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REPORT

Trade competitiveness and international carbon policies

Prepared for
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Summary

- **Trade distortions are an inevitable feature of current climate policy development.**
- **This is well recognised in most countries where various explicit or implicit measures are in place to attempt to deal with the issue.**
- **In the past there has been an expectation that as countries evolve towards a single world carbon price these trade distortions would be temporary or transitional.**
- **Now, the nature of the Paris Agreement means that potential trade distortions are likely to persist in the foreseeable future.**
- **The implementation of carbon policies at the sector level are crucial in determining the trade impacts of particular policies.**
- **This report considers lessons for Australian policy development by looking at competitiveness issues that arise from climate policies in key case study sectors.**
- **The key results from a number of case studies indicate that there is a large gap between announced policies and actual carbon costs at a sectoral level, even when the policies have been implemented.**
- **This gap should be an important consideration when developing Australia's carbon policies.**
- **When developing these policies, explicit consideration should be given to international policy development at the sectoral level accounting for the actual on the ground impact of policies as implemented, rather than just as announced.**

1 Introduction

This report

Australian carbon policy is evolving in the context of a changing international policy environment. The interconnections between countries through trade and investment mean that carbon policies in one country or region have economic implications (as well as environmental ones) for all countries.

One particular way that this comes about is through trade effects of climate policies. So called 'competitiveness' issues are a crucial consideration in the development of domestic policy.

This report considers the trade and competitiveness impacts of international climate policies through both general economic considerations, and through the examination of case study sectors.

- The remainder of this introduction sets out the broad issues that this report will consider.
- Chapter 2 considers the various competitiveness impacts of climate policy in more detail.
- Chapter 3 considers the ways in which the Paris Agreement creates a greater likelihood of trade issues to emerge.
- Chapter 4 introduces the case studies and illustrates the current broad picture of policies relating to those sectors.
- Chapter 5 looks at each of the case studies in more detail.
- Chapter 6 concludes.

The issue

While addressing climate chnage is a global, economywide issue, the practical implementation of carbon policies takes place on a country by country and sector by sector basis. This is particularly true since the implementation of the Paris Agreement which allows countries to determine their own actions and timetables for those actions.

The consequence of this is that climate policy is not trade neutral: climate policy not only affects the relative attractiveness of emitting versus non-emitting methods of production (the actual intent of climate policy), it also affects the relative costs of production between countries whether or not these genuinely reflect true differences in emissions intensity. Climate policy, therefore, can lead to carbon leakage as production shifts to low cost countries, or it can lead to unnecessary changes in the country distribution of production that do not necessarily reflect the best climate outcomes or the most efficient forms of abatement.

Avoiding this unintended consequence of climate policy provides a major challenge to on-going policy development in Australia. A number of key Australian industries are both emissions intensive and exposed to a highly competitive world market. Trade distortions, even if apparently small, can result in reduced income in Australia without any reduction in global emissions. It is extremely important that policies recognise this issue explicitly. The cost of meeting Australia's abatement target, and the global cost of abatement are both higher where there is carbon leakage.

This report demonstrates that competitiveness and associated leakage issues are sector-by-sector issues. Climate policy formulation must consider sector specific evidence to appropriately address carbon leakage and competitiveness impacts, and therefore avoid any unintended changes in current and future production.

Leakage and competitiveness distortions are built-in

The current structure of international climate policy inevitably leads to carbon leakage and generates competitiveness issues for Australian industry. There are two main reasons for this:

- policies, particularly under the Paris Agreement, are not coordinated either by sector or over time
- second, and most importantly, the underlying ***production*** focus of emissions accounting directly leads to non-neutral trade effects.

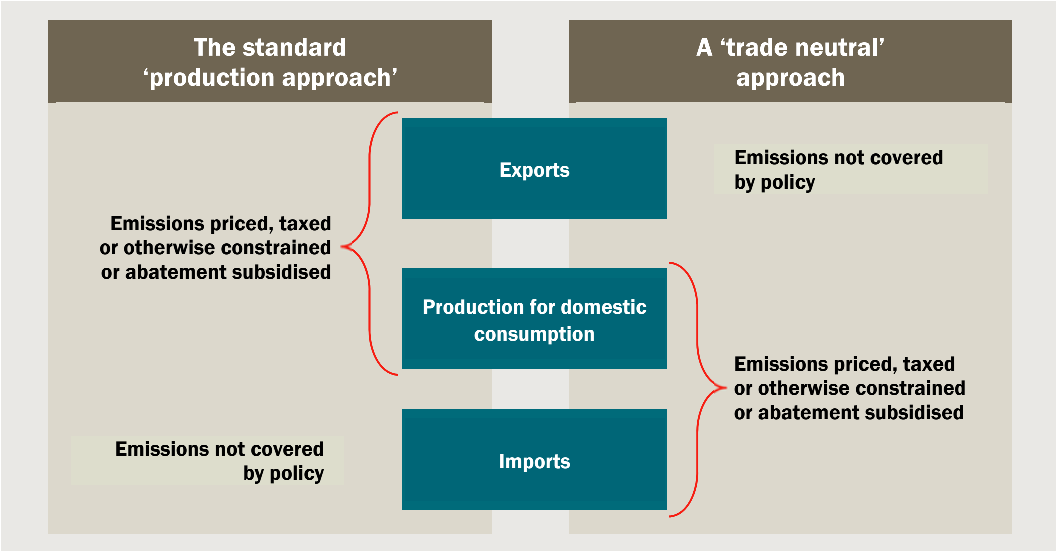
This second point can most easily be seen in the chart 1.1 which compares the standard production approach with a trade neutral approach — often called a 'consumption based' approach — to emissions accounting and policy formulation.

In a standard production approach, emissions related to both exports and production for domestic consumption are covered by domestic policy, while emissions related to imports are not. Thus, exports are in effect taxed, while imports face no constraint. This approach results in an implicit tax on exports and an implicit subsidy on imports.[1]

Under a trade neutral approach, emissions related to both production for domestic consumption and imports are covered by the policy, while exports are not. This is trade neutral.

1 Climate policies impose costs on production systems with greenhouse gas emissions. To the extent the cost of production is increased, this can be thought of as a tax. In reality, the policy that imposes this cost may be a carbon tax, emissions trading or regulations.

1.1 Carbon policy is typically not trade neutral



Data source: CIE.

Except in the unlikely circumstance that production based carbon policies are internationally coordinated (implemented at the same time with the same — implicit or explicit — carbon price for each sector), a production approach will inevitably distort trade. In contrast, a consumption approach remains trade neutral regardless of timing or implicit carbon price.

The reality, however, is the international focus of the United Nations Framework Convention on Climate Change (UNFCCC), under the Paris Agreement, is very much on production based emissions, and most policies are also designed on this basis.

It is important to note that these trade distortions arise regardless of the particular nature of the climate policy. It is as true for subsidies to reduce emissions as it is for prices or charges designed to reduce emissions.

Most existing or proposed policies have measures to deal with trade exposed sectors.

KEY LESSON

1 Trade effects are an inevitable consequence of production based carbon policy development. They are a feature of the policy landscape.

Not all trade changes are relevant

Policies to reduce emissions will inevitably impose costs throughout the economy. These will arise primarily through an (potential) increase in the price of energy and other emitting activities, and a reduction in activity in emission intensive sectors (potentially offset by an increase in activity in sequestering activities).

However, there are two conceptually distinct components to these costs.

- *Those that will arise even under international 'trade-neutral' mitigation efforts.* Some reduction in emission intensive activity is a necessary consequence of even full global abatement. This may be because:
  - there is an overall reduction in emission intensive activity even where there is no loss of Australian exports of particular products relative to our trade competitors, and/or
  - Australian producers are more emission intensive than foreign competitors.
- *Those that arise because of the fact that climate change policies are implemented differently, on different sectors and with different mechanisms between Australia and key trade competitors.* Differential application of climate policies may have the effect of reducing the 'competitiveness' of some of Australia's trade exposed industries, resulting in a loss of export income and hence national income.

The costs we are primarily concerned about in the context of addressing carbon leakage and competitiveness in Australian policy development are those that fall under the second category – the differential implementation of climate policies – that are not expected under a situation in which all countries impose comparable policies.

Costs incurred as a result of uncoordinated climate policy are not just a decline in production or activity from current levels, but a decline compared to what would be expected without the climate policy. This includes a failure for industries to realise future growth potential as a result of the climate policy.

The extent of any cost effects as a result of a climate change policy will vary considerably from industry to industry. The highest costs are likely to occur in emission intensive export activities. At the next level, industries which themselves are not necessarily emission intensive but which use the output other emission intensive industries (such as electricity) will experience a 'diluted' cost increase.

Competitiveness is a sector by sector issue

While overall competitiveness is often viewed at an economywide level, with an implicit view that changes in the exchange rate act to dampen competitiveness effects, it is also true that overall economywide costs are built up from sector by sector responses to global policies.

A purely macroeconomic perspective hides the microeconomic costs within the economy and risks understating the transitional and adjustment costs of policy implementation.

Almost all climate change policy that has been implemented includes a sectoral dimension. Regulations target specific sectors or technologies, carbon taxes and emissions trading schemes include only some sectors of the economy, or provide compensation or different treatment to particular sectors, resulting in a variance in net carbon cost paid by businesses and facilities between sectors and between countries.

In this report we explore specific policy settings in selected case study countries to illustrate how policies affect different sectors differently. This naturally leads to the conclusion that, when monitoring the international policy developments to understand competitive effects, it needs to be done at the sector, not economywide, level. The remainder of this report explores examples of how particular policy approaches give rise to the need to assess policies with a sectoral focus.

KEY LESSON

2 Competitiveness needs to be understood at a sector by sector level.

2 Competitiveness impacts of climate policy

How climate policy affects international competiveness

Global climate change mitigation is firmly established in a production-based approach, where emissions of a country are accounted for based on emissions produced in the country. Because of this production-based approach to emission accounting, competitiveness impacts are an inevitable and built-in consequence of emission mitigation policy[2].

Climate change policy which seeks to lower emissions of greenhouse gases in one way or another imposes a cost on the production of greenhouse gas emissions. For simplicity in this report we use the terms carbon or climate policy. This aims to capture both explicit carbon prices from a carbon tax or emissions trading scheme, and also other policies such as regulation which impose an implicit cost.

There are a number of ways of thinking about how a 'loss of competitiveness' could emerge, either in a particular industry, or economywide. These could be related to:

- Reduction in exports, relative to what would be the case without the climate change policy and abstracting from other developments in exports markets. This reduction could either be 'direct' in industries that are emission intensive and rely on exports, or 'indirect' for industries that buy inputs from other emission intensive industries (such as heavy electricity consumers). The reduction also includes a failure to capture future growth opportunities.
- Reduction in domestic sales, partly because of reduced domestic demand in response to price changes but also potentially because of increased import competition. This could arise for directly trade exposed industries or indirectly for industries selling to other trade exposed industries.
- Reduction in output (or a lower level of output than would have been expected without the policy) coming about as a result of a mix of changes in exports and sales on domestic markets.
- Reduction in profits arising because firms are not able to reduce costs and so offset the effects of sales reductions or because firms are unable to manage risks associated with climate change policy. This may in turn lead to a reduction in ongoing viability over time.
- Changed investment flows relative to what would otherwise have been the case.

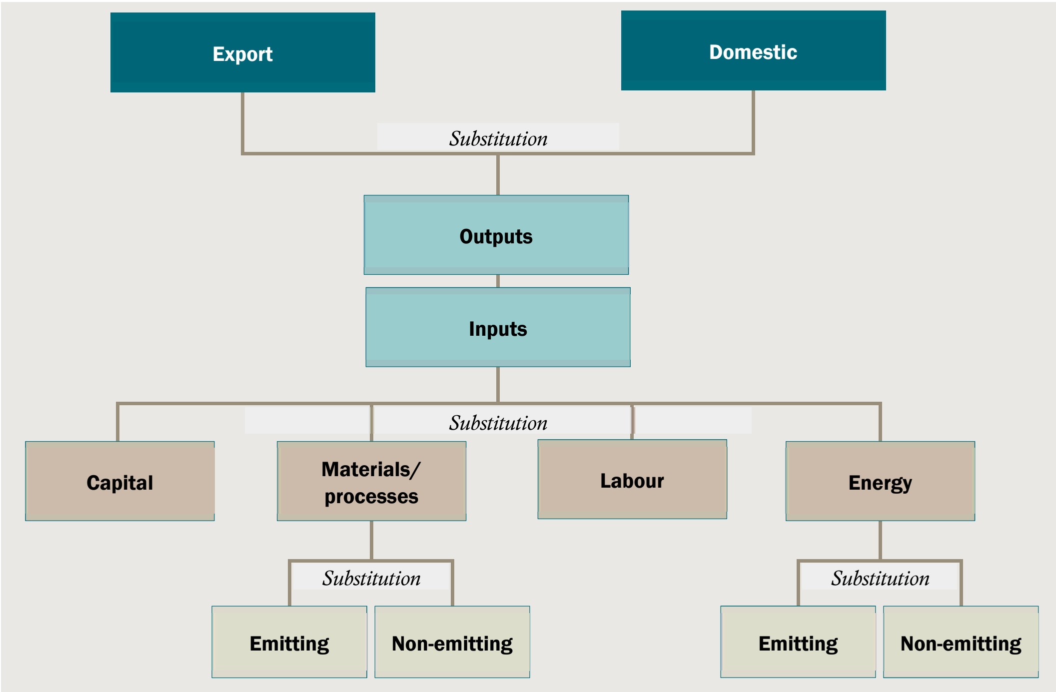
None of these is inevitable in response to an increase in the cost of production, due to carbon policy, in any particular industry, but depends on the particular features of the

2 While a production based approach is not the only, or even best, approach, it appears to be the one that is locked in place for the foreseeable future.

structure of production in that industry. Put another way, it depends on the firm's marginal cost of abatement which is itself built up from a number of different factors.

Chart 2.1 presents a stylised production system that can be used to consider the effect of introducing a carbon policy.

2.1 Stylised production system



Data source: CIE.

Impact on cost of production

Firms use a combination of inputs to produce their products. Input categories illustrated here are capital, labour, energy and materials/processes. Depending on the industry, there may be scope to substitute between these different inputs in response, for example, to relative price changes. The cost of production is the total cost of all inputs, and in competitive markets, prices reflect the cost of production.

Chart 2.1 clearly identifies inputs that are associated with greenhouse gas emissions. Energy is a significant source of emissions for many Australian industries. In 2014, fuel combustion for energy accounted for over 70 per cent of Australia's emissions. Other materials and processes used also generate emissions. For example, in steel production using a blast furnace, the chemical reaction when smelting iron ore and coke produces CO_2. Similarly, producing clinker (the key component of cement) requires a chemical reaction converting calcium carbonate to calcium oxide, which also produces CO_2. In the case of cement, these process emissions are around 60 per cent of total emissions.

Without facing carbon policies, firms will choose their combination of inputs to minimise costs for a particular quantity of output. Introducing carbon policy increases the cost of emitting inputs. Without any change in the composition of inputs, the carbon policy would increase the cost of production. The extent of the increase in cost of production would be determined by the carbon price (implicit or explicit) as a proportion of the cost of the emitting inputs, and the share of emitting inputs in total inputs.

However, as illustrated in the chart, these inputs could be substituted for one another in response to changes in relative prices. The extent of substitution (or the elasticity of substitution) will therefore determine the impact the carbon policy has on the cost of production.

In terms of energy inputs, these may be 'emitting' (of carbon, such as combustion of fossil fuels) and 'non-emitting' (renewable electricity, or biomass combustion).[3] Depending on the case, there may be scope to substitute between these two types of energy. For example, in low electricity use areas (such as residential electricity use) the elasticity of substitution between renewable and fossil fuel electricity sources is high. Other sectors, such as liquefied natural gas (LNG) liquefaction plants or aluminium smelters, require a highly reliable dedicated source of electricity. Intermittent energy, such as many renewable sources, is therefore less suitable in these sectors, and there is a low degree of substitution.

The introduction of a carbon policy will increase the price of the emitting source of energy (or the cost of using the emitting energy source).

- If there is scope to substitute between emitting and non-emitting energy sources, the response of the firm will be to substitute towards non-emitting energy. If the substitution elasticity is very high, the firm will completely switch and there will be little effect on its overall cost of production. The major constraint in this case will be the elasticity of supply of the non-emitting energy sources. If this is highly inelastic (that is, if it is hard to get additional capacity), then any attempt to substitute into this energy source will lead to an increase in its price and so will have an effect on the firm's costs. In this case, the cause of the cost increase is the lack of supply of non-emitting energy sources.
- If there is very little ability to substitute between energy sources (or the supply of non-emitting energy is highly inelastic) then the overall cost of energy will increase (the magnitude of this increase will be equal to the share of emitting energy in total energy multiplied by the increase in the price of emitting energy).

As a consequence of an increase in the price of energy, there are again a number of possibilities for a response.

- If the firm is easily able to substitute between energy and the other inputs, then it will do so. If the degree of substitution is very high, then the effect on the firm's overall costs will be small. In this case, the most important parameter will be the elasticity of supply of other inputs (capital, labour and materials).
- If the firm is not able to substitute away from energy, the firm's costs will increase (the magnitude of this increase will be equal to the share of energy in total costs multiplied by the increase in the price of energy).

3 The energy structure illustrated is clearly a gross simplification of the economy's energy system, but it will serve to demonstrate some key points.

