The Full-Cost Economics of Climate Change

Aluminium: A Case Study

by

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Research Partner

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He has authored or co-authored numerous reports on economic and social policy including Unlocking the Value of a Job (2008), The Investing Society (2007), Disability 2020 (2007) and Would You Live Here? (2006). His articles have appeared in the Sydney Morning Herald, the Age and the Weekend Australian.

David holds a BA with First Class Honours from UNSW and an MPA with Distinction from the London School of Economics where he won the George W. Jones Prize for Academic Achievement.

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Executive Summary

This report applies a full-cost economics approach to climate change adaptation, using the aluminium industry as a case study to illustrate the complexity of the policy challenge. The report examines the positive value of jobs within the upstream aluminium industry, and the negative value of carbon emissions from the sector. It estimates the value which flows from aluminium jobs to individual workers and to the wider community. The report provides a demographic survey of aluminium towns and finds that aluminium towns are less economically vibrant than the Australian economy as a whole, with lower median incomes (despite high aluminium wages), lower employment and lower workforce participation. This highlights the critical importance of aluminium to these towns, employing thousands of local workers at an average wage more than double the national median.

This report argues that the value of an aluminium job considerably exceeds its nominal wage, and includes health, justice system and social capital benefits. This value is shared between the individual and the community. Our analysis shows that an aluminium job generates a total value to the community of over $89,000 p.a., and that around $25,000 of this is social, or public, value. Across the 12,000 workers in the upstream aluminium sector (i.e. aluminium refining and smelting), the total value of these jobs is $1.215 billion per year.

The report considers the estimated costs of plant closures under various scenarios. Depending on the number of plants which may close and the potential re-hiring rates of displaced workers, the cost to the community of job losses in the sector ranges from $285 million to $1.124 billion. Against this, we have estimated the current value of carbon emissions from the sector at $861 million per year. Our analysis shows that in some scenarios carbon savings from plant closures exceed the social value of jobs, while in other cases, the carbon savings would not match the value of jobs lost.

We argue that government and the aluminium industry must work together to ensure the sector to deliver an appropriate balance between meeting its carbon reduction
obligations and continuing to provide high-value employment to thousands of Australians, and the ensuing flow-on effects to their communities.

The report offers four specific recommendations in this regard:

- Government should consider providing a partial exemption to the aluminium industry for a maximum of five years. This may take the form of a temporary exclusion from the ETS for alumina and aluminium, or a discount on the carbon market price which progressively reduces to zero;
- The aluminium industry should use this exemption to aggressively invest in developing its own carbon-neutral energy sources, particularly from sources whose construction will generate significant employment. Solar power, hydroelectricity and uranium are all options worthy of consideration;
- The industry should seek to meet future demand growth through efficiency gains including, but not limited to, recycled aluminium; and
- Government should offer income tax credits to companies for each additional employee hired, in order to stimulate further job creation which delivers an estimated $25,000 in social value per worker. This proposal is not specifically related to climate change adjustment, but reflects a broader full-cost economics view that both positive externalities (from employment) and negative ones (from carbon emissions) should be priced in wherever possible.
Section I: Introduction

Climate change is the great transformational issue of our time. The other global policy threats of the last 20 years - domestic terrorism, HIV/AIDS, financial system instability – have largely passed Australia by, through a combination of good management and good luck. Not since trade liberalisation have we faced an issue which presents such fundamental challenges to our economic and social structures.

Like trade liberalisation, climate change adaptation is urgent and unavoidable. Like trade liberalisation, it offers enormous long-term benefits but involves short-term adjustment pain. The role of government is to carefully manage this process so that benefits are achieved while the pain is minimised, especially for those groups in society most at risk: low-income households and workers in exposed sectors.

All the major interest groups in Australian society – government, opposition, business, unions, the community sector - now accept the need for carbon pricing. But while getting agreement on an emissions trading scheme (ETS) in principle is one thing, the devil is in the detail. Both the politics and the policy are incredibly difficult.

At heart, this is a problem of ‘full-cost economics’: we need to account for the widest possible range of social costs and benefits associated with an economic activity. The central debate in climate change adaptation is how to reduce carbon emissions (a social cost) without unnecessarily sacrificing employment (a social benefit).

The aluminium sector provides an excellent case study to illustrate this policy problem. This report, produced with the support of the Australian Workers’ Union, assesses both the positive value to the Australian community of employment in the upstream aluminium industry (refining and smelting), and the negative social value of emissions generated by the sector.

The aluminium sector in Australia is facing a challenging period. Rising energy costs and the introduction of carbon pricing do threaten the economic viability of some plants. Already much of the downstream industry, including extrusion and cutting,
has closed or moved offshore in the face of competition from lower-priced imports, particularly from China. There is a genuine prospect that refineries or smelters may be forced to follow suit.

