

'Australia's precious place in the coal industry's world'

Speech by

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This afternoon I want to talk about Australia's precious place in the coal industry's world--and specifically our coal exports—this country's biggest contribution to climate change by far. It's not that I don't care about the emissions that occur inside Australia—I do very much. But, the more I watch our coal export emissions grow, the more absurd it seems to me that they are not considered 'our problem'. Australia now exports over 270 million tonnes of coal annually which equates to around 730 million tonnes of CO₂. That's about a fifth more greenhouse pollution than is currently emitted within Australia's borders.

The 5 million tonnes of coal we export weekly produces the roughly the same amount of CO₂ as a million Australian households do yearly.ⁱ As Hunter residents will know, coal exports are set to double over the next 10-15 years with enthusiastic bipartisan political support. On average, that involves increasing coal exports by another million tonnes every fortnight—the CO₂ equivalent of adding nearly 50,000 cars every single day.ⁱⁱ We often hear about China building a new coal fired power station every week or so, but few of us realize Australian coal exports effectively add a new coal fired power station or steel mill somewhere in the world every 3 or 4 weeks.ⁱⁱⁱ

That statistic is worth dwelling on for a moment, especially with climate campaigners fired up about plans for a dozen new coal fired power stations within Australia. Those projects may be 'on the books' but all have to run the gauntlet of strong environmental campaigns against them, and ultimately some sort of carbon tax or price, so very few will be built over the next decade. Yet, over the next year, against almost no public opposition more than a dozen new coal-fuelled facilities will most definitely be built on the back of Australian coal exports.

The domestic emission reduction programs to which campaigners devote much attention are similarly dwarfed by coal exports. For example, if the federal government adopted a 25% emissions reduction target for 2020, implemented an ETS to get there, and tightly

limited the use of cheap imported carbon credits so that Australia made its emission cuts rather than outsourcing them, domestic emissions could fall by up to 249mt annually by 2020.^{iv} Sounds impressive until you realize that the emissions saved are wiped out by the addition of just two new coal mines in Central Queensland.^v

If we look at all the other initiatives since Labor's 2007 election, the 20% Renewable Energy Target; Solar hot water on 420,000 roofs; and what's left of the plan to insulate 2.7 million homes;^{vi} according to the Department of Climate Change, it shaves a mere 16mt annually from our projected emissions in 2020—down from 680mt annually to 664mt. That saving is erased 45 times over by coal export emissions growth if coal exports are allowed to double. Factor in a growing LNG export industry, increasingly reliant on coal seam gas under prime agricultural land, and Australia will export more CO₂ annually in fossil fuels than Saudi Arabia does today.^{vii} Yet, somehow, many of us are fixated with domestic emissions.

Even as television ads running nationally remind us that our coal exports are indeed 'something big', some seem to think a domestic carbon price and a 'no new coal fired power' campaign hurts the coal industry and coal addicted governments. Do they notice governments getting by expanding existing coal fired power stations and refurbishing mothballed ones, their coal export royalty revenue hardly affected? Do they realise that the coal industry's main game is exporting to developing nations, that the industry views sluggish domestic demand here and in other developed country markets as a fact of life? Do they really believe that stalling a few projects currently on the books 'hits them where it hurts'?

There's so much wool over so many eyes, so many convenient excuses to ignore coal exports. There's the accounting argument – that the international community has agreed that emissions should count where they occur. So, responsibility lies with the country burning the fossil fuels, not the country supplying them. Next comes the argument that coal isn't a big contributor to climate change – only ¼ of global emissions.^{viii} We're told Australia is a relatively small coal producer—accounting for just 5.6% of global production.^{ix} Then there's the line that our coal exports are essential for steelmaking, as if the comparable CO₂ from that process are magically benign for the climate. We're assured that carbon capture and storage and other 'clean coal' technologies will come to the rescue. And, anyway, we're told: if we didn't export the coal we do, someone else would. Last but not least, we're told the coal industry is our economic backbone—that messing with it is to 'taking the back of the axe to the Australian economy' as the Climate Change minister puts it.^x Lump all these arguments together and you have a seemingly unassailable case that interfering with the coal rush is economic vandalism of no environment benefit.