Non-energy materials or processes used by a business may also emit greenhouse gases. In a similar manner to energy inputs, there may be scope for the firm to substitute into non-emitting materials or production processes. For example, in the production of LNG, processes may be managed differently to minimise the venting and flaring of gases.[4] The elasticity of substitution between materials and processes, and the price and elasticity of supply of alternatives, will determine the overall increase in the cost of production.

Overall, the greater a firm's capacity, and available options, to substitute between emitting and non-emitting inputs, the lower the impact of a carbon policy on a firm's cost of production and the price increase required by the firm to operate.

Impact on sales

Starting from the top, the chart shows that the output of the firm or the industry can be sold on either the export or domestic markets. Depending on the details of the firm or industry concerned, there may be scope to substitute between these different sales destinations.

If, for example, demand on the export market is highly sensitive to price changes, then an increase in prices (driven by the carbon policy) is likely to result in a reduction in exports. For relatively homogeneous commodities, such as steel or LNG, export demand is highly price sensitive. For products that are less homogeneous, characteristics other than price may be more important. For example, many Asian consumers have a preference for Australian dairy products over local products. Therefore, Australian producers have greater scope to increase prices in these markets.

Where exports are reduced, firms may be able to increase sales in the domestic market and not see a significant decline in total sales. If domestic sales are constrained, however, or the firm cannot switch for a variety of reasons, then total production will decline. For many firms, this opportunity will be limited, or will have already been taken up.

Some firms may sell on the domestic market in competition with imports. In this case, an increase in price is likely to lead to the firm losing domestic sales which are then replaced by imports.

For non-traded goods (including electricity), there may be some scope to pass on higher production costs to consumers. Some loss in sales would be expected, however, due to the general negative relationship between prices and demand.

Impact on viability

Depending on the nature of the activity, the combined effects on costs and sales may reduce overall viability of the operation, leading to partial or extensive plant closures, or shortening the life of particular operations compared with otherwise.

4 Note that many, if not all, LNG plants in Australia already use low emission production processes.

Impact on investment

Another potential implication of carbon policies in Australia, but not in other trade partner countries, is the effect that it may have on the location of new investment projects. It is reasonable to expect that a firm considering a new project with a considerable energy (or emissions) component would choose to do so in countries without carbon pricing in place. In this case, new investment projects that would otherwise have taken place in Australia now take place in some other location.

However, if the carbon policy can be designed to reduce the risk to existing and new capital, a firm may be more likely to locate in a country that has a clear carbon policy than to one which may have low carbon costs now, but uncertainty over future costs.

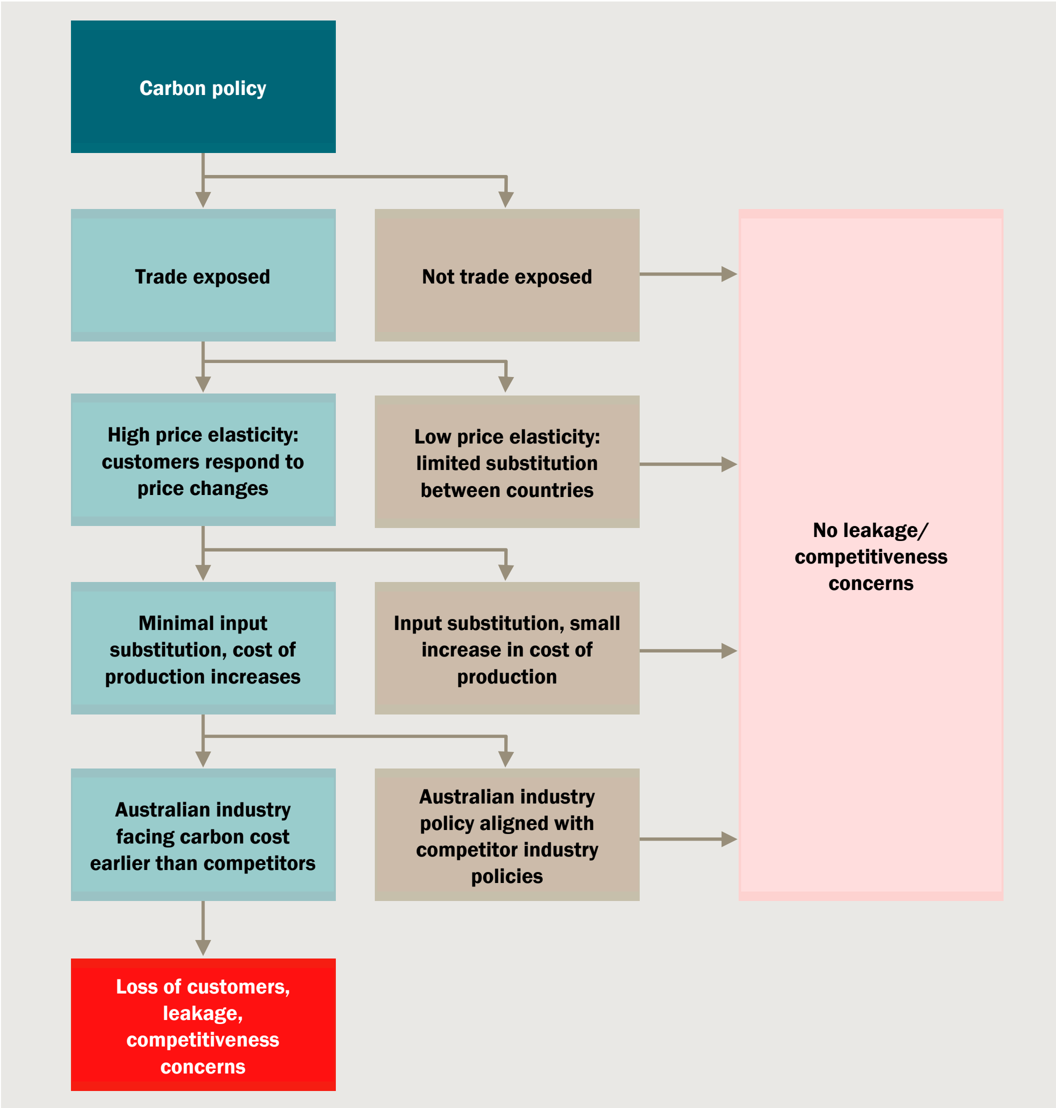
Investment decisions are driven by many factors, some of the most important ones being perceived risk of a particular location. Large fixed costs associated with industry mean investment decisions have long lived effects. There is a substantial risk that investment decisions made in the period of time between Australia implementing carbon policy and the rest of the world (or key competitors) taking comparable action would result in long lived investments shifting away from Australia. This will have ongoing implications for future production levels. If the efficient outcome in a world with comparable global climate change policy is for the project to be located in Australia, the long run result with displaced investment is likely to be inefficient.

What are the key factors that determine the extent that competiveness impacts will be realised?

Several key factors increase the likelihood that climate change policy will lead to leakage and competitiveness concerns for industry. Chart 2.2 sets out the conditions that need to be met for leakage to be expected.

This is essentially an expansion of the definition of emission intensive trade exposed.

2.2 Identifying emission intensive, trade exposed sectors



Data source: CIE.

Trade exposure and price elasticity

The concepts of trade exposure and price elasticity are related and refer to the extent that customers will switch away from consumption of Australian produced goods in the face of a price difference.

Products that are not traded (such as electricity and many services sectors) are not exposed to competition from firms under a different climate change policy and therefore are not at risk of leakage. This is not to say a non-traded firm will not see a decline in demand as a result of carbon policy. In many cases, the change in demand for non-traded goods will, however, be the desired or optimal change for the given policy. Exceptions arise when the reduction in demand come from the derived demand from another trade exposed industry.

Products with a very low elasticity of demand will similarly face a smaller risk of leakage. Low price elasticity is usually due to non-price factors being more important to customers. More specifically, products produced in other countries may not be seen as a substitute for Australian produce, due to the actual or perceived quality of alternatives. If this is the case, leakage is expected to be less of a problem. A prime example of this is Australian dairy produce which attracts a premium in China. The selected case study products, however, are all commodities. There is generally little difference between the products produced in Australia and those produced in other countries, and little ability to specialise or differentiate

As noted in the previous section, the impact of carbon policy on total sales from a firm will be affected by the degree to which it is trade exposed. Firms that are in direct competition with international producers who do not face an equivalent carbon policy will have less scope to increase their prices to cover increased costs associated with adhering to carbon policies. All six sectors included in the case studies for this report are highly trade exposed. Some sectors, such as LNG and aluminium are primarily export industries. Others are import competing, such as cement and petroleum. All their products are highly homogenous which means there is little differentiation between products produced in Australia and other countries. Price, therefore, is the overwhelming determinant of where consumers source the product from. Australia is a small player in the global market and therefore has little ability to affect world prices.

Emission intensity

As also previously noted the extent of the cost burden, and therefore the competitiveness effects, of carbon policy is related to the volume of emissions (or emitting inputs) involved in the production process. The greater the share of the carbon cost in the total production costs, the greater will be the competitiveness impact of the carbon policy. All of the selected case studies are emission intensive – either through the direct production of emissions, or indirectly through the use of electricity. That being said, any trade - exposed sector could potentially face some competitiveness impacts regardless of their emission intensity.

Abatement potential and cost

The abatement potential reflects the degree of substitution highlighted in the previous section. If a firm is able to substitute away from emitting inputs into non-emitting, or less emitting, inputs they are able to reduce the cost burden of the carbon policy, and therefore mitigate the competitiveness impacts of the policy. This substitution, however, is only possible where there are alternative technologies or processes available. And abatement opportunities will only be efficient to adopt if the cost of adopting it is less than the carbon price (implicit or explicit). While the resulting cost will be less than the carbon cost, it may still be significant.

For many of the case study industries, energy use accounts for the majority of their greenhouse gas emissions. Opportunities for energy efficiency improvements (and therefore lower emissions) have largely been exhausted given that there is already incentive to adopt them. Switching to non-emitting energy sources is not suitable for many industries.

- Large electricity users such as aluminium smelting, steel (produced using electric arc furnaces) and LNG liquefaction require very reliable supply which cannot be supplied by intermittent sources including some types of renewable electricity.
- For other industries, including steel (produced using blast furnaces), petroleum and cement, energy use is primarily heat energy derived from the combustion of coal or gas. The supply of renewable fuels (sustainably produced biomass) is limited and the combustion properties are not always well-suited to industry, particularly if very high temperatures are needed. For example, the use of charcoal in the steel industry is a subject of ongoing research.[5]

In addition to energy use, industrial emissions arise due to the production processes. For example, the primary component in cement is clinker. Clinker production is highly emission intensive due to the chemical reaction that must take place to convert calcium carbonate (limestone) to calcium oxide, which produces CO_2. The calcium oxide in the clinker is what gives cement its strength characteristics. There is no known way to produce calcium oxide without also producing CO_2 in fixed proportions. The only way for cement to be produced with fewer process emissions is to substitute clinker for alternative materials. The extent that this substitution can take place is limited under Australian standards. Substituting clinker for other materials can affect the strength, heat and setting requirements of the cement.

Policy responses in competitor economies

The final key factor that affects the extent of competiveness effects is the impact of climate change policy on producers in other countries with whom Australian producers are competing. If all major producers of a product face a comparable cost impost due to climate change policy, then there are not concerns around the competitiveness of the Australian industry. However, there are many reasons why other producers don't have the same cost impost.

- Governments in other countries may not implement climate change mitigation policies.
- Industries may be excluded from policies that are implemented.
- Industries may receive assistance (for example through the administrative allocation of permits under an emissions trading scheme) which reduces the burden of policies.
- Governments may implement other policies (which appear unrelated to climate change policies) to compensate industries for the impact of climate change policies.

Even when, at a national level, countries take action to reduce greenhouse gas emissions, that does not necessarily flow to costs on business in all industries and regions.

5 Mathieson, J.G., Rogers, H., Somerville, M.A., Jahanshahi, S. and Ridgeway, P. 2011, Potential for the use of biomass in the iron and steel industry, http://www.conference.net.au/chemeca2011/papers/252.pdf

It is not a trivial matter to determine the extent that businesses in other countries are facing costs due to climate change policies. The next chapter provides a discussion about the challenges in doing this and some examples of policies settings.

Combined effects

Working through each of the factors in chart 2.2 indicates that the Australian economy is particularly exposed to competitiveness issues because of a high dependence of trade exposed issues that have limited options for adjustment in a situation where major competitor countries have relatively cautious carbon policies.

3 The Paris Agreement: a step forward, but increasing trade concerns

Paris Agreement

Global progress toward an international climate change policy response appeared to advance with the conclusion of the UNFCCC Paris Agreement in 2015 and the subsequent ratification by 65 per cent of the parties (including China, US and India) covering more than 80 per cent of global emissions.

However, the bottom up and non-enforced nature of the Paris Agreement means there is as yet little change globally in terms of implemented climate change policies. Countries have made broad emission reduction commitments but the precise detail of policies to achieve the reductions are not yet clear. This lack of clarity means that comparing the costs of climate change action in individual sectors in different countries is difficult, if not impossible, and therefore presents challenges in understanding the competitiveness impacts of any proposed Australian policy.

Particular characteristics of the Paris Agreement also present challenges for policy analysis and increase the likelihood of competitiveness issues,

- Targets are set in different ways, some in terms of absolute emissions targets, some in terms of intensity (emissions relative to GDP targets), some expressed relative to a specific historical year, and some expressed relative to a future notional 'business as usual' (BAU).
- Some targets are conditional on action in other countries, for example Indonesia has a two-tier target, with greater action dependent on some level of international support.
- Some countries are developing policies that include relying on purchasing international permits. The mechanism by which this might happen is still subject to considerable policy development as is which countries are likely to generate excess emission reductions to sell. Furthermore, the extent that targets will be met through international permits compared to domestic action is not specified.
- In the majority of cases, the specific policies to reach the specified target are not well developed, so understanding the implications for cost burdens on individual industries is difficult in the short term.
- Monitoring and reporting on progress under Paris is likely to have long lead times and may be inconsistent.

How to understand competitiveness issues

The issue of competitiveness impacts of climate policy has been the subject of much discussion and alternative policy proposals.

In 2008, the Garnaut Climate Change Review framed the competitiveness issue in terms of Australia having a higher carbon price than competitors, requiring transitional assistance to correct a temporary distortion in production until such time that other countries evolve to having the same carbon price.

This framing presumes that other countries will, in fact, move to having the same carbon price. But there is no reason that this should be the case, particularly under the Paris Agreement where countries each have different targets expressed in different ways and where countries can chose how they get to the target.

What is likely to emerge is that for a variety of reasons, different entities in different countries will face very different carbon costs. This differential creates a competitiveness problem such that production patterns around the world will continue to be distorted if some other correction is not made. This distortion clearly needs to be defined against some sort of ideal; presumable common carbon costs everywhere in the world. The policy aim is to achieve changed production patterns to reflect carbon content differences rather than differences in policy application.

This structure of international policies creates a trade distortion which is potentially costly to the Australian economy. This is a cost not of adjustment to a lower carbon world, but a cost associated with a lack of coordination of policy. The coordination ideas of a uniform world carbon price are not coming to play in the immediate future. In designing Australian policy, consideration must be given to this distortion. To understand the magnitude of the potential distortion, it is important to drill down to the detail of policy implementation elsewhere in the world.

The Productivity Commission, in its 2011 report on carbon prices, concluded it was not possible to derive a single implied carbon price that summarises all of the effect of policy. Rather, impacts need to be assessed at the sector or even facility level.

Different policy frameworks and implications for competitiveness

Absolute and intensity targets

The flexibility in the Paris Agreement allows for countries to specify national targets in terms of an absolute emission reduction (relative to a specified base year, or a business as usual trajectory). Alternatively, countries may choose to set a target in terms of intensity. China has specified its emission reduction target in terms of intensity, as has India and several other countries.

Meeting an intensity target will require to a shift in economic activity towards low carbon activities, but this may not be additional to structural changes already underway within an economy. Over time the structure of economies shift. In the case of China, the government is actively encouraging growth in the services sector, and such a shift is expected in later stages of industrialisation. With this structural shift, emissions intensity will automatically decline. It is possible that structural change will satisfy an emission intensity target without any policies that impose costs on emitting sectors. Indeed, it may be possible to subsidise some emitting sectors and still see a decline in emission intensity at the economywide level. The existence of a target, therefore, is not itself evidence of a carbon price (implicit or explicit).

Targets specified relative to a notional 'business as usual' trajectory may also have different implications to other forms of target, particularly as they involve uncertainty about the actual carbon constraint.

Different target levels

The current international climate change mitigation framework allows for countries to set their own targets. Differing target levels will result in different potential carbon prices in each country. Competitiveness impacts, therefore are inevitable, even where countries have targets and include the relevant sector in a carbon pricing policy.

Trading of permits internationally may mitigate the price differences but the international trading regime has not been established as yet. This is likely to be difficult in a world in which countries have set their own differing targets. Countries may be resistant to trading that will tend to increase domestic abatement costs. Alternatively, where trading is expected to lower abatement costs, trading would be expected to be preferred.

Many countries in their (I)NDC (Intended Nationally Determined Contribution) state that they would be receptive to considering some form of international permit trading to meet their target. Other countries intend only to sell permits into an international market, a few countries excluded the possibility of purchasing international permits (EU, Russia), while others specifically stated their target is dependent on purchasing international permits (New Zealand, Korea). Many (I)NDCs did not make a specific statement regarding the use of international permits in the future.