It is possible to argue that this is the inevitable result of technological change, and that the consequent reallocation of capital and labour is critical to sustained economic prosperity. However the established counterargument points to the real, if transitional, social and economic costs associated with industrial closures. The lives of individuals, families and towns are painfully affected, sometimes permanently. Many developed countries have experienced this process of industrial dislocation over the last 30 years, from coal miners in Yorkshire to autoworkers in Detroit. In Australia, the seminal event was the dismantling of trade barriers in the 1980’s that precipitated major restructuring in the steel, manufacturing and textile, clothing and footwear sectors.

Each of these events has posed difficult questions for policymakers. What is the right policy framework to manage these transitions? What is the appropriate role for government? How should it evaluate and balance genuine, conflicting interests? How much assistance for ‘structural adjustment’ is warranted? Where is the line between value-creating government investment, and throwing good money after bad?

As indicated above, we believe the right framework for considering these issues is ‘full-cost economics’ (see Hetherington and Cooney, 2007). Full-cost economics involves a holistic accounting of all the costs and benefits associated with a particular activity. These include social costs and benefits (those borne by the community) as well as private ones which accrue to individuals and companies. A comprehensive understanding of these costs and benefits allows government to evaluate the net impact on social welfare of alternative policy options.

Additionally, a full-cost economics approach allows government to understand how costs and benefits are allocated within a particular sector. Social costs and benefits are known in economic jargon as ‘externalities’: production or consumption by one party which directly affects other unrelated parties, who are not compensated or
charged for these effects. Carbon emissions are the classic contemporary example. The key point is that he who generates the costs (‘negative externalities’) does not have to pay for them, and she who generates the benefits (‘positive externalities’) is not in turn paid for them. This means that there will be too many negative externalities produced, and not enough positive ones. Under a full-cost economics approach, governments can capture externalities by charging for negative externalities and paying for positive ones.

There are several reasons why the aluminium industry is such a good case study for a full-cost economics approach to climate change adaptation in Australia. It is energy-intensive, export-oriented and regionally concentrated. Along with bauxite, energy is one of the two key ingredients in aluminium production. This energy forms a very high percentage of the industry’s cost base, and generated 45.3m tonnes of CO2 emissions in 2006 (AAC, 2006).

Secondly, aluminium is an important part of Australia’s wider economy and export base. Alumina refineries and aluminium smelters employ over 12,000 full-time workers and a further 3,000 contractors. They generated over $10 billion in exports in 2005-06 (ABS, 2007), constituting over 5% of the country’s total export values (see Figure 1 below).
Thirdly, aluminium plants are typically located in regional towns with scarce jobs, with the result that these towns have come to depend on the industry for their livelihood. The prospect of plant closures threatens this livelihood. Finally, aluminium production generates a wide range of costs and benefits, both private and social. The totality of these private and social benefits and costs is illustrated in Figure 2 below.

Private benefits include profit flows to shareholders, and net wages, health benefits and superannuation payments to employees. Social benefits include individual and company tax payments to government, the multiple flow-on effects to the taxpayer of employment (reduced expenditure on welfare, justice and health) and the benefits to the community of social participation (volunteering, community leadership, etc). The standout social cost is pollution, and particularly carbon emissions. In this paper, we will be focusing on value flows to employees and to the community, rather than those to shareholders. When combined, these two flows form the total value to the Australian community of employment in the aluminium industry.

This report builds an incremental picture of the private and social costs associated with potential smelter closures, including individual income loss, costs borne by government and social capital losses. The picture offers a bottom-up snapshot, with estimates of site-specific losses for each of the thirteen communities which host

![Figure 2: Value flows in aluminium](image-url)
refineries and smelters in Australia. Throughout the paper, the terms ‘aluminium’ and ‘aluminium industry’ are used to refer to both alumina refining and aluminium smelting, but not downstream extrusion or cutting.

The analysis draws on publicly available data from the Australian Aluminium Council (AAC), the Australian Bureau of Statistics (ABS), the Australian Bureau of Agricultural and Resource Economics (ABARE), and annual reports of the plant owners. The bulk of the demographic data is drawn from the 2006 Australian Census, and the base year for all charts is 2006 unless otherwise indicated. We have used the Census’s Statistical Local Area (SLA) as the geographical unit for each town. The plant owners have provided average income and volunteering levels for employees across eleven Australian sites, and we have used these averages as a proxy for all workers in the aluminium industry.

The structure of the report is as follows. Section II outlines the profiles of each of the thirteen aluminium plants and provides a demographic overview of the towns which host them. Section III catalogues the private costs of job losses borne by aluminium employees, including net wages, superannuation and benefits. Section IV analyses the social costs of aluminium job losses, comprising foregone tax receipts, increased spending on welfare and health, and social capital lost to communities. Section V presents the combined private and public value of aluminium jobs to the Australian community. It contrasts this with the total value of carbon emissions resulting from refining and smelting, and concludes by presenting a set of policy alternatives which represent a full-cost economics approach to climate change adaptation in the aluminium industry.

