak in demand have resulted in losses[81]. The present oversupply is causing widespread closures. In hindsight it would seem that less investment in fossil fuel production capacity and a well developed clean energy industry would have placed Australia in a stronger position today. Fossil energy exports would have attracted higher margins as demand retraced. Australia would have had more of the clean energy programs being sought across the world; by our major trading partners and potential new ones.

The past is past, and investments that prove to have been misplaced cannot be undone. The concern today is that the Australian Government refuses to learn the lessons of the past. At the same time as the Treasury department is reeling from successive writedowns of expected revenue and our trade partners signal a shift in their energy sectors; the government is digging in on its narrow view of the future confident that a return to the old times is just over the horizon. What if it’s not?

Pro-active efforts are required which de-couple the economy from emissions intensive resources. Australians should not be alarmed by the intentions of our trade partners to move away from emissions intensive energy. This will be a positive development for global sustainability as well as for those nations’ domestic prosperity. Australia can and should be prepared to offer the products and expertise we all require for this transition.

Opportunities are available for Australia to achieve continued prosperity on sustainable foundations. De-carbonising economic pathways have been analysed and shown to provide ongoing employment and investment opportunities while respecting economic constraints. This has been shown at a generic level by the New Climate Economy project by the Global Commission on the Economy and Climate in support of the recent UN climate summit and upcoming negotiations in Paris[82]. It has also been shown for the Australian context in numerous works surrounding the introduction of the Clean Energy Future Package, by the Australian Treasury[83], the Garnaut Review[84], ACF and ACTU[85] as well as most recently in ClimateWorks’ contribution to the Deep Decarbonisation Pathways Project[86].

Unfortunately Australias capacity to participate in a global shift to clean energy has been impaired by the instability and dishonest venality of our domestic politics.

If Australia does not prepare for the global shift to clean energy, what will we have to offer the world in one of the greatest commercial opportunities ever?

Appendices

Appendix A

This provides all data and methods pertaining to the composition of the trajectory cases presented.

The appendix can be found online at *http://media.bze.org.au/fossileconomy/fossileconomy_app_a.xlsx*

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beyond ZERO emissions