Different allocation methods

There are generally two types of costs imposed by climate policy, and these have different implications for firm decisions. All climate policy directly related to the volume of emissions impose a cost on firms at the margin. That is, there is a trade-off associated with an additional unit of production – either a carbon cost is incurred, or a benefit is lost (for example the use of an allocated emission permit that could otherwise be sold). This marginal cost creates the firm's incentive to abate. Depending on the carbon policy, there may also be significant out-of-pocket financial costs associated with the carbon policy. A cap and trade scheme with no free allocation of permits, for example, can impose a significant cost on firms to purchase emission permits. This financial cost is less where there are free permit allocations or under a baseline and credit scheme where permits only need to be purchased of emissions over and above the baseline.

Even with countries with comparable targets and equivalent effective carbon prices, competiveness may still be a real concern for individual facilities due to permit allocation approaches. This can be illustrated as follows.

- Consider two facilities in different countries. Both countries have an established emissions trading scheme with the same sectoral coverage and carbon price at the margin. In one country individual facilities must purchase emission permits at auction (or on the secondary market). In the other country a facility in the same industry is grandfathered its permits – receiving them for from the government. At the margin, both firm face the same cost, but the financial impact of the two schemes is very different. The first facility has a potentially significant additional production cost to cover that is not faced by the second facility.
- Again consider two facilities in different countries, both with established baseline and credit schemes and with the same carbon price. In one country the baseline is set in absolute terms based on historical emission levels. In the second country the baseline is specified in intensity terms based on historical emissions intensity. A facility in the first country with an absolute baseline will face significant costs if it wishes to expand production beyond its baseline. In the second country, the costs of expansion are marginal.

KEY LESSON

3 The bottom up nature of the Paris Agreement, with considerable variation between countries in how targets are expressed and how policies are actually implemented provide greater tendency for competitiveness issues to arise.

Example: China and intensity targets

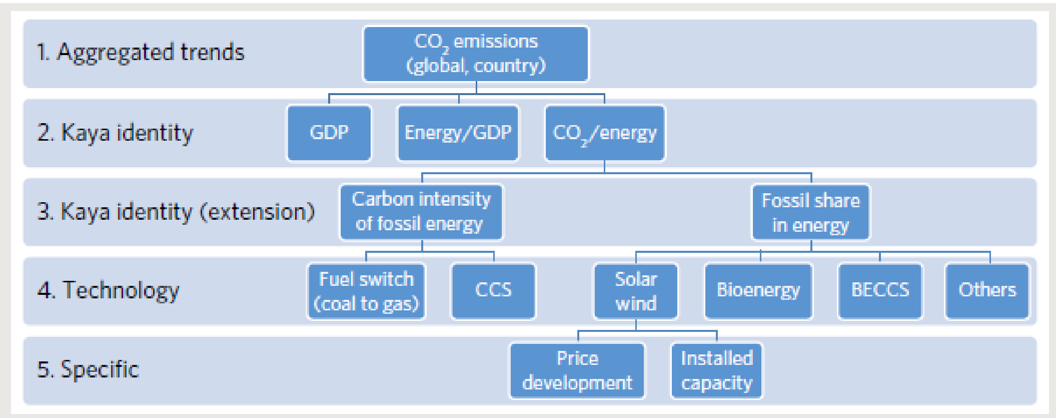
Charts 3.1, 3.2 and 3.3 summarise results from a recent study decomposing China's recent changes in emissions.

As chart 3.1 illustrates, emissions growth can be decomposed in a variety of ways; here emissions growth is first composed of GDP growth, growth in the energy share of GDP and growth in the CO_2 share of energy (the so-called 'Kaya Identity'). The CO2 share of energy (emissions intensity) can be further divided into changes in the carbon intensity of fossil energy and changes in the fossils share of energy.

Chart 3.2 illustrates that China's emissions growth has changed significantly over the past decade, with emissions growth declining despite steady growth in GDP. This means that China's emissions intensity has been steadily declining.

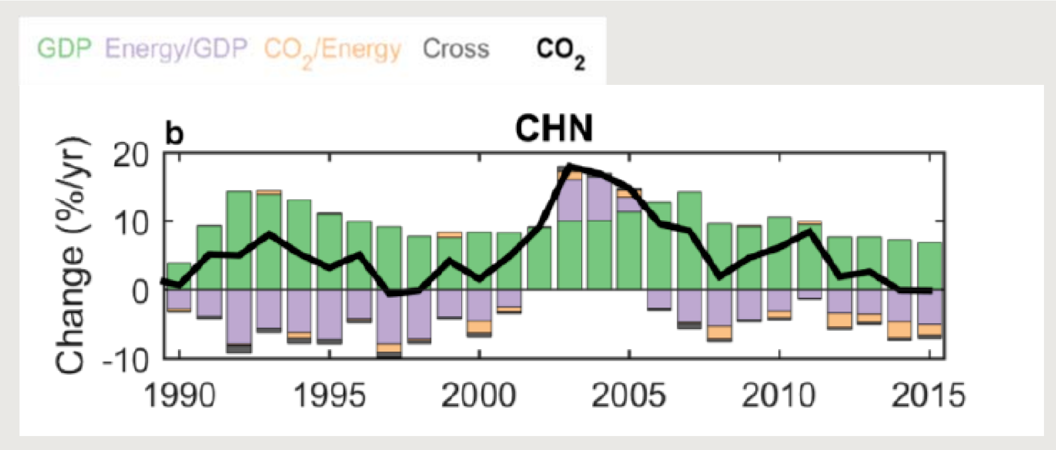
As chart 3.3 illustrates, a large part of this has been a decline in the CO_2 share of energy, brought about by declining fossil fuel intensity and fossil fuel share of energy (as a consequence of investment in renewable sources)..

3.1 Decomposition of emissions growth



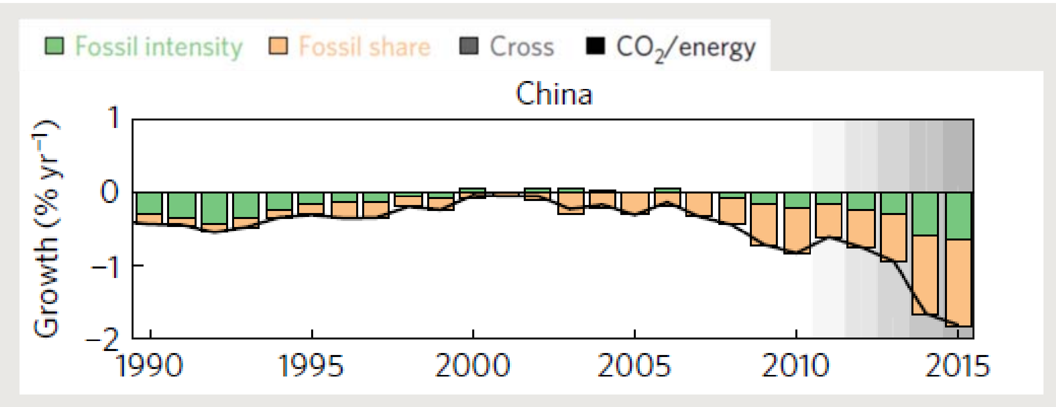
Source: Peters et al 2017 'Key indicators to track current progress and future ambition of the Paris Agreement' *Nature Climate Change* 30 January 2017

3.2 Decomposition at levels 1 and 2



Data source: Data source: Peters et al 2017 'Key indicators to track current progress and future ambition of the Paris Agreement' *Nature Climate Change* 30 January 2017

3.3 Decomposition at level 3



Data source: Peters et al 2017 'Key indicators to track current progress and future ambition of the Paris Agreement' *Nature Climate Change* 30 January 2017

The challenge with interpreting these impressive changes at a macro level is that they provide no indication of the carbon costs actually faced by particular industries at a micro level.

Given significant structural change in the Chinese economy, reductions in emissions intensity are in part a consequence of a shift away from heavy manufacturing to other forms of manufacturing and towards services.

This shift is consistent with a variety of outcomes at the individual sector level and does not, in itself, provide information about the actual implementation or effect of policies. Considerably more information at the sectoral level is required for this.

KEY LESSON

4 Macroeconomic detail can often miss what his happening at an individual sector level.

4 *Illustrating the points: case studies*

Summary of case study sectors

For this report we have selected a number of case study sectors and countries to illustrate key points. A summary of the case study sectors is set out in table 4.1. The selected sectors are all trade exposed – they are either exports, or import competing, industries. A significant common characteristic of the case study sectors are that they all produce commodities – there is very little difference between the products produced in Australia and those produced in other countries.

4.1 Case study sectors – key figures

	Australian production volume	Export as share of production	Imports as share of consumption	Top 5 world producers	Top 5 world exporters
Steel	5 Mt (2015-16)	16%	35%	**China**, EU, Japan, USA, India	**China**, EU, Korea, Japan, USA
Aluminium	1.7 Mt (2015-16)	87%	-	**China**, EU, Russia, Canada, **UAE**	**China**, EU, USA, Russia, Canada
Alumina	20.5 Mt (2015-16)	86%	-	Australia, **China**, Brazil, Guinea, India	Australia, Brazil, USA, EU, Jamaica
Cement	9.7 Mt (in 2015-16)	-	5.5%	**China**, India, EU, USA, Turkey	**China**, UAE, EU, Thailand, Turkey
Clinker	5.5 Mt (in 2015-16)	-	37%	**China**, India, USA, Vietnam, Russia	Vietnam, **China**, EU, UAE, **Japan**
LNG	37 Mt (2015-16)	Almost 100%	-	**Qatar**, Australia, **Malaysia**, Nigeria, **Indonesia**	(as for producers)
Petroleum	26.7 ML (2015-16)	-	59%	USA, EU, China, Russia, India	Saudi Arabia, Russia, Iraq, UAE, Canada
Nickel (processed)	142 kt (2013)			China, Russia, Japan, Australia, Canada	Russia, Canada, USA, Malaysia, Singapore
Nickel (mined)	234 kt (2013)			**Indonesia,** Philippines, Russia, Australia, Canada	Canada, Indonesia, Philippines, Botswana, New Caledonia

Note: Countries listed in bold have been selected for the case studies

Source: See details in case study appendices

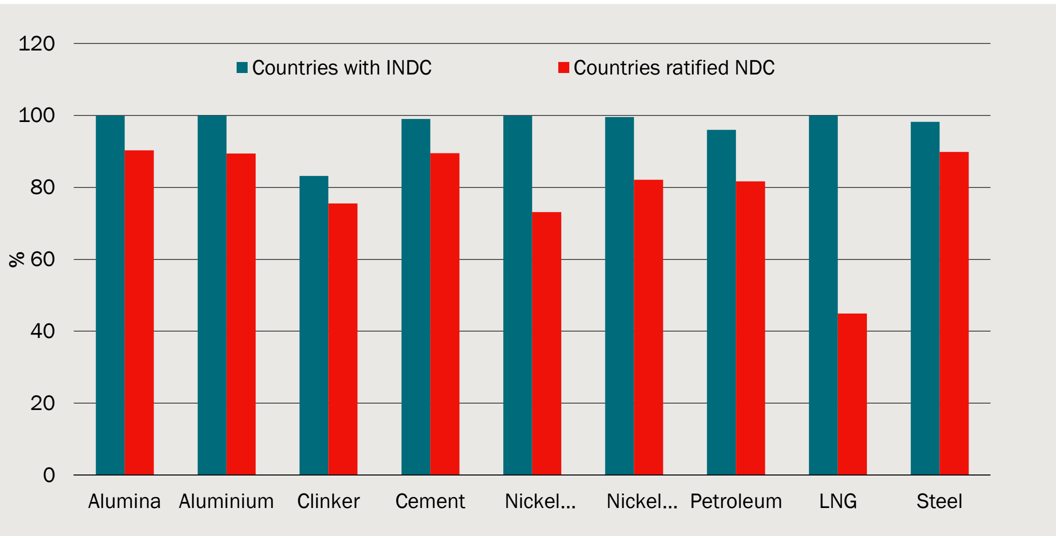
For each case study sector, one or two competitor countries have been selected to focus the analysis in this paper (countries listed in bold in table 4.1). The selected countries represent significant producers and/or exporters of each commodity that Australia directly competes with.

Overview of international action within case study sectors

Evidence of climate change policy at the highest level is indicated by the participation in the UNFCCC Paris Agreement through submission of an INDC and subsequent ratification of the agreement. Chart 4.2 shows the proportion of global production of each of the case study commodities that is produced in countries that submitted an INDC and ratified the Agreement. It shows that nearly all producers of these commodities are participating in the international climate change process in some way. Less than 100 per cent of production of petroleum and steel is covered by an INDC, mostly due to production in Taiwan which is not a member of the UN.

The share of production in countries that have ratified the Paris Agreement is less for all commodities. The key countries that have not ratified the agreement are Russia, Turkey, Philippines and Qatar.

4.2 Proportion of global commodity production covered by NDCs



Note: Comprehensive individual country data was not available for clinker, 17% of production was allocated to 'Other countries' and therefore policies cannot be allocated against this production.

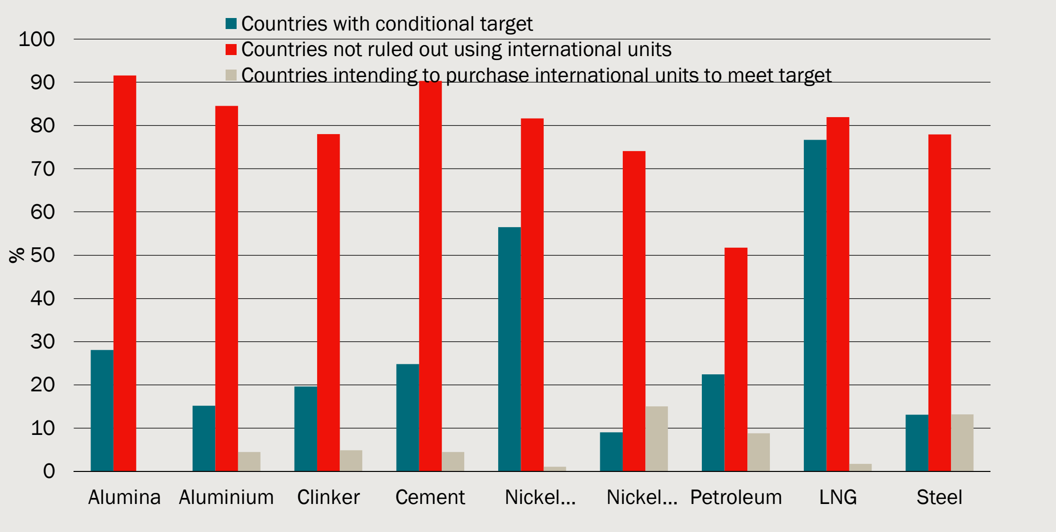
Data source: For sources of production data see details in case study sections. INDC and NDC status from WRI, CAIT Climate Data Explorer. 2016. CAIT Paris Contributions Map. Washington, DC: World Resources Institute. Available at: http://cait.wri.org/indcs/

A closer look at policy details provides a greater understanding of which commodities are more likely to face competitive pressures.

The targets specified by many countries are conditional on either international financial support, or on comparable international action. This conditionality adds some degree of uncertainty to the targets being enforced. This is particularly the case for LNG producing countries, and also nickel mining countries (see chart 4.3).

Most countries have not ruled out the possibility of using international units to meet their targets. Purchasing international units will lower the domestic cost of abatement, and therefore lessen the impact of the target on domestic industries. Some countries have stated that meeting their target is conditional on them using international units (for example Turkey, Korea and Japan have all stated they will count overseas abatement towards their target).

4.3 Proportion of global commodity production in countries with conditional (I)NDC targets



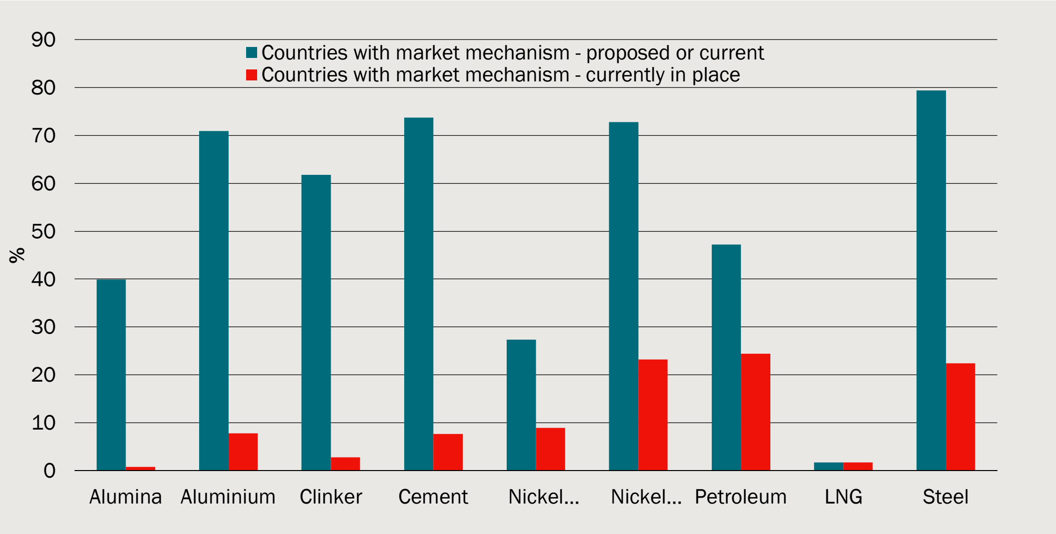
Data source: For sources of production data see details in case study sections. INDC and NDC details from WRI, CAIT Climate Data Explorer. 2016. CAIT Paris Contributions Map. Washington, DC: World Resources Institute. Available at: http://cait.wri.org/indcs/

Chart 4.4 shows the share of production of each commodity that is in countries that have proposed a market mechanism (emissions trading or carbon tax), or currently have a mechanism in place. The clear message from this chart is the difference in coverage of proposed and actually implemented market mechanisms. While for a number of the case study commodities up to 70 or even 80 per cent of production would be covered under proposed policies, less than 25 per cent of any commodity is in a country that currently has an explicit carbon price.[6]

Production of LNG is very clearly located in countries that do not have a current or proposed market mechanism. The only LNG producing country with a (current or proposed) explicit carbon price is Norway which is not a direct competitor with Australian LNG..