Section II: Aluminium towns
There are seven alumina refineries and six aluminium smelters across Australia. The refineries employ 7,117 people, with Pinjarra the largest employer at 1,615 staff and Yarwun the smallest at 781 staff. The smelters employ 5,089 people. Tomago is the largest with around 1,200 staff and Kurri Kurri the smallest with 500 staff. The full-time staffing levels (excluding contractors) of all refineries and smelters are shown in Figure 3 below.
The towns that host aluminium plants are extremely diverse. They vary in population from 2,725 in Northern Calliope (which hosts the Yarwun refinery) to 48,063 in inner city Newcastle (host to the Tomago smelter). Their economies range from vibrant (Gladstone in Queensland) to lethargic (Bell Bay in Tasmania). And they include high-density urban communities (Tomago and Kurri Kurri on the NSW Central Coast) as well as remote mining townships. The Gove refinery in the Northern Territory supports the adjoining mining town of Nhulunbuy, as well as the nearby Aboriginal township of Yirrkala. Two refineries, Pinjarra and Wagerup, are in the same SLA (Murray) and for the analytical purposes of this paper are considered to be in the same community, although they in fact draw on a wide range of small towns in the surrounding area, rather than a single centre. The populations of each of the aluminium towns, along with the staff numbers of each plant, are shown in Figures 4 and 5 below.¹

¹ Note that the population of Point Henry refers to the Statistical Local Area of Bellarine (Inner) rather than the entire city of Geelong.
In some cases, the plant employees make up a significant share of the town population such as in Yarwun (29%) and Gove (27%). In others, such as Point Henry, Kurri Kurri and Tomago, aluminium employees make up less than 5% of the local SLA populations.

In aggregate, aluminium towns are less prosperous than the Australian community as a whole. They have lower median incomes, lower labour force participation and higher local unemployment. This is despite the presence of aluminium plants whose
average incomes are far higher than the local medians, and which obviously boost local labour participation and employment. Clearly, aluminium plants are good for local economies: they are situated in depressed towns which would be even more depressed, were it not for the presence of the aluminium sector. Figure 6 shows the median individual income of aluminium towns. Only three of the towns (Gladstone, Gove and Boyne Island) have median incomes higher than the Australian median of $466 per week.

Figure 7 shows labour force participation rates in aluminium towns in 2006. Labour force participation is defined as the percentage of all 15-64 year olds either in work or looking for work (excluding those in full-time study). Only four of the twelve towns have participation rates above the national rate of 64.6%. Three towns, those which host Bell Bay, Kurri Kurri and Pinjarra/Wagerup, have participation levels below the key 60% figure.
Labour force participation is closely correlated with employment opportunities. Areas with limited employment opportunities typically exhibit low participation rates, as people stop looking for work after trying for some time without success. We see this relationship in the unemployment rates of aluminium towns: those with high participation rates have relatively low unemployment. The unemployment rates of refinery and smelter towns are outlined in Figure 8.

The average unemployment rate in aluminium towns in 2006 was 6.7%, compared to 5.2% for Australia as a whole. Eight of the twelve aluminium towns have unemployment higher than the national average. The exceptions are in Western Australia and Queensland where the national skills shortage is at its most extreme,
and the town of Gove in the Northern Territory whose isolation gives it unique local circumstances.

Each of these metrics of economic well-being – median income, participation and unemployment – tells a story of aluminium towns underperforming relative to the national average. To check whether this was the result of a factor specific to aluminium, Per Capita has compared the metrics of aluminium towns to all adjoining towns that do not contain refineries or smelters. This analysis shows that aluminium towns have higher average incomes and unemployment, but marginally lower participation than other towns (see charts in Appendix A). The implication is that the presence of aluminium plants does lift incomes relative to surrounding areas (due to demand for skilled labour), but does not have the same positive effect on local employment levels, which remain in line with or lower than neighbouring towns. This may be because aluminium towns attract more workers than the plants can actually employ, and that some people who move to these towns in the hope of gaining employment do not succeed in their quest.

Finally, this section examines the impact of potential plant closures on employment rates in aluminium towns. This impact is summarised in Figure 9 below, which provides a breakdown of local workforces into aluminium workers, other workers and unemployed.
This chart shows that the impact of plant closures would be dramatic. Aluminium workers constitute 26.2% of the local workforce in refinery towns and 7.5% of the workforce in smelter towns. At Yarwun, Gove, Pinjarra/Wagerup, Worsley, Bell Bay and Boyne Island, aluminium workers make up more than one fifth of the town’s workforce. In the most extreme scenario, where all aluminium plants were to close, the average unemployment rate would jump from 4.9% to 31.2% in refinery towns and from 7.4% to 14.9% in smelter towns. Yarwun would experience unemployment of 65%, Gove of 47% and Bell Bay of 42%. Although an unlikely prospect, this scenario does highlight the enormous importance of the aluminium industry to local economies. Having looked at the number of jobs in question, let us now turn to the value of those jobs.

Section III: The private value of aluminium jobs
In this section, we consider the private value which flows to workers from jobs in the aluminium sector. We are explicitly excluding the private value which flows to shareholders, given that the remit of this paper is to examine the value of aluminium jobs to the Australian community. As the shareholders in the sector are primarily foreign, we have not included net profit flows within our definition of value to the Australian community.

The private value to workers from aluminium jobs includes net wages, superannuation and other benefits provided by employers, such as health insurance and extended shift allowances. The data provided by plant owners for employee wages indicates that the base salary for a senior operator is $60,785 p.a. and that the total package including superannuation, twelve-hour shift allowance and health benefits allowance is $87,321 p.a. We have used these figures as proxies for the average wage levels across the refining and smelting sectors. For the purposes of this study, we have assumed that the additional benefits are non-taxable and flow entirely to the employee. Depending on the specific nature of the benefits, it may be that they do in fact incur tax but this would not affect the overall calculation of the value of aluminium jobs to the community – the taxable portion would simply flow to the community through taxes rather than through net wages.
If the base wage level is $60,785, the employee is liable for $12,835 in taxes in the 2007-08 year, resulting in a net wage of $47,950. Superannuation at 9% of this base wage is $5,471 and the total value of the additional benefits is $21,065. Taken together, these components result in a net income to the worker of $74,486. This annual private value to the average worker of an aluminium job is illustrated in Figure 10 below.

If we multiply this value created for individual aluminium workers across each of the thirteen aluminium plants in Australia, we see that the total annual private economic value of full-time aluminium jobs is $1.01 billion, of which $631 million is generated through refineries and $380 million through smelters. The annual value flows to workers through each plant is illustrated in Figure 11 below.
Having ascertained the private value of aluminium jobs to the Australian community, we now turn to a consideration of the social, or public, value of these jobs.

**Section IV: The social value of aluminium jobs**

Aluminium jobs benefit communities as well as workers. Those benefits that accrue to the public at large, rather than to individual employees, constitute the social value of aluminium jobs. Some benefits flow to the community through government – they include income tax paid by workers, and reduced spending on health and welfare associated with employment. Others, such as civic leadership and volunteer participation, pass directly to the local community.

Per Capita has assembled a bottom-up picture of the social value of the employment of a single aluminium worker. We have then rolled this valuation across each of the thirteen aluminium plants to develop an aggregate view of the value to communities of upstream aluminium jobs.

The starting point for our bottom-up picture is the income tax paid by an individual worker. Our representative worker from Section III above earns an annual wage (before superannuation and non-taxable benefits) of $60,785, and will therefore pay $12,835 in income tax. This is the direct cash benefit to government of aluminium employment. We have chosen to exclude corporate tax receipts, as these are not
generated solely by workers but by the industry as a whole (workers, raw materials, and capital). Typically, returns to workers (wages) are taxed through the individual tax system, while returns to capital (profits) are taxed through the company tax system, so by focusing on individual taxes only, we are limiting ourselves to the social value created by workers.

While personal taxes are the only direct government receipts from aluminium jobs, there is an additional set of indirect benefits which government captures. These are the savings in welfare, health and justice system expenditures that the state would otherwise have to outlay if aluminium employees were not working.

The value of welfare savings is quite straightforward. If we make the conservative assumption of the lowest welfare savings possible (for a worker who is living with a partner), then the unemployment benefit saved as a result of employment in the aluminium sector is $394.40 per fortnight, or $10,254 per year. This saving goes straight to the government’s bottom line.

The other, more intangible benefits of employment offer the dual advantages of decreasing taxpayer outlays and improving quality of life. Evidence suggests that a person in employment will enjoy better health. Mathers and Schofield (1998) show that unemployed Australians between the ages of 25 and 64 are twice as likely to report being in poor or fair health (in contrast to good or excellent health), and report 30-40% more chronic serious illnesses than their working compatriots. These differences could not be explained by higher levels of smoking, drinking, inactivity or obesity. According to the Commonwealth Department of Health, annual health expenditure per person in Australia is $3,785 and Mathers and Schofield’s work suggests that unemployed persons experience health problems at least 50% greater than employed Australians. Based on this, Per Capita estimates that the marginal benefit to the community from health savings associated with employment is half the average national health expenditure, or $1,893 per worker per year.