6 Note that this only measures the proportion of production in countries that have an explicit carbon price of some sort, it does not specify whether the case study commodity is directly covered by the carbon price. Were that calculation to be done, the share of production facing a carbon price would be expected to be very small.

4.4 Proportion of global commodity production in countries with a proposed or current market mechanism



Note: Australian production is not counted as being covered by a proposed or current market mechanism.

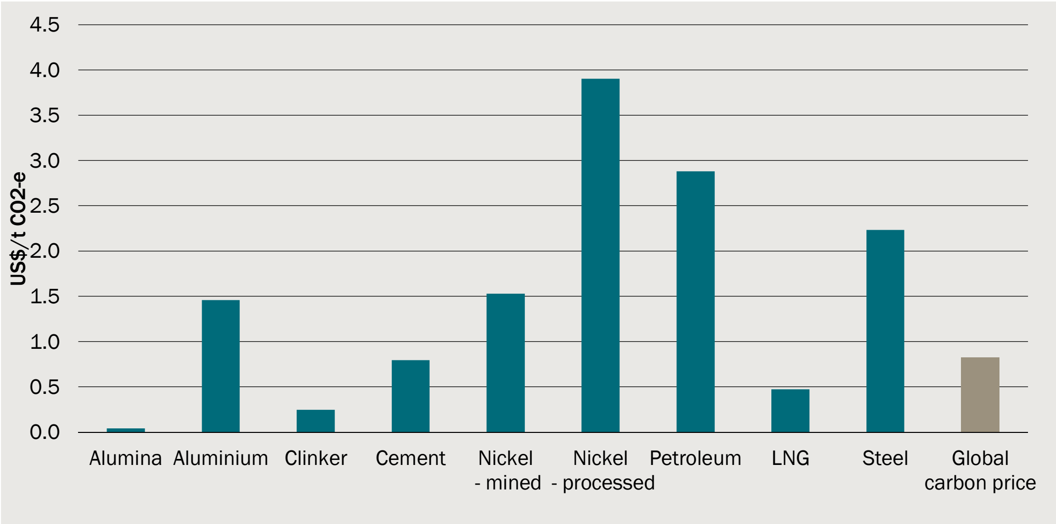
Data source: For sources of production data see details in case study sections. Carbon price data from World Bank 2016, Carbon Pricing Watch 2016, https://openknowledge.worldbank.org/bitstream/handle/10986/24288/CarbonPricingWatch2016.pdf?sequence=4&isAllowed=y

Chart 4.5 shows the average global carbon price potentially faced by producers in each case study commodity. This is the weighted (by production) average carbon price in the world, averaged over all producers of the particular commodity. Note that this represents the weighted price in those countries that have a carbon price; it does not necessarily mean that these prices are actually faced by those producers.

The key point is that these potential prices are very low. For example, the weighted price in countries that produce aluminium is US$1.46 per tonne. That is, if all those aluminium producers actually faced a carbon price, then on average it would be US$1.46 per tonne. As discussed further below, there are a number of reasons why producers do not actually face this price.

The average global carbon price is currently around US$0.8 per tonne.

4.5 Weighted average carbon prices potentially faced by case study commodities



Data source: Carbon price data from World Bank 2016, Carbon Pricing Watch 2016, https://openknowledge.worldbank.org/bitstream/handle/10986/24288/CarbonPricingWatch2016.pdf?sequence=4&isAllowed=y

By way of comparison, all of these prices are lower than the current auction price under the Australian Emissions Reduction Fund (which was $11.83 per tonne, to date). Thus, in Australia, entities that may be required to purchase ACCUs to cover any increase in production will face a higher price.

Current climate policies in case study countries

Table 4.6 summarises on the ground views (derived through in country consultations) of the state of climate policy development for the case study countries.

4.6 On the ground views of policy development

Country and nominal target	Overview of on-ground views of policy
Overview	Except in South Korea, in-country investigations concluded that, at the individual operating site level, carbon policy (and its potential impact) was generally poorly understood and not considered a priority, with most respondents clearly more focused on growing their economies. South Korea is more advanced, forming and implementing of carbon policy. It's ETS is operational and, at the individual operating site level, is acknowledged, if not fully understood. For the other countries, carbon policy is mostly a low priority, intangible issue relative to other policies viewed as having a more direct impact on the profitability of an individual operation.
China (Target: to reduce emissions intensity by 60-65% relative to 2005 by 2030)	Generally a poor level of understanding, although a significant difference in understanding (and its impact) exists between SOEs and private companies. Chalco (SOE) is currently developing its own emissions reduction strategy, private operators in the sector are not.

Country and nominal target	Overview of on-ground views of policy
Indonesia (Target: reduce emissions 29% below BAU by 2030, unconditional, Conditional a 41% reduction)	Clearly focused on forestry management and electrification of rural areas as priorities, both of which have secondary impacts on emissions Moving to reduce subsidies on liquid fuels for transport
South Korea (Target: Emissions 37% below BAU by 2030)	Significantly more advanced in its understanding and response. Established its ETS in January 2015, which is currently operational (covers major polluting sectors). Policy is well communicated and understood, but continues to face opposition from industry groups.
Taiwan (Target: Emissions 50% below 2005 levels by 2050)	Did not participate in the UNFCCC conference and is developing its own legal framework for reduction targets, mitigation and adaptation. Steel industry has mandatory reporting of GHG emissions, but can reduce voluntarily. China Steel has set a road map for emissions reduction and set a target of less than 1.97 t CO_2-e per tonne of crude steel by 2020.
Qatar (No target)	The least informed of the group of countries studied. Heavy reliance on gas for industry rather than oil means lower relative emissions, so not considered important. LNG regarded as clean fuel, and so abatement contributions are seen as coming through LNG exports. Have a national plan to improve energy efficiency and flare mitigation

Source: CM Group, UNFCCC

Further details of key elements of climate policy in the case study countries are summarised in table 4.7. The policies in place range from nothing, with no intention of implementing policy (for example Qatar), to a fully operational ETS (such as in Korea). The carbon price, where in place, ranges from $3/t CO_2-e up to around $24/t. The final column, however, shows that the actual effect on the case study sector is currently minimal for all sectors and countries.

4.7 Summary of climate policies

Sector	Country	Carbon policy	Notional carbon price potentially applicable	Notional price per tonne of product if carbon price actually imposed	Allocation or offset mechanisms in place	Current actual effect on case study sector
Aluminium	China	ETS, moving from pilots to national	Pilot prices range from $3 to $10 (see table).	$47-156/t aluminium (excluding alumina)	Free allocation most likely. Existing pilots have range of offset arrangements	Permits over allocated – no impact
	Middle East	RET (UAE)	-	-	-	Nil

Sector	Country	Carbon policy	Notional carbon price potentially applicable	Notional price per tonne of product if carbon price actually imposed	Allocation or offset mechanisms in place	Current actual effect on case study sector
Cement	China	ETS, moving from pilots to national	Pilot prices range from $3 to $10 (see table).	$2.5-8/t cement	Free allocation most likely. Existing pilots have range of offset arrangements	Permits over allocated – no impact
	Japan	Tax, Tokyo Cap and Trade Program (energy related emissions), Saitama Emissions Trading System, National ETS (proposed)	$3/t CO_2 tax, around US$15/t for Tokyo and Saitama	$2.5-12.5/t cement	Tax only on fossil fuels, coal use for cement excluded. Grandfathering for Tokyo and Saitama.	Unknown, if any
LNG	Qatar	None	-	-	-	Nil
	Other Asia	-	-	-	-	Nil
Petroleum	South Korea	ETS	KRW20 800 at March 2017 (~A$24)	$7/t petroleum product	Free allocation, moving to 10% auction for non-EITE sectors by 2021 (100% free allocation to EITE in all phases). Also price stabilisation measures	Face marginal price, but full free allocation
	Singapore	Carbon tax (proposed)	S$10 to $S20 per tonne from 2019	$3-6/ t petroleum product	Government to discuss with industry	Unknown
Nickel	Indonesia	-	-	-	-	Nil
Steel	Taiwan	ETS (proposed)	-	-	Electricity excluded	Unknown
	China	ETS, moving from pilots to national	Pilot prices range from $3 to $10 (see table).	$7-24/t steel	Free allocation most likely. Existing pilots have range of offset arrangements	Permits over allocated – no impact

Source: CM Group, CIE, various

The policy approaches in the case study countries (and more broadly) fall into a few categories which can help in thinking through the potential competitiveness impacts of an Australian policy.

No action – Qatar

Qatar signed the Paris Agreement but in its submitted INDC there is no indication that Qatar will implement any climate policies that will impose costs on any sector of the economy. Qatar does not have any form of emission reduction target.

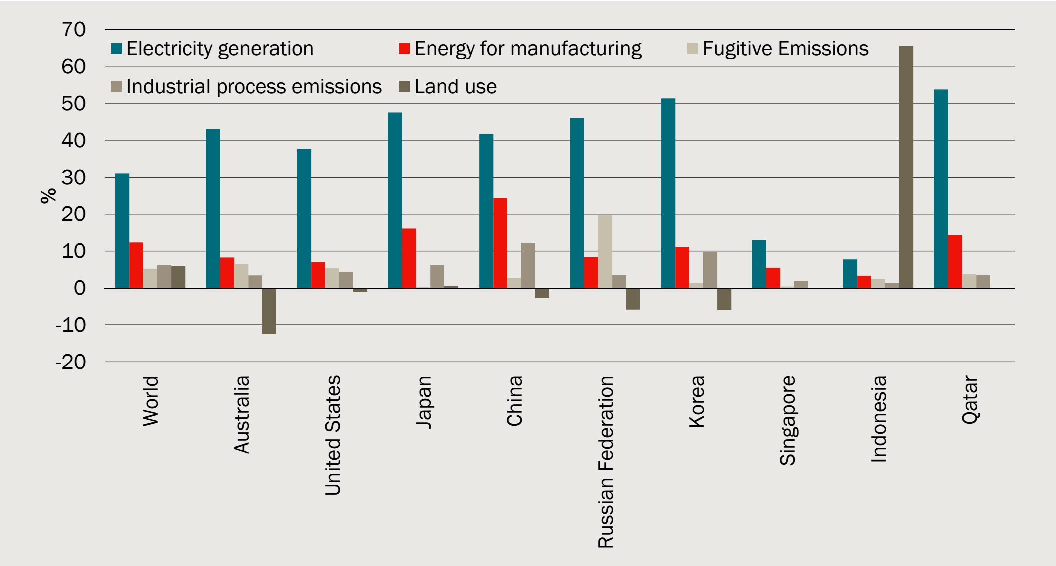
Qatar currently produces 32 per cent of the world's LNG, the largest producer in the world. The main gas producer in Qatar, Qatargas, is one of the lowest cost producers in the world. Qatar is also responsible for around 1 per cent of global aluminium production. Without any climate policy expected in the foreseeable future in Qatar, any cost impost on Australian producers will be seen as a loss in competitiveness.

Likely action, but not in relevant commodities – Indonesia

Indonesia has ratified the Paris Agreement and has set an unconditional reduction target of 29 per cent below business as usual by 2030, and a conditional reduction target up to 41 per cent. Most of the effort, however, to reduce emissions in Indonesia will be focused on the land use sector. The land use sector accounts for over 65 per cent of total greenhouse gas emissions and therefore needs to be the focus of climate policy. Industrial sectors such as nickel and LNG account for a very small proportion of emissions (industrial process emissions are 1 per cent of total emissions, and energy emissions associated with energy use are 3 per cent) and therefore are unlikely to face a carbon price that will lower production.

Chart 4.8 shows the broad break down of emission sources in selected key countries. In general, a country will need to focus abatement efforts on the main sources of emissions. In most case study countries the majority of emissions are associated with electricity generation. In China, however, 24 per cent of emissions are from energy use in the manufacturing sector, and another 12 per cent are industrial process emissions. China, and to a lesser extent Japan, would therefore be expected to focus some abatement efforts in the industrial and manufacturing sectors.

4.8 Sector proportion of total country emissions



Data source: CIE estimates, UN data.

This example shows that participation in the Paris Agreement, and setting a reasonable emission reduction target, does not mitigate competitiveness concerns for particular sectors. With Indonesia's climate policy not expected to impact on industrial activities, a cost impost on competing Australian producers will have competitiveness impacts.

Policy in principle, details yet to come – Singapore

Singapore announced in early 2017 that it would implement a carbon tax from 2019.[7] The tax rate will be in the order of S$10-20 (approx. A$10-20). Precise details of the policy, however, were not revealed. The policy is part of the country's actions to meet its 2030 target under the Paris Agreement, a 36 per cent reduction in emission intensity compared to 2005. However, previous analysis suggests that no new policies are required to meet the target. Furthermore, the government has previously expressed hesitation about imposing competitive costs on its petroleum sector. In 2014, the Prime Minister stated, in the context of climate policy:

> I want to assure all the energy and petrochemicals companies here that the Singapore government stands fully behind them and will continue to help them to succeed.[8]

Until the policy is fully developed including any compensating adjustments, it should not be assumed that Singaporean petroleum producers will face a carbon price. The implemented policy may exclude some facilities or provide some other means of compensation.

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7 Liang, C. Z. 2017, 'Carbon tax on greenhouse gas emissions from 2019', *Straits Times*, 21 February 2017, http://www.straitstimes.com/politics/carbon-tax-on-greenhouse-gas-emissions-from-2019

8 Liu, C. 2015, 'Wealthy Singapore Resists Tough Domestic Climate Action', *Scientific American,* https://www.scientificamerican.com/article/wealthy-singapore-resists-tough-domestic-climate-action/

Policy announced, not yet implemented – China

The policy development process is more progressed in China than Singapore. China is expected to expand its 7 pilot emissions trading schemes to a national scheme. The national ETS is expected to cover all the major industrial sectors, including petrochemicals, chemicals, building materials, iron and steel, non-ferrous metals, paper making, power, and aviation.[9] Permits are expected to be freely allocated based on benchmarking or historical emissions intensity. Despite some details on the design of the scheme being available, until the policy is actually implemented, the carbon price on competitors should not be assumed.

There are several examples of other countries that have developed climate policy but have failed to implement it. For example, South Africa has been debating the introduction of a carbon tax for 10 years. Political challenges has led to a myriad of allowances and ongoing implementation delays. The currently proposed plan will cover between 5 and 40 per cent of national emissions.[10]

Implemented policy, with sectoral support – Korea

Korea established a national cap and trade scheme in 2015 covering 68 per cent of the country's emissions, including the petroleum sector and other major industrial sectors.[11] The current price under the scheme is around KRW 20 800 (or around A$24), indicating permits are in demand and therefore some abatement is occurring. However, in the first phase of the scheme (2015-2017) all permits were freely allocated. In future phases some permits will be auctioned, but EITE sectors will be allocated 100 per cent free permits for all phases of the scheme. There is no planned phasing-out of free allocation in response to international action. Under this policy, petroleum producers competing with Australian producers face a carbon price at the margin, but they have no actual cost impost.

Case study: pilot emissions trading in China

Overview of the pilots

In late 2011, the Chinese NDRC approved the establishment of seven pilot emissions trading schemes. The broad coverage of the schemes, and the thresholds for inclusion of companies are summarised in table 4.9. Each of the pilots was given considerable

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9 International Carbon Action Partnership 2017, *China,* https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=55

10 Gilder, A. and Stiles, G. 2017, 'Canada and South Africa: a Comparison of Two Different Approaches to Carbon Taxation', *Bloomberg BNA*, 29 March 2017, https://www.bna.com/canada-south-africa-n57982085888/

11 International Carbon Action Partnership 2017, *Korea Emissions Trading Scheme,* https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=47

flexibility in establishing the details of the scheme, and each scheme operates on a different basis. Currently, just over 2000 companies are covered by the pilots.

4.9 Broad coverage of Chinese pilot schemes

Province(City)	Industries covered	Threshold	Number of companies
Shenzhen	26 industries, mainly electricity, electronic, manufacturing etc.	Emission >5 kt/a CO_2	635
Shanghai	Iron steel, electricity, chemical, nonferrous, construction material, textile, papermaking, rubber, polyester etc.	Emission >10 kt/a CO_2 in 2010-2011	312
Beijing	Aviation transportation, petroleum, coking and nuke fuel manufacturing, electricity and heating, iron steel and downstream, nonferrous etc.	Emission >10 kt/a CO_2	543
Guangzhou	Electricity, cement, iron steel, ceramic, petroleum, textile, nonferrous, plastic, papermaking etc.	Emission >20 kt/a CO_2 since 2011	202
Tianjin	Iron steel, electricity, chemical, petroleum	Emission >20 kt/a CO_2 since 2009	114
Hubei	Iron steel, chemical, cement, automobile, electricity, nonferrous, glass, papermaking etc.	Standard coal consumption > 10 kt/a	236
Chongqing	Aluminium, Ferro-alloy, calcium carbide, caustic, cement, iron steel.	Emission >20 kt/a CO_2 in 2008-2011	242

Source: CM Group

Current prices

The successful operation of the pilots can be seen in the actual prices in each exchange, varying broadly from $2.50 to $10.00 per tonne (table 4.10).