Further studies show that unemployment increases likelihood of contact with the justice system. In a review of regional indigenous communities, Weatherburn et al. (2006) find that unemployed residents are 54% more likely to be charged with a
According to Hinds (2002), average national crime expenditure per person in Australia during the 1990’s was $476 p.a. per person. If we apply this level of expenditure to Weatherburn’s lower figure of 54% greater likelihood of criminal charges for unemployed persons, we arrive at an estimated marginal benefit of $259 p.a. per person from justice savings associated with employment.

There is also an intergenerational multiplier effect at play here: the children of an employed person are themselves more likely to be employed and enjoy these same benefits. In this analysis, we have not sought to quantify the intergenerational benefit as it accrues a long time into the future and would likely be discounted close to zero under conventional finance theory. However, the wider community value of the intergenerational transmission of (un)employment should not be forgotten.

Each of the above benefits, whether direct or indirect, flows to the community through government accounts. However, other benefits flow straight to the local community. Employees of aluminium plants devote thousands of hours per year to community activities in their hometowns. They coach local football teams, run church groups, and lead Boy Scout and Girl Guide troops. They participate in Clean Up Australia Day, work as surf lifesavers and join community bush fire fighting brigades.

It is difficult to fully quantify the value of this social capital investment, but perhaps the best proxy is the value of the volunteering hours contributed to community-building initiatives by aluminium employees. This will not cover the entirety of the social capital investment made by these workers, but it gives us an accurate valuation of what is by far the largest component.

Aluminium workers volunteer in both enormous numbers and wide-ranging capacities. Alcoa employees volunteer for projects as diverse as dog rescue training at Kwinana and the Timehelp schools volunteer program in Geelong. Rio Tinto workers co-ordinate community volunteer efforts in environmental rehabilitation projects in Gladstone. The aluminium companies support their employees’ volunteer efforts in various ways, whether through matching cash contributions or provision of recruitment, administration and management support.
Industry data indicate that the average worker in a refinery or smelter contributes 8.85 hours of volunteer time per year. About 12 percent of all workers actively volunteer, and these workers typically contribute 72 hours volunteer time annually. To estimate the total volunteer contribution across the aluminium sector, we have used the figure of 8.85 hours p.a. as a representative number for the industry. Conventionally, the value of leisure time (which employees are effectively donating through volunteering efforts) is measured at the employee’s net wage rate. If we assume that aluminium employees are working four 12-hour shifts per week with four weeks annual leave per year, then the average net wage rate for the industry is $20.81 per hour. This gives us a total value of volunteering time per employee of $184.20 per year.

If we combine these social benefits of aluminium employment – tax receipts, welfare savings, health and justice system savings, and volunteer contributions – then the total social value of an aluminium job to the community is $25,425 p.a. (illustrated in Figure 12 below).

![Figure 12: Annual Social Value of an Aluminium Sector Job to Community](image)

When we consider this figure extended across the aluminium sector, we see that the social value of aluminium jobs to the Australian community is $344 million per year. The breakdown of this value by plant is shown in Figure 13.
In concluding this section, we should note that this valuation of $344 million is a conservative estimate. It includes full-time employees only, and not contractors. It assumes the lowest possible welfare savings and excludes intergenerational benefits. Also, it does not include an income multiplier effect which some economists use to estimate the value of the flow-on effects of employee spending in a local community. Some studies estimate this as high as 0.96 times the original dollar spent (see ABS, 2002). The concept of income multipliers has lost credibility amongst professional economists as it has been realised that this flow-on spending is usually displaced elsewhere in the economy, particularly at times of full employment such as Australia is currently experiencing. For this reason, we have not included an income multiplier effect in the valuations presented in this study.

However, while flow-on spending would be absorbed elsewhere in the economy, there would be a one-off short-term cost given the lag time involved in this process. The jobs sustained by service activities in aluminium towns would certainly disappear, with an ensuing economic and social cost to these towns above that calculated in this report, even if the medium-term effect on the national economy is neutral. This reinforces the point that our estimate of the social value of aluminium jobs is a conservative one. It now remains for us to combine the private and social value of these jobs to give us a picture of their worth to the Australian community as a whole.
Before doing so, one additional point is worthy of mention. This is the level of government support provided to aluminium producers in the form of cheap electricity. This has long been a contentious issue of debate, as some have argued that governments effectively subsidise the sector by selling power to them below market price (see Turton, 2002). As the contracts in question are commercially confidential, it is difficult to quantify accurately the total level of any subsidy. However, under a full-cost economics approach, providers should be required to pay market rates for electricity over time as they move to lower-carbon energy sources, especially if they are provided with any form of exemption from an ETS.

Section V: Conclusion and policy recommendations

The compilation of private and social values of aluminium jobs presented in Sections III and IV now allows us to present a holistic picture of the total annual value of aluminium jobs to the Australian community.

In theory this is a simple matter of adding the private and social values, with one important exception. An aluminium job saves the government welfare expenditure since it does not have to pay unemployment benefit. If the job is lost, the government forgoes this saving (it must pay the benefit), but the value is transferred to the newly unemployed worker, so the net value change for the community is zero. In effect, although the worker loses the $74,485 private value of the job, this is partially offset by the $10,254 unemployment benefit, so the net value loss to the worker is $64,231.

When we add the net private value of $64,231 to the social value of $25,425, we find the total annual value of an aluminium job to the community is $89,656. The breakdown of this value is illustrated in Figure 14 below.
If we take this value of an individual aluminium job and apply it across the sector as a whole, we see that the total value of aluminium employment to the community (excluding contractors) is $1.215 billion per annum. Of this, $759 million is generated through refineries and $456 million through smelters. Viewed differently, $870m is private value which flows directly to employees and $345m is social value which accrues to the wider community. The value created by individual plants across the industry is shown in Figure 15.

When we are considering the potential cost to the community of job losses through aluminium plant closures, the annual employment value of $1.215 billion represents an extreme estimate of this cost. Essentially, it assumes two unlikely developments: 1) that all aluminium plants in Australia close; and 2) that none of the displaced...
workers find new employment within a year. As the probability of both these developments occurring is very small, the $1.215 billion cost estimate is very much a worst-case scenario.

In order to estimate a more realistic set of outcomes, we have evaluated the cost of job losses under alternative plant closure and worker re-employment scenarios. We have used three scenarios for aluminium plant closures:

- **Scenario 1**: All refineries remain open and all smelters close
- **Scenario 2**: 50% of refinery capacity closes and all smelters close
- **Scenario 3**: All refineries close and all smelters close

In conditions of near full employment, it is likely that at least some aluminium employees would find work elsewhere in the event of plants closing. However, experience tells us that finding work can be difficult in regional towns whose main industry has shut down. Workers find their specialist skills are no longer in demand, and those who do obtain employment often find themselves in low-skilled jobs considerably below their previous pay rates. For present purposes, we have developed three re-employment scenarios under which a percentage of displaced workers find jobs six months after aluminium plant closures, some at their previous pay rates and others at half the previous pay rates. The three scenarios are as follows:

- **Scenario A**: 50% of workers rehired at full pay at 6 months; 50% of workers rehired at half pay at 6 months
- **Scenario B**: 30% of workers rehired at full pay at 6 months; 30% of workers rehired at half pay at 6 months
- **Scenario C**: 10% of workers rehired at full pay at 6 months; 10% of workers rehired at half pay at 6 months

If we combine Scenarios A-C with Scenarios 1-3, we get nine different plant closure and re-employment scenarios, ranging from the lowest cost disruption to the industry (Scenario A1) to the most expensive disruption (Scenario C3). This shows that the most optimistic estimate of the costs of aluminium job losses (A1) is $285 million in the first year, and the most costly estimate is $1.124 billion. The full range of scenario estimates is presented in Figure 16.
What does this range of values mean in practice, and how can we put it into context? As a benchmark, it is useful to compare these figures against the valuations of carbon dioxide emissions from aluminium plants, which have been identified as a likely trigger for plant closures. This takes us back to the full-cost economics approach. One of the main arguments in favour of carbon pricing is that it puts a dollar value on a negative externality imposed by producers on the community as a whole. This new charge on producers (and in turn consumers) will discourage excessive levels of carbon emission and deliver an efficient level of carbon output, one which consumers are willing to pay for.

However, we cannot consider the value of these carbon reductions in isolation. If they contribute to the closure of aluminium plants, we must offset them against the costs of job losses to the community. To do this, we need to estimate the value of potential carbon savings from aluminium plants in Australia. In 2006, Australian alumina refineries generated 13.9 million tonnes of CO2 equivalent, while smelters generated 31.4 million tonnes (including those from electricity generation). The best available data on the price for carbon emissions in Australia is the recent inaugural trade in Australian Emissions Trading Units (AETU’s) in May 2008 between AGL and Westpac, which valued CO2 emissions at $19 per tonne. At this price, the value of

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**Figure 16: Total Year 1 Value of Aluminium Job Losses under Alternative Closure and Rehire Scenarios**

<table>
<thead>
<tr>
<th>Scenario 1: All refineries remain open</th>
<th>Scenario 2: 50% of refinery capacity closes</th>
<th>Scenario 3: All refineries close</th>
</tr>
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<tbody>
<tr>
<td>All smelters close</td>
<td>All smelters close</td>
<td>All smelters close</td>
</tr>
<tr>
<td>Scenario A: 50% of workers rehired at full pay at 6mths; 50% of workers rehired at half pay at 6mths</td>
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<td>$522m</td>
</tr>
<tr>
<td>Scenario B: 30% of workers rehired at full pay at 6mths; 30% of workers rehired at half pay at 6mths</td>
<td>$354m</td>
<td>$648m</td>
</tr>
<tr>
<td>Scenario C: 10% of workers rehired at full pay at 6mths; 10% of workers rehired at half pay at 6mths</td>
<td>$422m</td>
<td>$773m</td>
</tr>
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Source: Per Capita analysis
refinery emissions in Australia in 2006 was $264 million and the value of smelter emissions was $597 million.