The relevant question for this report is the extent to which these prices are actually faced by our case study producers.

4.10 Permit prices in Chinese pilots as at 22 March 2017

Market	Price RMB/t	Price AUD/t
Beijing	51.90	9.86
Chongqing	16.13	3.06
Guangdong	15.54	2.95
Hubei	17.31	3.29
Hubei May 2017	20.62	3.92
Shanghai	38.15	7.25
Shanghai May 2017	39.86	7.57
Shenzhen v16	35.42	6.73
Tianjin	13.55	2.57
Fujian	36.60	6.95

Source: Carbon Pulse

Pilot coverage by case study sector

Table 4.11 summarises the number of firms in our case study industries that are covered in the emissions trading pilots. Within our case study groups, the greatest coverage is within iron and steel and cement (with 148 and 156 firms covered, respectively). There are significantly fewer petroleum firms covered (61) and only 5 aluminium and 5 natural gas producers covered. The vast majority (over 80 per cent) of firms covered are outside the case study industries.

This coverage represents around 15 per cent of total Chinese steel production, 10 per cent of total Chinese cement production, and less than 5 per cent of each of aluminium, natural gas and petroleum.

4.11 Producer Mix in Pilot Provinces

Province(City)	Iron Steel	Cement	Aluminium	Natural Gas	Petroleum	Other
Shenzhen	2	0	0	1	0	632
Shanghai	3	0	0	0	8	301
Beijing	1	7	0	0	26	509
Guangzhou	63	68	0	0	9	62
Tianjin	51	0	0	0	9	54
Hubei	21	45	1	0	8	161
Chongqing	7	36	4	4	1	190
Total	**148**	**156**	**5**	**5**	**61**	**1909**
Proportion of total production covered (%)	**15**	**10**	**< 5**	**< 5**	**< 5**	

Source: CM Group analysis

Impact of pilot on sample companies

In order to assess the actual impact of the pilot scheme on producers in the case study sectors, CM Group undertook in-country consultations with a sample of firms to determine in detail the implications of the scheme for that firm's operations. The results of this consultation are summarised in table 4.12.

4.12 Producer Feedback – CM Survey

Producer	Province	Emission Quota Standard	Government Compensation	Impact
Aluminium Producer 1	Chongqing	Industry average	Never heard of it, no need	No impact, average quota is too high, there is no emission quota exchange for alumina and aluminum producers in Chongqing
Cement Producer 1	Chongqing	Historic emission	No	Production cuts amid poor market, allocated emission quota is sufficient
Cement Producer 2	Hubei	Historic emission	No	Upgraded energy source from coal to nature gas based on government requirements, so allocated emission quota is enough
Cement Producer 3	Guangdong	Historic emission	No	Quota has minimal impact on current production
Steel Producer 1	Guangdong	Average historic emission in 2008-2010	No	Production before 2010 was higher than now, so emission quota is now sufficient. Exchange activity in Guangdong is low and carbon price keeps falling.
Steel Producer 2 -	Chongqing	Average historic emission	No	Quota system has minimal impact on current production
Steel Producer 3 -	Guangdong	Average historic emission	No	Quota system has minimal impact on current production

Source: CM Group in-country consultations

These results indicate that while firms did not receive any particular compensation for the operation of the scheme (in terms of the adjustment of other policies), without exception the initial allocation under the scheme was more than adequate for ongoing production needs.

These results illustrate the key challenge in interpreting carbon schemes in other countries: the true extent to which they place a cost on production for particular sectors of interest. Despite a positive carbon price in each of the schemes, available evidence suggests that there is no actual cost implications for specific case study sectors.

KEY LESSON

5 The implementation details of policy are crucial. It is possible for the actual effects at a sector or facility level to be considerably different to that implied by broad descriptions of the policy.

The transition to a national scheme

China is planning to transition to a national emissions trading scheme, reportedly in late 2017. While this has the potential to become the world's largest emissions trading scheme, at the time of preparation of this report, details of its operation are not available.

It is broadly expected that the scheme will cover up to 4 billion tonnes (Bt) of CO_2 a year, covering up to 7 000 companies across the country. Based on results from the pilot schemes, the permit price is expected to be around US$4 per tonne.

The lessons from the pilot indicate that in order to understand the competitiveness effects of the national scheme, considerable attention will need to be paid to actual coverage, permit allocation, and overall trading rules.

KEY LESSON

6 Policy announcement is not the same as implementation.

5 Case study sectors

Steel

Australian steel production, consumption and trade

Australia produced 5 Mt of carbon steel in 2015-16.[12] This is below the production capacity of Australian producers of around 6.5 Mt.[13] Australia both imports and exports steel. In 2015-16, 2.3 Mt of crude steel was imported to Australia. Exports were 0.8 Mt in 2015-16. Australia also exported 1.6 Mt of scrap steel.[14] Products are predominantly imported based on price advantage.

Apparent consumption of steel in Australia in 2015-16 was 6.5 Mt. The primary Australian consumers of steel are in the construction (residential and non-residential), engineering, agriculture, mining and manufacturing sectors. Australian producers each produce a range of different steel products. The steel market is segmented, with different steel products being produced at different mills, and used for different purposes.

There are two steel[15] producing companies in Australia – BlueScope Steel and Arrium.[16] And there are two different steel production processes used in Australia – integrated iron and steel production, and electric arc furnace production. Most steel (77 per cent, or around 3.85 Mt) is produced using the integrated production process, and the remaining 23 per cent using the electric arc furnace production process.[17]

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12 OCE 2016, *Resources and Energy Quarterly September 2016*, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/REQ-September-2016.pdf

13 Prior to the closure of Blast Furnace No.6 (2.5 Mt capacity) at BlueScope Steel's Port Kembla steelworks in October 2011, capacity was estimated at around 9 Mt (ASI 2010, Capabilities of the Australian steel industry to supply major projects (March 2010), http://steel.org.au/media/File/678_ASIINDUSTRY_REPORT_9410.pdf, accessed 26 October 2016)

14 OCE 2016, *Resources and Energy Quarterly September 2016*, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/req/REQ-September-2016.pdf

15 Here the term 'steel' is used to refer to carbon steel and excludes high alloy steels such as stainless steel.

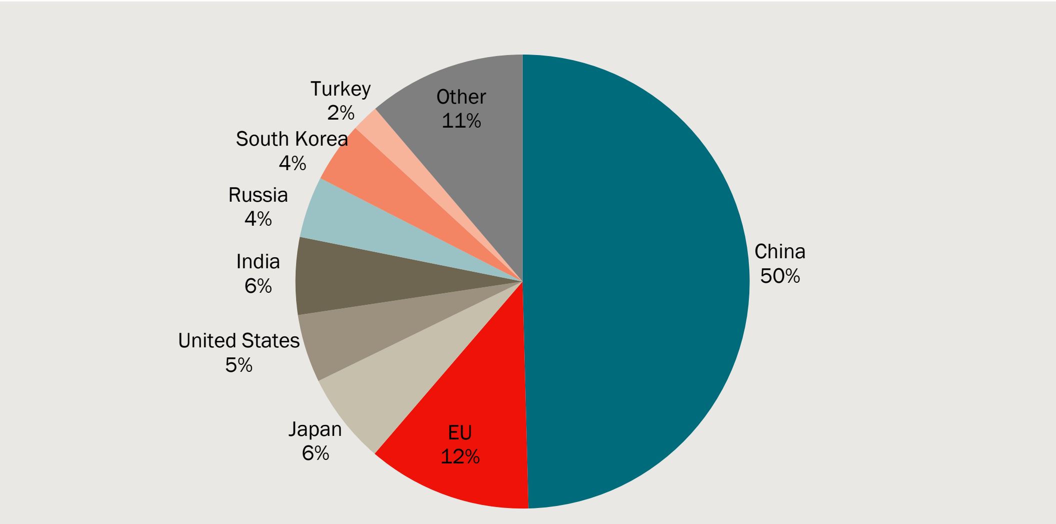
16 Arrium's Moly-Cop business has recently been sold, which will result a third company involved in Australian steel production.

17 World Steel Association 2016, *World Steel in Figures 2016,* http://www.worldsteel.org/publications/bookshop/product-details.~World-Steel-in-Figures-2016~PRODUCT~World-Steel-in-Figures-2016~.html

World steel production and trade

Australian production and use of steel is 0.3 per cent of the world total.[18] The world's largest steel producer is China, producing around half of the world's steel annually, followed by Japan which produces around 6 per cent.[19] Other major producers are India, the US, Russia and South Korea. These six countries account for 75 per cent of the world's production.[20]

5.1 World steel production shares, 2015



Data source: World Steel Association 2016, *World Steel in Figures 2016,* http://www.worldsteel.org/publications/bookshop/product-details.~World-Steel-in-Figures-2016~PRODUCT~World-Steel-in-Figures-2016~.html

World steel output has declined since a peak in early 2014. Production increased from 2012 to 2014 as China increased production, but has since fallen through production declines in Japan, North America and the Commonwealth of Independent States (CIS) countries, predominantly Russia.[21] China has increased its share of world production from 31 per cent in 2005 to 50 per cent in 2015.[22]

In 2015, 31 per cent of world finished steel production was internationally traded. This proportion has fallen from a peak of 39 per cent in 2000.[23] Excluding intra-regional

18 World Steel Association 2016, *World Steel in Figures 2016,* http://www.worldsteel.org/publications/bookshop/product-details.~World-Steel-in-Figures-2016~PRODUCT~World-Steel-in-Figures-2016~.html

19 ibid.

20 ibid.

21 ibid.

22 ibid.

23 ibid.

trade, China is the largest exporter of finished steel, followed by Japan. The EU, US and other Asian countries are the greatest importers of steel.[24]

Production levels increase and decrease each year in response to market needs. Recent economic slowdown in China has resulted in over production, yet there is continued demand in other markets. Demand for steel is strong in India, supported by government infrastructure and building projects, but domestic production is protected through trade policies. In Australia, the recent pipeline of infrastructure projects from state governments has assisted the domestic market for carbon steel products.

Taiwan

Taiwan is seen as a key competitor for the Australian steel industry. After China, Taiwan is the second largest supplier of Australian steel imports. In 2015, Taiwan produced 21.4 Mt of crude steel, or 1.3 per cent of world production.[25] This places Taiwan as the 12^{th} largest steel producer. Taiwan exports 53 per cent of the steel it produces.

Taiwan is not a member of the UN and therefore not party to the UNFCCC. Thus, Taiwan has no official NDC submission. It has, however, established its own legal framework for addressing climate change which includes an emission reduction target. The GHG Reduction and Management Act was introduced in 2015 and requires national emissions to decrease by 50 per cent compared to 2005 levels by 2050. The specifics of policies that will be implemented to reach this target have not been fully developed.

The steel industry is currently required to report GHG emissions mandatorily, but can reduce emissions voluntarily. Despite this, carbon policy remains a secondary issue at the operating site level.

An emissions trading scheme is included as a possibility in the legislation. This will be implemented depending on the actions of other countries. There are specific requirements in the Act for the emissions cap to take into consideration industry trade intensity and reduction costs, as well as emissions leakage and international competitiveness.[26] The reserved approach to implementing emissions trading (conditional on international action), and the specific mention of competitiveness in the act, we could conclude that the government is unlikely to impose carbon price on key trade exposed sectors, such as steel. Purchase of international credits will also be used to reach the emission reduction target.[27]

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24 World Steel Association 2016, *World Steel in Figures 2016,* http://www.worldsteel.org/publications/bookshop/product-details.~World-Steel-in-Figures-2016~PRODUCT~World-Steel-in-Figures-2016~.html

25 ibid.

26 Chien, H., Shih, R. and Hu, W. 2015, *Taiwan: Laying the foundation for a carbon market*, IETA Greenhouse Gas Market, http://www.ieta.org/resources/Resources/GHG_Report/2015/Articles/Taiwan_laying_the_foundation_for_a_carbon_market_HChien_RShi_WHu.pdf

27 ibid.

China

China produced 50 per cent of the world's steel in 2015, it is the largest consumer of steel and also the largest exporter. The Chinese steel sector is currently characterised by overcapacity and over production as the sector adjusts to lower levels of economic growth.

Around 94 per cent of Chinese steel production is through the integrated iron and steel production (blast furnace process) and the remaining 6 per cent through electric arc furnace production.[28]

China ratified the Paris Climate Change Agreement in September 2016. Its NDC states that by 2030, total emissions will peak, emissions intensity will be lowered to 60-65 per cent of 2005 levels, the share of non-fossil fuels in primary energy consumption will fall to 20 per cent and forest stock volumes will increase.

Seven pilot emissions trading schemes have been operating in China (using a baseline and credit design), and a national scheme is being developed. It is expected that the national scheme will be designed on a similar basis to the provincial pilots. The iron and steel sector will be covered in the national scheme, as it has been in the pilots. However, evidence from the pilot programs indicate inclusion in the scheme may not result in producers facing a binding carbon price.

The government (NDRC) allocates emission quotas to main producers for free (according to average historic emissions in the case of steel). The allocated quotas are expected to be decreased year by year. A total of 148 steel producers participated in the pilot schemes, across all the provincial pilot schemes. Feedback from three steel producers (in Chongqing and Guangdong) were that the scheme had minimal or no impact on production. For at least one producer, historical production levels were higher than current levels meaning the quota provided was greater than what was required.

Implications for Australia

Steel is a CO_2 intensive, import competing industry. Over 35 per cent of steel consumed in Australia is imported. The Australian sector is already under significant competitive pressures and has been undertaking restructuring to realise cost reductions. Emissions generated from an integrated steelmaking plant result from the chemical reaction between coal and coke (carbon) and iron ore in the blast furnace. There are currently limited opportunities for abatement, with any financially viable energy efficiency measures already being adopted. Steelmakers around the globe are researching new technologies to significantly reduce emissions. In electric arc furnace operations the main source of emissions is from the supply of electricity. Emission reductions in electricity generation would lower the emission intensity, however this is beyond the control of steel producers.

28 World Steel Association 2016, *World Steel in Figures 2016,* http://www.worldsteel.org/publications/bookshop/product-details.~World-Steel-in-Figures-2016~PRODUCT~World-Steel-in-Figures-2016~.html

In Taiwan, implementation of a cap and trade scheme is dependent on actions in other countries. The government also appears to be cognisant of competitive impacts. This reserved approach to implementing emissions trading, and the specific mention of competitiveness in the Act lead us to conclude that the government is unlikely to impose a carbon price on key trade exposed sectors, such as steel, or that at the very least any scheme would contain significant provisions to limit competitiveness impacts (for example through free permit allocations).

China dominates the world steel market in terms of production, consumption and exports. A national emissions trading scheme is expected to be implemented. However, understanding the true cost pressures in the Chinese economy is difficult. Evidence from the pilot schemes and discussions with steel producers suggest that steel producers are not currently facing a carbon cost from pilot schemes and are not expected to do so for some time.

Overall, for Taiwan and China, there is limited prospect of any significant carbon cost within the steel industry in the short to medium term.

LNG

Australian gas production and exports

Australia's LNG sector is part of the wider natural gas sector. In 2014-15, Australia produced 2587 PJ of natural gas.[29] Production of gas has increased at a rate of around 5 per cent a year for the past decade.[30] Over 60 per cent of gas production is in WA, mostly for export as LNG, most of the remaining gas supply is produced in the eastern market. [31] Gas production in Queensland increased by 45 per cent in one year (from 2013-14 to 2014-15) as coal seam gas (CSG) production grew. In 2004-05 CSG accounted for less than 3 per cent of total gas production. That has increased to 18 per cent in 2014-15. [32]

Around half of Australia's natural gas is exported in the form of LNG and the remaining amount is consumed domestically –for electricity generation, manufacturing, mining and residential uses.[33] Natural gas used for the production of LNG can be sourced from conventional gas fields or coal seam gas. Australia produces LNG at seven plants, and a further three projects are due for completion in 2017 or 2018. LNG exports are predominantly from Western Australia (77 per cent of LNG exports in 2015), where most of Australia's conventional gas fields are located, and Queensland (23 per cent of

29 OCE 2016, *Energy in Australia 2015,* Canberra, January, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Energy-in-Australia.aspx

30 ibid.

31 ibid.

32 ibid.