If we compare these values against our scenarios for the value of aluminium job losses, we see that in some scenarios (those with minimal plant closures) the value of carbon saved is greater than the value of the jobs lost, while in others (those with the most closures) the situation is reversed and carbon savings do not offset the value of lost jobs. In general, because smelters are highly intensive, their carbon savings do exceed the value of jobs lost, while carbon savings from refineries, which use less energy, do not offset job losses. The variation between alternative scenarios is considerable, at around +/- $300 million. The results for the two most extreme scenarios (A1 and C3) are depicted in Figure 17.

Given these findings, what steps can the Australian government and the aluminium sector take to preserve the community value of aluminium jobs while acting to reduce carbon emissions? To conclude this paper, Per Capita proposes four specific policy recommendations which are outlined below.

**Recommendation 1**
As with the great transformational process of trade liberalisation in the 1980s, the transition to an environment of carbon pricing must be carefully managed in a staged
fashion. Like that process, this transition will bring enormous long-term benefits, and a significant amount of short-term pain. The challenge for government is to deliver the benefit while minimising the pain, particularly on the most vulnerable citizens – low-income households and workers in energy-intensive and export-oriented sectors, such as aluminium, iron, steel and cement.

There are two possibilities to manage the transition so as to permit a smooth adjustment and (within reason) minimise the threat to aluminium jobs. Firstly, the government might consider providing a temporary exclusion or ‘holiday’ from carbon pricing for alumina and aluminium for a maximum of five years. A modified version of this idea, covering all aluminium output, was recently proposed by Clive Hamilton (2008).

Alternatively, the trading scheme might initially offer a discounted carbon price to aluminium producers with the discount progressively reducing to zero over five years. The industry would be permitted to buy its existing emissions requirement at, for example, one third of the average auction price of the initial bid round. It would not be able to sell these permits outside the sector for profit, and it would pay the full market rate for any additional permits bought on the market. After year one, the discount would be reduced year-on-year until it phases out completely in year five, and the sector would be fully integrated into the trading scheme.

This approach is not a fig leaf for inaction. The purpose of a gradualist approach is to give the industry time to develop low-emission energy sources, reducing its emissions without suffering plant closures as a result of competition from jurisdictions which do not levy a carbon charge. If Australian production is simply displaced to jurisdictions without carbon pricing, then the overall impact on emission reductions is zero at great cost to aluminium workers, their families and their towns.

**Recommendation 2**

The aluminium industry must use any partial exemption from a trading scheme to aggressively invest in developing its own carbon-neutral energy sources. A formal acceptance of the need for climate change adaption came late to Australia – it was only in 2007 that the Howard government joined the opposition in agreeing the need
for carbon pricing. For most groups in society, a long lead-time is not vital but for energy-intensive, export-oriented sectors, it is absolutely critical. The aluminium industry requires a significant lead-time to invest in the carbon-reduction programs which will allow it to remain competitive under carbon pricing - this is a principal justification for a partial exemption from the ETS. It has had reasonable success to date in reducing emissions per tonne, from 16.1 tonnes of CO2 per tonne of production in 1990 to 14.2 tonnes in 2006, but it must now go much further (AAC, 2006).

Australia has three significant competitive advantages in aluminium production: proximity to bauxite, cheap energy, and a transparent, highly regarded investment climate. The introduction of carbon pricing will affect one of these advantages, cheap energy, but leave the other two untouched. The goal for the industry, therefore, is to develop alternative, economically viable energy sources which do not attract a carbon price. At least three alternative sources warrant consideration.

The first are solar technologies which will themselves require considerable aluminium input and whose construction will generate significant employment. Concentrating solar power (CSP) technology is now delivering up to 100MW per plant, is readily scalable and can be fitted with gas-fired boilers to produce electricity anytime day or night. Although this plant size is less than an individual smelter’s requirement, a distributed approach to power generation may be part of the overall solution. Aluminium plants in Queensland, Western Australia and the Northern Territory are all located in or near areas with high levels of annual sunshine hours, making them ideally suited to solar-powered electricity.