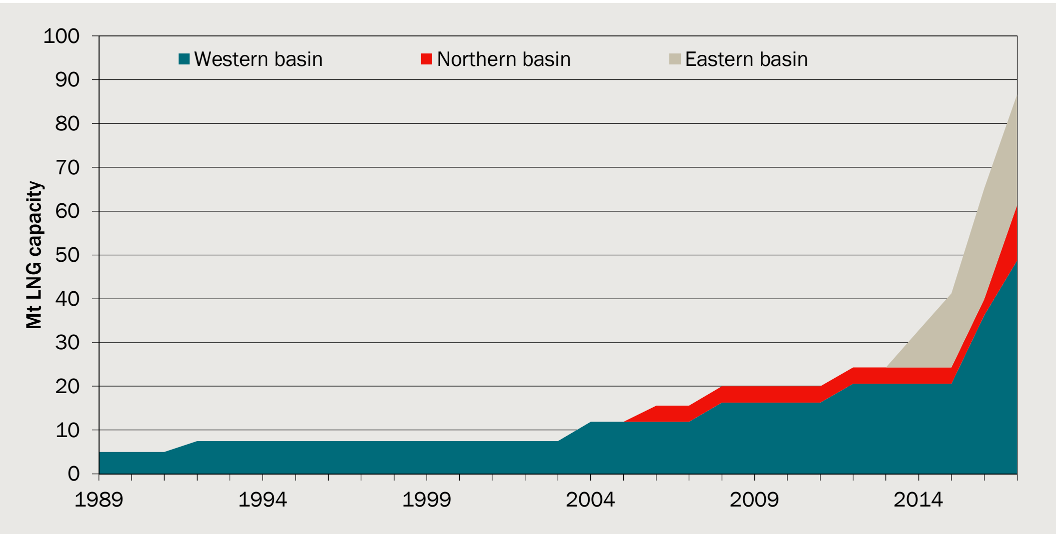
33 ibid.

exports in 2015) where coal seam gas sources are used for newer LNG plants.[34] Gas exports were valued at A$17 billion in 2014-15.[35]

Australia has been exporting gas (as LNG) from the North West Shelf since 1989. Chart 5.2 shows the growth Australia's cumulative LNG capacity since 1989. Australia's LNG capacity has increased significantly since 2012. Current capacity is around 65 Mt LNG per year, and is expected to reach 86 Mt when capacity still under construction comes online in 2017 and 2018. The recent large increase in capacity has been driven by growing energy demand in Asia, global energy prices, and technology developments which have made Australia's undeveloped gas resources accessible. Earlier lower gas prices had meant that the gas resources were previously not financially viable for development. Following the decline in world gas prices in 2014, growth in new LNG developments has returned to the slower long term rate. Development of the CSG resources in eastern Australia (and the associated LNG facilities) was also enabled by technological innovation, growing Asian demand and higher gas prices.

Even with the recent increase in gas extraction, Australia has significant gas reserves (and even more significant gas resources). At the current rate of production, conventional gas reserves are expected to last 51 years, and CSG 133 years.[36]

5.2 Historical and planned LNG production capacity by basin



Data source:

The Asia Pacific region is the greatest consumer of natural gas in the form of LNG, and the share of gas in total energy consumption in the region is expected to grow. The main consumer of Australia's LNG is Japan, importing 80 per cent of LNG exported from

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34 APPEA 2016, *Key Statistics,* http://www.appea.com.au/wp-content/uploads/2016/06/Key-Stats_2016.pdf

35 OCE 2016, *Energy in Australia 2015,* Canberra, January, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Energy-in-Australia.aspx

36 OCE 2016, *Energy in Australia 2015,* Canberra, January, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Energy-in-Australia.aspx

Australia in 2014. Another 16 per cent of exports were destined for China, Australia's second largest LNG customer. Other consumers include South Korea and Taiwan.

International market

There are currently 19 countries that have the capacity to export LNG, up from just eight countries in 1990. Six countries hold over 60 per cent of LNG liquefaction capacity - Qatar, Indonesia, Australia, Malaysia, and Nigeria. In 2016, Australia was the second largest LNG exporting country, behind Qatar, and accounted for around 17 per cent of world LNG trade.[37] Australia is projected to have the greatest LNG capacity by 2018 after the new LNG facilities in WA and Queensland start operating.[38] Even before the new capacity comes online, existing plants are not yet producing to capacity, leaving significant opportunities to increase production and exports.

The United States is currently the 16th largest LNG exporter but has new LNG capacity in the pipeline and is expected to have the third largest liquefaction capacity by 2020.[39] Capacity amounting to 62 Mt was under construction in 2015 in the US and an additional 330 Mt of capacity had been announced (although not all of this is expected to result in actual capacity buildout).[40] Market oversupply, weak demand growth in key import markets and lower oil prices (impacting on capital budgets) mean announced projects with higher cost profiles may not eventuate.[41]

Global capacity utilisation has averaged 86 per cent since 2010. Slightly lower rates (around 84 per cent) were observed in 2014 and 2015 due to reduced LNG production in Egypt (gas feedstock used domestically), Yemen (increased political violence) and Angola (technical difficulties). Utilisation rates in 2015 were highest in Russia, Malaysia, Qatar, PNG, Norway and Equatorial Guinea. The utilisation rate in Australia was around 75 per cent in 2015. While global utilisation rates are well below 100 per cent, international competitors are well placed to increase production should demand increase, or other producers reduce supply.

Demand for LNG in Japan and Korea declined in 2015. The outlook for demand from Japan will be affected, in part, by the future of nuclear power in the country. Demand, however, is not expected to be strong due to energy efficiency improvements, increased use of solar power and a downturn in manufacturing. In Korea, the government favours coal over gas to meet electricity needs. Possible increased demand in Taiwan is not expected to make up for the lower demand across the rest of east Asia.

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37 International Gas Union 2017, 2017 IGU World LNG Report, http://www.igu.org/sites/default/files/103419-World_IGU_Report_no%20crops.pdf

38 ibid.

39 LNG World News 2017, 'Report: Asia becoming largest importer of U.S. LNG', *LNG World News,* http://www.lngworldnews.com/report-asia-becoming-largest-importer-of-us-lng/

40 International Gas Union 2016, 2016 IGU World LNG Report, http://www.igu.org/publications/2016-world-lng-report

41 ibid.

In addition to competing with other LNG suppliers, Australia's LNG is also competing against other source of gas (such as pipeline gas) and other fuels – particularly coal.

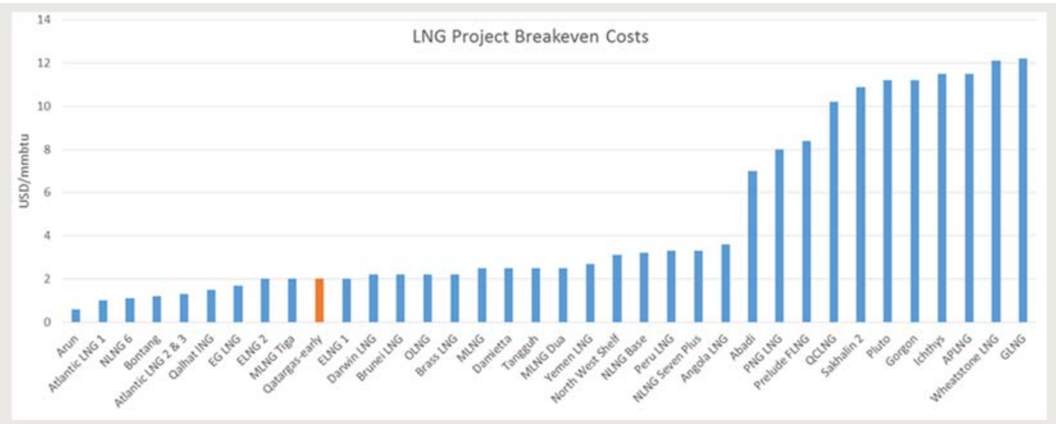
Overall, increases in global supply, low oil prices and economic weakness in northeast Asia are expected to put downward pressure on LNG prices. Low gas prices will mean ongoing LNG production will be a marginal activity, with limited profit margins.[42] In addition to the effects of global prices, Australian producers are also exposed to exchange rate fluctuations. Further development of Australia's gas fields, therefore, will only proceed if a low cost base and conducive regulations in Australia can be achieved.

Qatar

Qatar is the largest LNG producer, and has been for the past decade.[43] Recent declines in demand from the Pacific region combined with an increase in the number of new projects in the Pacific region has meant that Qatar's LNG exports have been diverted to the Atlantic market. Despite this, Japan and Korea remain the largest consumers of Qatari LNG. New no projects are expected in Qatar between now and 2021.

The largest LNG producer in Qatar is Qatargas and accounts for over half of Qatar's LNG capacity. Qatar's LNG projects are among the lowest cost projects in the world (see chart 5.3).

5.3 LNG project production breakeven costs



Data source: Core Energy, IGU, company and analyst reports

Qatar has not included a greenhouse gas emissions reduction target in their INDC, and has not indicated any climate change mitigation policies are expected to impact the LNG industry. Therefore, the largest LNG producers in the world do not currently, and are not expected to, face any carbon price.

42 Letts, S. 2016, 'LNG glut will continue for years as demand falls and supply surges: IEA', *ABC News*, http://www.abc.net.au/news/2016-06-09/lng-glut-will-continue-as-demand-falls-and-supply-surges/7494850

43 International Gas Union 2016, 2016 IGU World LNG Report, http://www.igu.org/publications/2016-world-lng-report

Asian LNG producers

Other major LNG producers in the region include Malaysia and Indonesia.

Malaysia is currently the third largest LNG exporter. Malaysia has ratified the Paris Agreement, and its NDC has a target to reduce the emission intensity of GDP by 45 per cent by 2030, relative to 2005. No measures have been indicated that will impact on LNG exporters. Through changing economic structures, it is possible to reach emission intensity targets without specific emission reduction measures, or imposing costs on emitting sectors.

Similarly, Indonesia has ratified the Paris Agreement and has set an unconditional reduction target of 29 per cent below business as usual by 2030 and conditional reduction target up to 41 per cent. Again, specific policies to reduce emissions have not been detailed. With most emissions in Indonesia arising from the land use sector, emission reduction efforts are expected to be focused on the land sector. Indonesian LNG producers do not currently face a carbon cost, and are not expected to do so in the near future.

Implications for Australian LNG producers

LNG, due to significant energy requirements in the liquefaction process, is an emission intensive sector. It is also a highly traded sector. Indeed, LNG is almost fully exported[44] and consumers are able to source LNG from the lowest cost supplier. Due to the competitive nature of the market, Australia's LNG producers have already pursued available energy efficiency measures. Emissions from LNG liquefaction vary from project to project, and producers currently use emission mitigation technology and processes as standard practice in Australia.

Of LNG exporting countries, the only country with an emissions trading scheme (in place or proposed) is Norway (currently 1.7 per cent of the world market). Norway, however, does not generally compete in the same LNG markets as Australia. Mitigation actions in the other countries are expected to have no, or little, impact on the LNG sector.

Aluminium

Aluminium production and exports

The Australian aluminium industry had an estimated industry gross value add of $600 million in 2014-15, equivalent to almost 4 per cent of national GDP.[45] There are four

44 There are two small domestic LNG receiving plants at Dandenong and Kwinana.

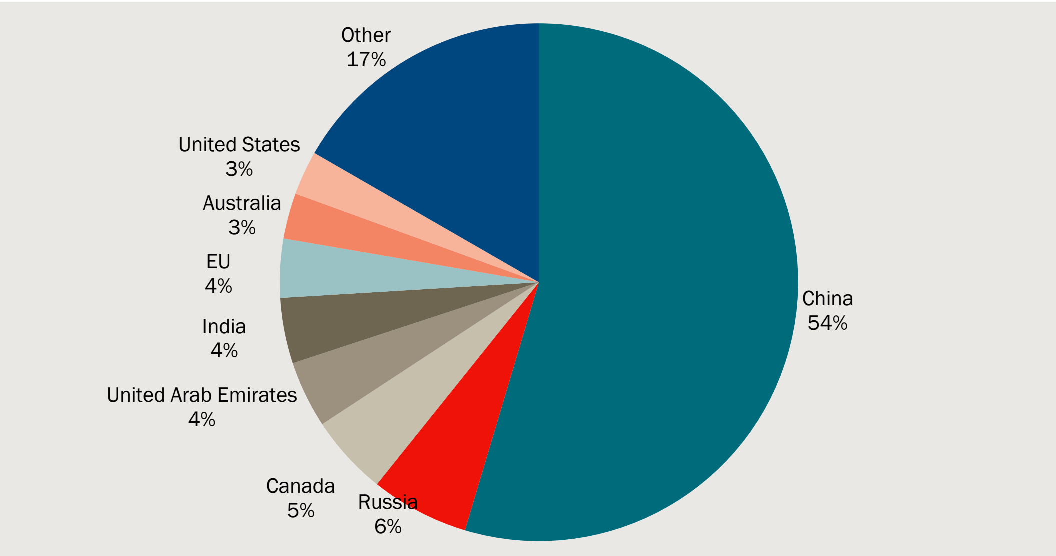
45 OCE 2017, *Resources and Energy Quarterly February,* Department of Industry, Innovation and Science, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx#
and Anti-Dumping Commission 2016, *Analysis of steel and aluminium markets report to the Commissioner of the Anti-Dumping Commission*,

producing aluminium smelters in Australia, and a further two have recently closed. The four smelters are run by Alcoa of Australia and Rio Tinto Alcan.

- Alcoa of Australia's Portland, Victoria, smelter has capacity of 358 kt per year and produces around 300 kt per year or 20 per cent of Australia's aluminium.
- Rio Tinto Alcan has three facilities:
  - Bell Bay Aluminium, near Launceston, Tasmania, produces 180 kt a year.
  - Boyne Smelters, Gladstone produces 570 kt a year.
  - Tomago Aluminium, in Tomago NSW is Australia's largest smelter. It produces 585 kt a year (25 per cent of Australia's aluminium).

World aluminium production in 2015 was 57.5 Mt.[46] The largest producer worldwide was China, producing 55 per cent of all aluminium. Other major producers are Russia (6 per cent of production), Canada (5 per cent), UAE (4 per cent) and India (4 per cent). Australia produced 1.7 Mt of aluminium, or around 3 per cent of world production.

5.4 World aluminium production, 2015



Data source: USGS 2016, *Minerals Year Book: Aluminium*, Table 13, https://minerals.usgs.gov/minerals/pubs/commodity/aluminum/

Despite being the largest producer, China is not the largest aluminium exporter. This is due to high aluminium consumption levels in China. The EU exported the most aluminium (by value) in 2015, followed by China, USA and Russia, Canada and UAE. Australia exports 86 per cent of its aluminium product. Key export markets are Japan, South Korea, Taiwan and Thailand.

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http://www.adcommission.gov.au/adsystem/referencematerial/Documents/MASTER%20-%20Steel%20aluminium%20report%20%20-%2031%20August%202016%20-%20for%20public%20release.pdf

46 USGS 2016, *Minerals Year Book: Aluminium*, Table 13, https://minerals.usgs.gov/minerals/pubs/commodity/aluminum/

The aluminium market is currently characterised by underutilised capacity[47] and product oversupply[48]. In the period before the global financial crisis aluminium production, particularly in China grew extremely rapidly. China's production increased from 6.7 Mt in 2004 to 31 Mt in 2015. The crisis rapidly decreased demand for aluminium and supply contracted at a slower rate resulting in stockpiled product. Sunk costs associated with establishing aluminium smelters means that it is cheaper to reduce production rather than closing plants. This means that, with underutilised capacity, producers can easily increase production again if the demand returns.

The two major aluminium regions now are China (with very large market share in both aluminium and alumina, and underutilised existing capacity) and the Middle East, a region seeing rapid growth in aluminium and alumina production capacity. The Middle East is an attractive destination for new investments due to the availability of energy in the region.

China

China became the world's largest aluminium smelting region in 2003 and between 2005 and 2015 the average annual growth rate in China's primary aluminium capacity was 14 per cent, compared with 0.6 per cent for the rest of the world (see chart 5.4). Despite only 76 per cent of capacity currently being utilised in 2015,[49] more capacity is currently under construction and more projects are expected to be announced over the next two years.[50]

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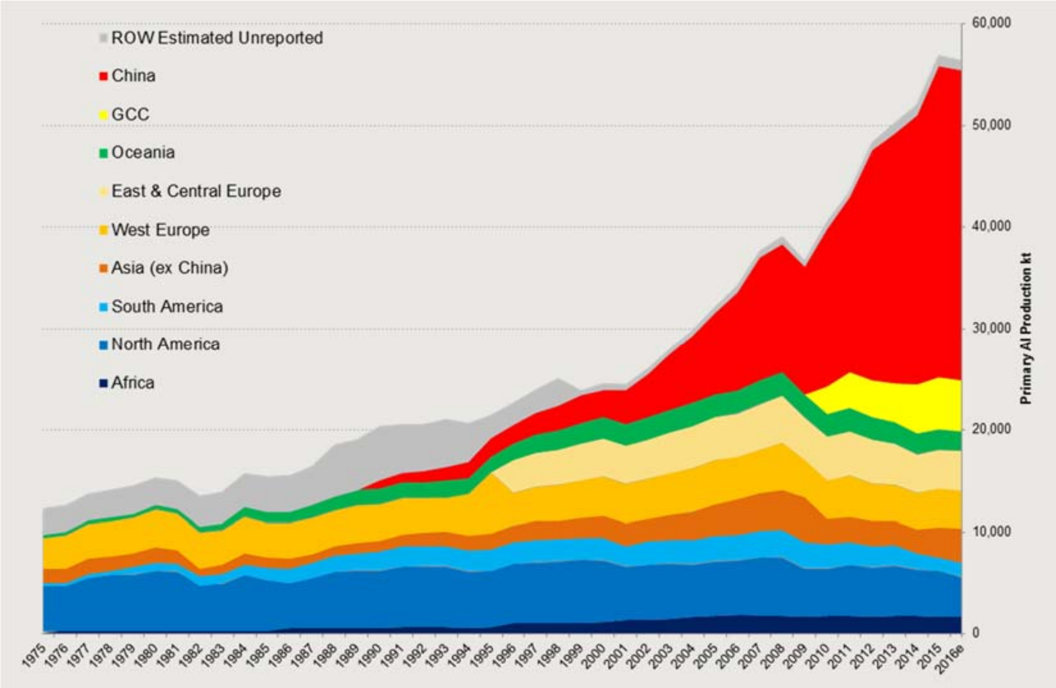
47 European Union Chamber of Commerce in China 2016, *Overcapacity in China: An Impediment to the Party's Reform Agenda,* http://www.iberchina.org/files/2016/Overcapacity_in_China.pdf