The second carbon-free energy source is hydroelectricity, which already fuels the Bell Bay smelter in Tasmania. Hydroelectricity may well provide a model for the next generation of carbon-free smelters. The proposed BHP Billiton smelter in the Congo would be a state-of-the-art facility drawing up to 2,000 MW of carbon-free, hydroelectric power. Hydroelectricity is likely to be best suited to aluminium plants in the wetter regions of southeastern Australia, including Point Henry and Portland. Wind farms in the Bass Strait could provide additional energy capacity in the form of
‘pumped storage’, where water is pumped uphill to provide hydroelectricity. Such systems are already in operation in Norway.

The final, most controversial potential source of carbon-free electricity is uranium. One kilogram of yellowcake sells on the world market for $160. Alternatively, that same kilogram can be used to make $1,520 of electricity which in turn can produce $5,420 of aluminium, increasing the value of yellowcake over 30 times and retaining that added value in Australia. The optimal place to enrich the uranium and produce electricity is Roxby Downs in South Australia. The electricity could be delivered to Portland and Point Henry on a purpose-built transmission line. A similar line could supply the NSW smelters near Newcastle. It is even possible that a joint venture could be established under which this generation facility would also supply power to the Olympic Dam mine site. This approach addresses the two fundamental problems of nuclear power: waste and proliferation. Waste disposal would be achieved by burying the spent uranium adjacent to the mine site itself, putting it back from where it came and overcoming the key difficulty of nuclear proliferation, as nothing but electricity ever leaves the site.

**Recommendation 3**
Wherever possible, the industry should seek to meet future demand growth in part through efficiency gains, including but not limited to, recycled aluminium. Australian refineries and smelters would continue operating at their current (full) capacities, but above this base, the industry should rely on recycling to increase supply. This will have the effect of shifting value from the upstream industry to the downstream industry, but vertically integrated producers could choose to cross-subsidise their upstream assets. This would retain the valuable employment provided by the upstream industry, while significantly reducing the carbon intensity of total aluminium output.

As an example, the energy required to produce one aluminium can could run a television for around three hours, while a recycled can requires only 5% of that energy (Pearce, 2008). At present, Australia has an aluminium can recycling rate of around 70%, with 2.46 billion cans recycled annually (Planet Ark, 2007). If we could achieve Switzerland’s rate of 91%, we would recycle an additional one billion cans, or
15,000 tonnes per year. This initiative only reduces emissions by around 1% but it is an important starting point, and could be extended beyond cans to other sources of aluminium scrap.

**Recommendation 4**

Government should seek to recognise the full social value of employment generated by firms throughout the economy. The simplest way to achieve this is to offer income tax credits to companies for each additional employee they hire. If each job delivers $25,000 in social value, then it is economically efficient to incentivise companies to hire additional workers wherever possible.

This idea builds on the notion of place-based employment incentives which offer tax credits to employers who provide jobs in disadvantaged areas. The Empowerment Zones program in the United States offers employers a tax credit of up to US$3,000 for each worker resident and working in 38 federally designated areas of disadvantage (see Hanson, 2006). An extension of this concept would offer tax credits to all employers for each job they provide, in recognition of the social value these jobs generate. The effect would be to stimulate job creation and retention, particularly in situations where employers are making marginal decisions between investment in capital or labour, or between investment in Australia or overseas.

It should be noted that this proposal is not specifically related to climate change adjustment, but reflects a broader full-cost economics view that both positive externalities (from employment) and negative ones (from carbon emissions) should be priced in wherever possible.

The adoption of these four recommendations by government and industry would allow the aluminium sector to deliver an appropriate balance between meeting its carbon reduction obligations and continuing to provide high-value employment to thousands of Australians, and the ensuing flow-on effects to their communities.
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Appendix A: Comparisons of aluminium towns with neighbouring areas

Figure A: Ratio of Aluminium Smelter Town Unemployment to Surrounding Town Unemployment *

<table>
<thead>
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<th>Ratio</th>
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<tr>
<td>Gove</td>
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</tr>
<tr>
<td>Karumba</td>
<td>1.6</td>
</tr>
<tr>
<td>Palm Valley</td>
<td>1.8</td>
</tr>
<tr>
<td>Weipa</td>
<td>1.8</td>
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<tr>
<td>Weipa</td>
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Notes: * Excludes surrounding towns which also host refineries or smelters

Figure B: Ratio of Aluminium Smelter Town Labour Participation to Surrounding Town Labour Participation *

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<tr>
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<td>Palm Valley</td>
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<td>Weipa</td>
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Notes: * Excludes surrounding towns which also host refineries or smelters

Figure C: Ratio of Aluminium Smelter Town Median Income to Surrounding Town Median Income *

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<tr>
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<tr>
<td>Weipa</td>
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</table>

Notes: * Excludes surrounding towns which also host refineries or smelters

Source: AIB, Per Capita analysis