48 Anti-Dumping Commission 2016, *Analysis of steel and aluminium markets report to the Commissioner of the Anti-Dumping Commission*, http://www.adcommission.gov.au/adsystem/referencematerial/Documents/MASTER%20-%20Steel%20aluminium%20report%20%20-%2031%20August%202016%20-%20for%20public%20release.pdf

49 European Union Chamber of Commerce in China 2016, *Overcapacity in China: An Impediment to the Party's Reform Agenda,* http://www.iberchina.org/files/2016/Overcapacity_in_China.pdf

50 CM Group

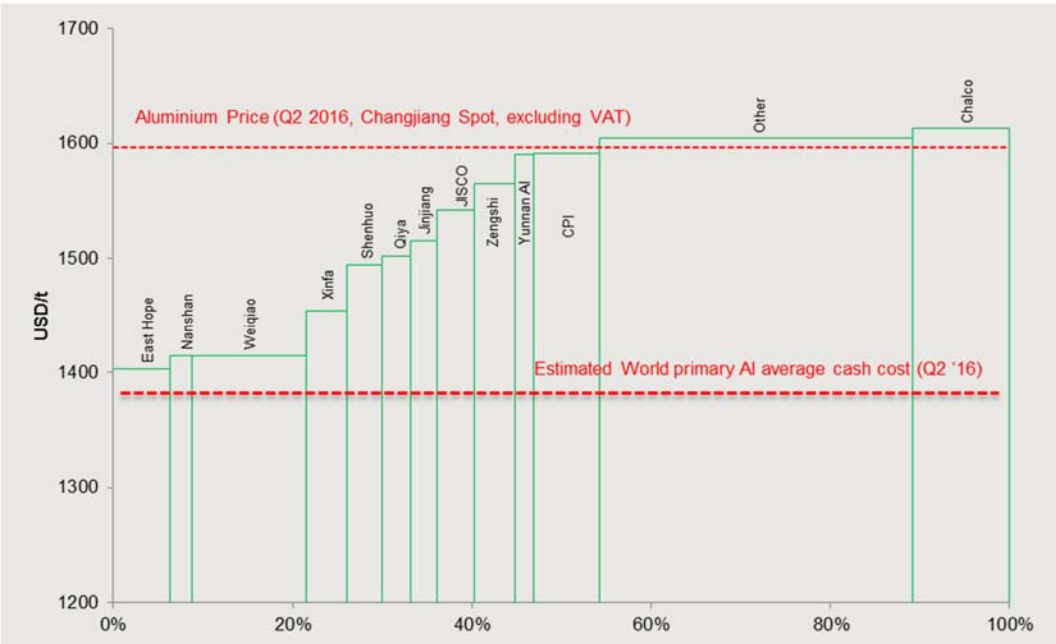
5.5 World aluminium production, 1975-2016



Data source: ROW - IAI, China - CM Group

Up to 54 per cent of smelters in China make use of captive power supply, many plants are specifically located in regions with abundant coal resources to take advantage of low cost power. This is particularly the case in Xinjiang and Shandong provinces. Facilities with captive power supply generally have lower overall production costs. Despite this, Chinese production costs are higher than the world average, and costs at some smelters are above the world aluminium price (see chart 5.6).

5.6 China's primary aluminium cash cost by major producer



Data source: CM Group analysis

Chinese climate change policy

China ratified the Paris Climate Change Agreement in September 2016. Its NDC states that by 2030, total emissions will peak, emissions intensity will be lowered to 60-65 per cent of 2005 levels, the share of non-fossil fuels in primary energy consumption will fall to 20 per cent and forest stock volumes will increase.

Seven pilot emissions trading schemes have been operating in China (using a baseline and credit design), and a national scheme is being developed. It is expected that the national scheme will be designed on a similar basis to the provincial pilots. The aluminium sector is expected be covered in the national scheme, as it has been in the pilots (although the seven pilot programs covered less than 5 per cent of aluminium production in China)=. However, evidence from the pilot programs indicate inclusion in the scheme may not result in producers facing a binding carbon price.

The government (NDRC) allocates emission quotas to main producers for free (according to their industry average emissions in the case of aluminium in Chongqing). The allocated quotas are expected to be decreased year by year.

Only five aluminium producers were included in the pilot schemes, four in Chongqing province and one in Shenzhen. There are other aluminium smelters in these regions that were not part of the scheme. The reason for this is unclear. Feedback from one of the producers in Chongqing participating in the scheme was that the scheme had no impact on their business. The average quota was higher than emissions and there is no emission quota exchange for alumina and aluminum producers in Chongqing.

Table 5.7 summarises views on future climate change policy from parties in the aluminium sector. Overall, aluminium producers are not expecting to face a real impact for several years.

5.7 Chinese aluminium views on climate policy

Sino-Carbon Innovation and Investment Co.	Tsinghua University is responsible for developing the permit allocation scheme. They say the system could be released for comment in a month or two. Individual permit allocations will be calculated based on the electricity consumption per tonne of aluminium to minimize the variance between smelters. The national carbon trading system is likely to take effect leading up to this year's National Congress, so that would imply in the period Jun – Sep, 2017. At the early stage of carbon trading, all permits will be free to facilitate producers' acceptance of and participation in the scheme. The free permits will last for at least three years. Third-party verification of aluminium smelters has apparently been underway for a while, to provide detailed and accurate data for permit allocation. Although in theory the carbon trading scheme could become effective sometime this year, any real, quantifiable influence on aluminium smelters would not come into effect for at least 2 to 3 years after any announcement . China's government seems to be taking a solid approach towards the national carbon trading system. So much so, it was listed on the work tasks for the Central Comprehensive Deepening Reform Leading Group, led by President Xi and Prime Minister Li. As recently as yesterday (Sunday), at the People's Congress in Beijing, Prime Minister Li re-affirmed China's commitment to the Paris agreement.
China non-ferrous industry association (CNIA)	CNIA has held discussions with China's primary aluminium sector on carbon trading to familiarize them with the related information. Their view is it likely to happen, so you may need to familiarise yourselves with the policy and its potential implications. As the final permit allocation plan has not been published, the actual impact on smelters is still unclear. Knowledge and understanding from the producers varies considerably, the CNIA thinks the large SOEs can take a lead position and small producers can follow suit regarding carbon trading. For most producers, they won't take any action at all until they fully understand the impact on their margins.
Chalco	SOE's, in particular Chalco, are surprisingly well-informed about China's carbon policy and its potential impact. This is in stark contrast to private producers, who are mostly not well-informed about carbon policy, although they have at least heard about it. Chalco has already undertaken in-house training about carbon emissions and has reportedly summarised its own carbon emissions on a plant-by-plant basis across its assets, in readiness for the release of a more detailed policy and further explanation about its likely impact. Chalco also believes a more detailed policy is likely to be introduced during 2017, through China's NDRC. It is at this point, Chalco will consider the various options and develop a strategy about how to tackle any direct impact on its business. In general, private producers have very little understanding of the policy and its intent. They are mostly aware of the issue and find it "very interesting", but it is very much a watch-and-see approach.

Source: CM Group

China is also implementing a 'new for old' policy which is currently driving an upgrade in aluminium smelting capacity. Old, inefficient plants are closing down and being replaced with new facilities with lower emission intensities.[51]

51 OCE 2016, *Resources and Energy Quarterly September,* Department of Industry, Innovation and Science, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx#

Much greater policy action is expected with objectives to reduce particulate matter pollution (measured by PM2.5) due to the immediate and visible impact of particulate matter on population health. Many of the major sources of particulate matter pollution are also emitters of greenhouse gases. Coal combustion in particular is a major source of PM pollution and also a key source of greenhouse gas emissions. Work by Jun Ma[52] examining air pollution issues in China highlight some of the policy challenges associated with reducing polluting activities. These observations are also relevant to the climate change policy problem and provide insights into the potential impacts and implications of policy in China. As most of the emissions associated with aluminium production are due to coal fired electricity generation, the aluminium sector may be affected by efforts to curb PM 2.5 emissions.

Policy action based on addressing PM 2.5 pollution, however, is more likely to be implemented on a regional basis, focused on areas where pollution levels are particularly high. This will give rise to further difficulty in understanding policy implications for competitiveness and would require analysis at a regional, or even facility level. Of the 10 most polluted Chinese cities in terms of PM 2.5, just two are in provinces with high aluminium smelting capacities (Jinan in Shandong and Zhengzhou in Henan). This observation may lead to the conclusion that efforts to reduce PM 2.5 pollution will have little impact on Chinese aluminium production.

Middle East

The Middle East is seeing the strongest growth in aluminium smelting capacity outside of China. Existing global aluminium firms are selecting the region for new capacity investments due to the availability, and low cost, of electricity. The alumina refining capacity of the region is also increasing, providing the aluminium sector with abundant supply of its two key inputs – alumina and power. With electricity generation powered by natural gas, the sector is more emission efficient and lower cost than many other producers. The UAE is expected to remain one of the world's lowest cost producers for years.[53]

Most of the product (85 per cent) from the region is exported, and despite some domestic demand growth, further aluminium smelting capacity is expected to lead to further exports.

The Middle East economies, including UAE, Bahrain, and Qatar, do not have significant climate change policies in place. None of these countries included a specific emission reduction target in their (I)NDCs to the Paris Agreement and there is no discussion of policies that would impose cost on aluminium, alumina or electricity producers in the region. Aluminium producers, therefore, are not expected to face any carbon price in these countries in the foreseeable future.

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52 Ma, J. 2016, *The Economics of Air Pollution in China: Achieving Better and Cleaner Growth,* Columbia University Press.

53 Metalworld 2016, *Middle East Offers Immense Opportunities for Aluminium Industry*, http://metalworld.co.in/Newsletter/2016/july16/infocus0716.pdf

Implications for Australian producers

Aluminium is a highly emission intensive sector, with emissions arising from electricity use as well as process emissions from chemical reactions in the production process. The key input, alumina, is also highly emission intensive. There are limited emission reduction opportunities available to the Australian aluminium sector given the age of the facilities and reliance on grid supplied electricity.

Aluminium producers in China, the key competing aluminium producing country, do not face a binding carbon price. Implementation of a national emissions trading scheme has the potential to impose a cost of producers, but excess permit allocation, as occurred in the pilot schemes, would mean no actual cost for individual aluminium facilities.

The Middle East countries of UAE, Bahrain and Qatar are becoming significant aluminium producers. These new facilities have very low costs and are not going to face a carbon price in the foreseeable future.

A carbon cost imposed on Australian producers is likely to result in carbon leakage as Australian facilities are closed down in favour of investments in countries with lower, or no carbon cost. This is a relatively easy transition for international aluminium firms who are always considering the optimal location for further investment and ongoing operations.

Cement

Cement production and trade

In 2016, 4,200 million tonnes of cement were produced worldwide, and global clinker capacity was 3,700 million tonnes[54]. The largest cement producer by far is China, accounting for over 50 per cent of global cement production and clinker capacity. India is the next largest producer with 7 per cent of the global market, followed by the United States, Turkey and Vietnam – all around 2 per cent of the market.

In Australia there are three major cement producers – Adelaide Brighton Ltd, Cement Australia Pty Ltd and Boral Cement Ltd. The sector produced $2.4 billion of product and employed over 1 200 people in 2015-16.[55] Cement products in Australia are used predominantly in building and construction – including major infrastructure projects. Demand for cement (and clinker) has remained relatively steady over the past couple of decades, in line with economic development (see chart 5.8, apparent consumption of clinker has remained between 8 and 9 Mt for the past decade).[56]

The Australian cement manufacturing industry, however, has been through a period of consolidation over the last two decades, which has seen the number of integrated clinker and cement facilities reduce from 13 in the late 1990s to the five operating today.

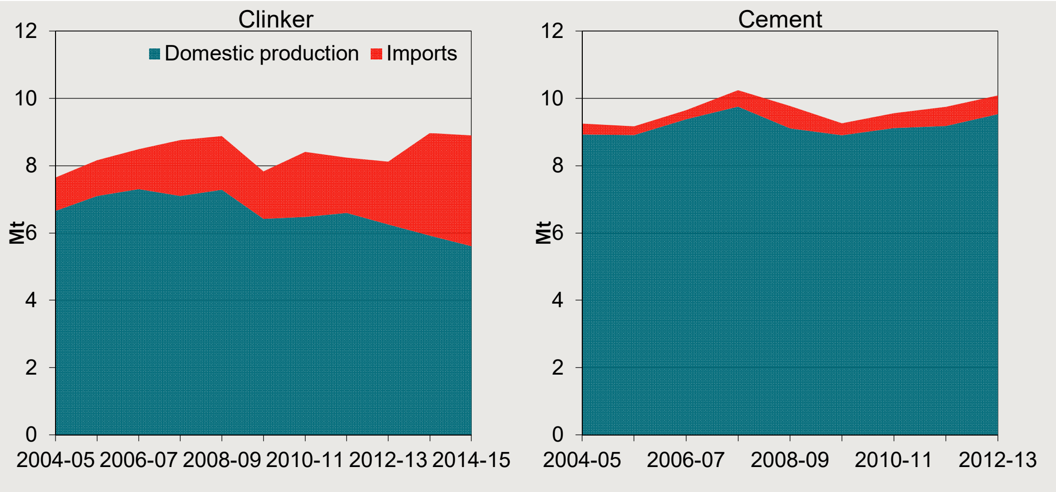
54 https://minerals.usgs.gov/minerals/pubs/commodity/cement/mcs-2017-cemen.pdf

55 CIF 2016, *Australian Cement Industry Trade Statistics 2015-16*

56 ibid.

As a result, domestic clinker production has trended downwards over the period whilst cement production has remained steady.[57] Clinker imports have increased to meet the drop in domestic clinker production (see chart 5.8) and are now double what they were five years ago. Clinker imports into Australia now represent around 40 per cent of the Australian clinker market.[58]

5.8 Australian clinker and cement apparent consumption (domestic production and imports)



Data source: CIF 2016, *Australian Cement Industry Trade Statistics 2015-16, ABS 2014, Cat No. 8301.*

Cement import levels, on the other hand, have exhibited more variability over the last decade as the low unit value and handling requirements of cement discourage transport over long distances (see chart 5.8). Cement imports into Australia currently represent around 2 per cent of the domestic market, however, this could potentially change as seen recently in New Zealand.[59]

Globally, the largest producers of cement are China, India and US. In 2014, a total of 4.2 Bt of cement was produced.[60] Most of the growth in cement demand and production is centred on emerging economies, China and India in particular. China currently accounts for over half of the world's cement production. Imports of clinker to Australia are mainly sourced from Japan and China.[61]

57 Clinker is the key component in cement. Clinker is mixed with gypsum and ground to a fine powder to make cement.

58 CIF 2016, *Australian Cement Industry Trade Statistics 2015-16*

59 World Cement 2014, *Holcim New Zealand holds ground-breaking ceremony for new terminal*, https://www.worldcement.com/asia-pacific-rim/15102014/holcim-new-zealand-holds-ground-breaking-ceremony-for-new-terminal-666/

60 USGS 2015, *Mineral Commodity Summaries: Cement*, January, http://minerals.usgs.gov/minerals/pubs/commodity/cement/mcs-2015-cemen.pdf

61 CIF 2016, *Australian Cement Industry Trade Statistics 2015-16*

China

China is the world's largest cement producer and potentially a significant exporter. Currently, China exports less than one per cent of its production of cement and clinker. However, cement consumption in China is projected to decline in the coming year[62], and capacity is also projected to increase (table 5.9). These two factors have the potential to result in increased cement exports from China.

5.9 China clinker and cement production and capacity, 2014-2017

	Production		Capacity		Utilisation		App Consumption
	Clinker	Cement	Clinker	Cement	Clinker	Cement	Cement
	Mt	Mt	Mt	Mt	%	%	Mt
2014	1421	2470	1906	2731	75	90	2480
2015	1335	2348	1935	2772	69	85	2357
2016	1314	2310	1963	2812	67	82	2319
2017	1307	2299	1969	2822	66	81	2307

Source: Provided by CIF: The Global Cement Report XI (2014), International Cement Review (April 2016); Global Cement (http://www.globalcement.com/news/item/4533-has-china-s-cement-production-peaked)

In the longer term, a slowdown in economic and population growth, and a shift away from investment lead growth, is expected to lead to a substantial decline in Chinese cement consumption. The extent of the projected change, however, varies significantly between analysts. Morgan Stanley estimate a 1.7 Bt reduction in demand between 2017and 2040. Other commentators suggest cement demand will continue to grow for 10-15 years.

Chinese consumption and production of clinker and cement is immense compared to the Australian market. Just one of China's cement producers has the capacity to produce more than 40 times more clinker in one year than the total volume produced in Australia.

Chinese climate change policy

China ratified the Paris Climate Change Agreement in September 2016. Its NDC states that by 2030:

- total emissions will peak
- emissions intensity will be lowered to 60-65 per cent of 2005 levels
- the share of non-fossil fuels in primary energy consumption will fall to 20 per cent, and
- forest stock volumes will increase.

Seven pilot emissions trading schemes have been operating in China (using a baseline and credit design), and a national scheme is being developed. It is expected that the national scheme will be designed on a similar basis to the provincial pilots. The cement

62 CW Group 2016, *2016 World cement demand forecast revised downward on Chinese slowdown,* http://www.cwgrp.com/news/research/426715-2016-world-cement-demand-forecast-revised-downward-on-chinese-slowdown

sector will be covered in the national scheme, as it has been in the pilots. However, evidence from the pilot programs indicate inclusion in the scheme may not result in producers facing a binding carbon price.

The government (NDRC) allocates emission quotas to main producers for free (according to their historic emissions in the case of cement). The allocated quotas are expected to be decreased year by year.

In the pilot schemes, 156 cement producers were covered, in four of the seven pilot regions. Evidence collected from three cement producers in different provinces show that the pilot schemes are not impacting on production. The allocated emission quotas have fully covered requirements as production has declined compared to the baseline level, and/or other government requirements to switch from coal to gas fired energy sources.

As national emissions trading scheme is expected have a similar design to the pilot schemes, even if cement producers were covered there may be no cost faced by cement producers until quota allocations are reduced.

In general, the policy settings in China tend to favour economic over environmental outcomes.[63] There is, however, growing pressure to address particulate matter (PM2.5) air pollution. This will also act to lower greenhouse gas emissions associated with fossil fuels and other sources. The cement industry is also a source of PM2.5 pollution and therefore any policies primarily aimed at addressing PM2.5 air pollution may constrain the Chinese cement industry.

Policy action based on addressing PM 2.5 pollution, however, is likely to be implemented on a regional basis, focused on areas where pollution levels are particularly high. This will give rise to further difficulty in understanding policy implications for competitiveness and would require analysis at a regional, or even facility level.

Japan

In 2015 Japan produced 50.3 Mt of clinker and 59.5 Mt of cement (see table 5.10). Export share of both clinker and cement is around 9 per cent. While not a significant producer in terms of world production (Japan accounts for 1.4 per cent of world cement production and clinker capacity), Japanese producers are the primary international competition for Australian producers as Japan is the source of most of Australia's imports.

The Japanese economy has been stagnant since the 1990s. Demand for cement from investment in infrastructure by both the government and private sectors has been declining, and cement producers have been looking increasingly towards export

63 Ma, J. 2016, *The Economics of Air Pollution in China: Achieving Better and Cleaner Growth,* Columbia University Press.

markets.[64] Singapore is the largest importer of Japanese cement, followed by Australia. In 2015, Japan exported 2.0 Mt of cement to Oceania, 20 per cent of all exports.[65]

However, both short and long term cement demand until 2020 are envisaged to benefit from ongoing earthquake construction projects as well as from expanded public sector investment. In addition, urban redevelopment and the 2020 Tokyo Summer Olympics are expected to provide further impetus to domestic cement markets.

5.10 Japan clinker and cement production and trade, 2010-2015

	Production		App. Consumption	Imports	Exports	
	Clinker	Cement	Cement	Cement	Clinker	Cement
	Mt	Mt	Mt	Mt	Mt	Mt
2010	47.8	56.6	41.8	0.6	4.9	5.4
2011	47.7	56.4	42.1	0.7	4.8	5
2012	49.9	59.3	44.3	0.8	4.3	5.4
2013	51.5	61.7	47	0.8	3.5	5.2
2014	52.1	61.9	46.4	0.6	3.8	5.3
2015	50.3	59.5	43.4	0.3	4.4	5.7

Source: Provided by CIF 2016

Japan has ratified the Paris Agreement and set a target to reduce emissions by 26 per cent compared to 2013, by 2030. It has also nominated a reduction target of 80 per cent by 2050.

At the national level, a fossil fuel tax is in place, at \$3/t CO_2, however, as the majority of emissions from cement and clinker production are process emissions, this tax will have little impact on cement producers.

There have been discussions of an emissions trading scheme or carbon tax for years. Industry has successfully lobbied against a carbon price so far.[66] Measures listed in the NDC to meet the 2030 target include the introduction of innovative cement production processes. Whether these processes will be introduced through regulation or subsidies is not clear.

Implications for Australia

The cement industry is highly trade exposed. Cement and clinker are easily substituted for imports due to the homogeneous nature of the product. Domestic prices are generally based on import parity. This leaves the domestic industry little room to increase prices in

64 Nikkei Asian Review 2016, *Japan's cement exports rise as domestic demand sinks*, 22 January 2016, http://asia.nikkei.com/Markets/Commodities/Japan-s-cement-exports-rise-as-domestic-demand-sinks?page=1

65 Figures provided by CIF

66 Reklev, S. 2016, 'Japan environment minister won't give up on carbon pricing', *Carbon Pulse*, 29 March, https://carbon-pulse.com/17656/

response to any increase in the cost of production. Recent closures of cement and clinker plants would indicate that the industry is already in a very competitive international market. Emissions from cement production are primarily associated with unavoidable process emissions in the production of clinker. There are no substantial opportunities for the sector to reduce emissions.

The major cement and clinker producing and exporting countries do not currently have a price on greenhouse gas emissions. A price may emerge for cement producers in China, but at this stage cement producers that are covered by emissions trading in pilot schemes are not impacted.

Petroleum

Petroleum production and trade

In 2015, 79.6 million barrels a day (mmbd) of oil were refined across the world. Global refinery capacity was 97.2 mmbd in 2015, operating at around 82 per cent of capacity. The countries refining the greatest volumes of oil were the USA (20 per cent), EU (15 per cent), China (13 per cent) and India (6 per cent). Australia refined 401 thousand barrels a day (kbd), or 0.5 per cent of the global total, operating at 91 per cent of capacity.

Over the past decade there has been a trend of increased refinery capacity in developing Asian economies – such as China and India – and declining capacity in developed countries in Western Europe and in Australia.[67]

There are four companies in Australia refining petroleum:

- BP Australia refines crude oil at the Kwinana refinery in WA.
- Caltex operates the Lytton refinery in Brisbane.[68]
- Mobil Oil refines oil at the Altona refinery in Melbourne.
- Viva Energy Australia run the refinery in Geelong.

Table 5.11 summarises the production capacity of the refineries.

67 OPEC 2017, *Data download Table 4.3,* http://asb.opec.org/index.php/data-download

68 Mining Link n.d., *Lytton Oil Refinery,* http://mininglink.com.au/site/lytton-oil-refinery

5.11 Australian refinery capacity

Refinery	Capacity
	Million litres per year
Kwinana	8 300
Lytton	6 300
Altona	4 640
Geelong	7 470
Total	**26 710**

Source: APH Economics Committee 2013, *Report on Australia's oil refinery industry*, http://www.aip.com.au/pdf/APH%20Economics%20Committee%20Report%20-%20Oil%20Refining%20Industry.pdf

Emissions from refining are around 8 million tonnes a yerar, with around 6 million tonnes from generation of heat and 2 million tonnes from emissions embodied in energy consumption.

The Australian oil refining sector has been under substantial commercial pressure because of a global oversupply of petroleum projects.

These pressures have meant that Australia's refinery throughput has declined over the past decade as refineries have closed and been converted to import terminals – a reflection of the import competition facing the domestic industry. Mobil Oil closed its Adelaide refinery in 2003, Shell converted its Clyde refinery to an import terminal in 2012, and Caltex converted its Kurnell refinery to a fuel import terminal in 2014 and BP closed its Bulwer Island refinery in 2015. In 2015-16 Australian production of refined petroleum products was 25 821 million litres, 34 per cent less than in 2010-11.[69]

In 2015-16 around 59 per cent of refined petroleum products sold in Australia were imported. Imports were sourced from Korea (30 per cent), Singapore (24 per cent) and Japan (15 per cent).[70]

Compared with refineries in Asia, Australian refineries suffer from disadvantages in capital and operating costs which work to preclude Australia from consideration for major refinery projects.

South Korea

South Korea refinery throughput in 2015 was 3.4 per cent of world throughput making the country the 7th largest producer. After China, India and Japan, Korea is the largest producer in the Asia-Pacific region and a major exporter.

Korea ratified the Paris Agreement and has an economy-wide target to reduce its greenhouse gas emissions by 37 per cent below business-as-usual (BAU) emissions of 850.6 Mt CO_2-e by 2030. Korea implemented a national emissions trading scheme in 2015 covering around 67 per cent of emissions. The first phase of the scheme covers refineries, where emissions are over 250 000 t CO_2-e a year, or for companies with

69 Department of the Environment and Energy 2016, *Australian Petroleum Statistics October 2016*, http://www.environment.gov.au/energy/publications/petroleum-statistics-oct-2016

70 ibid.

emissions over 125 000 t CO_2-e a year.[71] In the first phase all permits are allocated free based on activity data from 2011-2013. In future phases a lesser share of emissions will be allocated freely and the rest will be auctioned. Sectors deemed emission intensive and trade exposed, however, will continue to receive 100 per cent free permits.

With free permits provided to trade exposed sectors, including oil refineries, the refineries will not face a cost impost from the climate policy.

Korea has also stated that it intends to purchase international permits to achieve the 2030 target. The use of international permits will lower the impost on the domestic economy to realise the emission reduction target.

Singapore

Singapore was responsible for 1.1 per cent of world refinery throughput in 2015 and is a major oil hub for the Asia-Pacific region. The oil industry accounts for 5 per cent of the country's GDP.

Singapore ratified the Paris Agreement and has an emissions target of 36 per cent reduction of emissions intensity below 2005 levels by 2030. This target is expected to be reached without any further policy action. Currently policies are focused on energy efficiency measures. It appears as though the Singapore government is hesitant to implement policies affecting the petroleum industry.[72] In 2017, the government announced that it would introduce a carbon tax on greenhouse gases from 2019. Further details of the policy, and what (if any) concessions will be provided to petroleum refineries are not yet available.

Implications for Australia

Petroleum products are highly traded commodities. The Australian industry is already facing competitive pressures and therefore has incentives to implement all available energy efficiency opportunities. Most emissions are associated with fuels used to heat the crude oil for distillation with little opportunity for emission reductions. Australia's key competitors in the petroleum sector, Korea and Singapore, are at varying stages of climate policy implementation. However, competing facilities currently do not pay a carbon price. Policy is yet to be implemented (or even fully announced) in Singapore and refiners in South Korea receive all required emission permits under the emissions trading scheme for free. Korean refiners face a carbon price at the margin, but no actual cost impost due to the free permits.

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71 International Carbon Action Partnership 2017, *Korea Emissions Trading Scheme*, https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems%5B%5D=47

72 See https://www.scientificamerican.com/article/wealthy-singapore-resists-tough-domestic-climate-action/

Nickel

International production

World nickel mine production in 2015 was 2.15 Mt.[73] The largest nickel producing countries are Philippines (21 per cent of world production), Canada (9.5 per cent), Russia (9.5 per cent), Australia (9 per cent), New Caledonia (7.5 per cent) and Indonesia (7 per cent).[74] World production of nickel has steadily increased over time, apart from a small decline in 2008 and 2009 with the global financial crisis.

Once mined, nickel is processed into various different grades of purity – including processing ore, intermediate I, intermediate II and refined. World refined nickel production was 1.98 Mt in 2015.[75] Key producers of refined nickel are China (31 per cent of production in 2015), Russia (13 per cent), Canada (8 per cent), Australia (6 per cent), New Caledonia (5 per cent) and Indonesia (2 per cent).[76] Recent production of refined nickel has been affected by domestic policies in Indonesia. Production increased significantly (by 191 per cent) in 2016 as the government implemented a ban on the exports of raw ores to encourage domestic processing activity. Production in the Philippines may be hampered in the near future as a number of mines have failed environmental audits and been forced to close.

Nickel ores can also be used to produce nickel pig iron (NPI). NPI is a relatively new product, produced in China since 2005. NPI production levels reached 390 000 t in 2015. All NPI is consumed in China in the production of stainless steel, replacing stainless steel scrap and pure nickel metal. NPI can be produced using blast furnaces or electric arc furnaces (the same production technologies used in steel production).

China is the largest nickel consuming country, accounting for 51 per cent of total global consumption in 2015. Recent growth in Chinese consumption has been significant. In 2005, China accounted for just 18 per cent of global nickel consumption.

Consumption of refined nickel is mostly driven by the production of stainless steel, around 68 per cent of nickel is used for the production of stainless steel. Approximately 16 per cent is used as an alloying metal in other metals including other steel products. Other uses of nickel are in plating (9 per cent), coins, batteries and production of nickel chemicals. Stainless steel and other metal alloys are used in the industry and construction

73 OCE 2016, *Resources and Energy Quarterly December,* Department of Industry, Innovation and Science, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx#

74 USGS 2016, *Mineral Commodity Summaries: Nickel,* http://minerals.usgs.gov/minerals/pubs/commodity/nickel/mcs-2016-nicke.pdf

75 OCE 2016, *Resources and Energy Quarterly December,* Department of Industry, Innovation and Science, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx#

76 OCE 2016, *Resources and Energy Quarterly March,* Department of Industry, Innovation and Science, https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Pages/Resources-and-energy-quarterly.aspx#

sectors, and also in the production of household products such as pots and pans, and kitchen sinks.

The competitiveness of the nickel industry is affected not only by the cost of production and the price of nickel, but also the price of by-products such as cobalt and copper.

Australian production

Australia mines and refines laterite nickel ore at Glencore's Murrin Murrin operation. Nickel West (owned by BHP) runs a nickel smelter in Kalgoorlie and a refinery at Kwinana which processes sulfuric ores from their own, and third party, mines. Many of the mines have onsite concentrators. Concentrate produced is either exported or transported to a smelter and/or refinery for further processing.

The Yabulu refinery in Queensland, which refined sulfuric ore imported from New Caledonia, Philippines and Indonesia, has been placed into receivership.

Australian nickel production responds to the world price. While the price is low, lower margin or lower grade mines decrease production. Several mines have recently been put into 'care and maintenance', including mines operated by Panoramic Resources and Mincor.

Australia exports refined and intermediate nickel. In 2015-16 total exports were 215 kt, down from 255 kt in 2014-15, reflecting the falling nickel price.

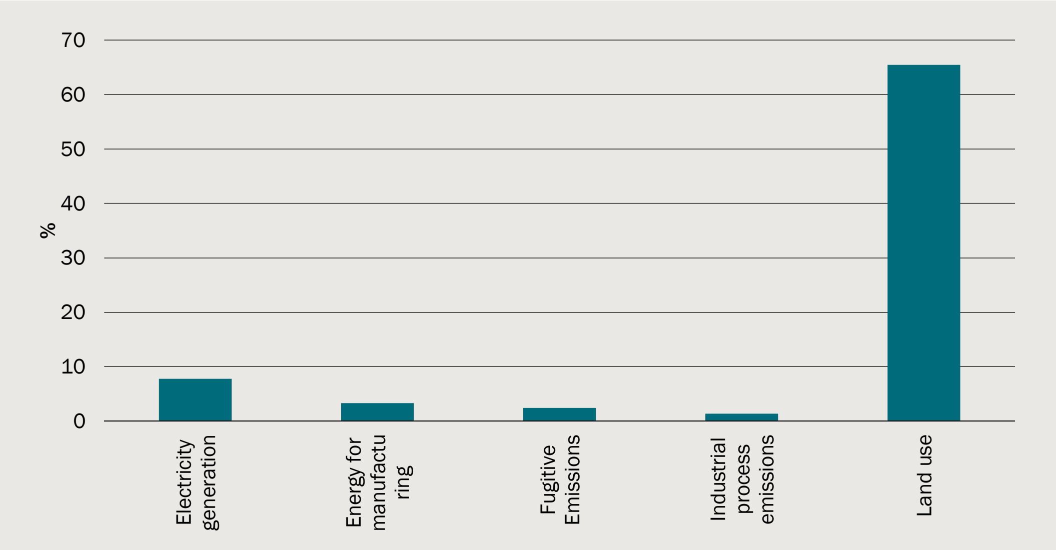
Indonesia

In terms of supplying Australia's key nickel markets, Indonesia is a key competitor, and has the potential for significant growth.

Indonesia has ratified the Paris Agreement and has set an unconditional reduction target of 29 per cent below business as usual by 2030 and conditional reduction target up to 41 per cent.

Much of the effort to reduce national emissions in Indonesia is focused on the LULUCF sector. This is to be expected based on the large proportion of emissions that arise from this sector (see chart 5.12). In Indonesia's 2011 National Action Plan For Reducing Greenhouse Gas Emissions, just 1 Mt CO_2-e of abatement was expected from the industrial sector through process modification, clean technology implementation, and energy management in energy-intensive industries.

5.12 Indonesia emission sources



Data source: CIE estimates, UN data

In 2014 Indonesia implemented a ban on the export of raw mineral ores, in an effort to boost the domestic refining capacity. Indonesia's production of nickel ore fell from 834 kt contained nickel in 2013 to 177 kt in 2014. In January 2017, however, the ban was revised to allow some export of unprocessed ore.

Given the Indonesian government's focus on boosting mineral processing facilities, and the focus on land use emissions, it is unlikely that the Indonesian nickel refining sector will face a carbon cost.

6 *Conclusions*

Examination of evolving carbon policy using a number of case studies provides an important set of key lessons that need to be taken into account when developing Australian policy. These lessons are summarised below.

	KEY LESSONS	Page ref.
1	Trade effects are an inevitable consequence of production based carbon policy development. They are a feature of the policy landscape.	4
2	Competitiveness needs to be understood at a sector by sector level.	6
3	The bottom up nature of the Paris Agreement, with considerable variation between countries in how targets are expressed and how policies are actually implemented provide greater tendency for competitiveness issues to arise.	20
4	Macroeconomic detail can often miss what his happening at an individual sector level.	21
5	The implementation details of policy are crucial. It is possible for the actual effects at a sector or facility level to be considerably different to that implied by broad descriptions of the policy.	35
6	Policy announcement is not the same as implementation.	35

Together, these lessons imply that the formulation of Australian policy should explicitly account for trade effects that arise at the individual sector level and that arise from the actual practical implementation of policies, rather than their in-principle or announced operations.

While accounting for this level of detail is more demanding than making simple aggregate presumptions, it will allow a much more accurate consideration of the implications of the inevitable trade distortions for the Australian economy.

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