A depressingly broad cross-section of Australia has bought into this logic—including most ‘big brand’ environment groups. Some with limited resources consider coal export emissions too big, and a few of the excuses plausible enough to leave it in the ‘too hard basket.’ Until now, for those with an interest in keeping coal exports off the table in the debate, the list of excuses has been a sweet recipe for success. But, as coal export emissions spiral, becoming more conspicuous internationally, they’ll come out of the too-hard-basket. So, today let’s chip away at the seemingly unassailable case, ask why the excuses are unsustainable, and consider why phasing down coal exports *can* have a much bigger environmental benefit internationally than we think, without wrecking our economy.

Let’s begin with the accounting argument. Under the current internationally agreed framework, countries only count emissions occurring inside their borders. Fair as that may sound, it means that large exporters of fossil fuels like coal don’t have to worry about the emissions generated when their product is eventually used offshore. In a world where all countries had to reduce their total emissions, this wouldn’t present a problem. Even if there was a global deal that *collectively* required large emission reductions you might have an argument for standing back and allowing the ‘invisible hand’ of a global carbon market to either clean up or cut fossil fuel use worldwide. The world we live in, though, is different. Almost all the growth in fossil fuel demand is in developing countries that don’t have to worry about absolute emission reduction targets any time soon. And because there’s little pressure for them to constrain emissions, they’re importing much more fossil fuel, and more crucially, the overall use of fossil fuels globally is spiraling along with emissions.

When you look where the emissions path we’re on is rapidly heading, it’s clearly unsustainable to keep ignoring fossil fuel export emissions. If China and India import potentially 1-1.5 billion tonnes of coal annually by 2020, as is projected, with much of it coming from developed countries like Australia and the US, the chance of returning the climate to safe territory evaporates, even if developed countries cut their own coal use to zero. For Australia, to double its coal exports over the next 10-15 years is to brazenly gamble that in 2025 the global community will still turn a blind eye.

Next we come to the argument that coal shouldn’t be singled out. The industry argues quite correctly that global warming has many causes—there are many emission sources, various fossil fuels, and deforestation is a major contributor. Yet, among these factors, coal is pre-eminent. Around 50% of fossil fuel emissions have come from coal; in the last few years it’s overtaken oil as the most significant fossil fuel emission source; and, as the industry brags, coal has been the fastest growing fuel source over most of the past decade.^{xi} The reason why scientists like James Hansen say that eliminating coal emissions is 80% of the solution to the global warming crisis is that if the world’s coal reserves are

used without carbon capture and storage, the probability of keeping temperature increases under 2 degrees falls to less than 30%, even if we cut all other emissions to zero.^{xii} In other words, there can't be an effective climate change response unless coal is singled out.

One of the favourite excuses used to ignore our coal export emissions is to argue that much of our coal is used for steelmaking rather than power generation. The Queensland government routinely argues that most of its coal exports are for steel, and shrugs its shoulders, as if the emissions are unavoidable. Perhaps terms like 'carbon-steel' lead people to imagine that where coal is used for steel there *are* no CO₂ emissions. In fact, the amount of carbon retained in steel is minimal and steel production produces roughly the same amount of CO₂ per tonne of coal as coal-fired power.^{xiii} Moreover, when someone says 'but our coal is for steel', it implies that steel is sacrosanct—that you can't make steel without coking coal, and that there are no practical alternatives to steel.

It's an increasingly flimsy argument. Because the most emission intensive way to make steel is the cheapest, iron ore, coking coal and a blast furnace are what you mostly see. But it's not the only way to make steel, which was produced with charcoal for centuries before we started using coal instead. Brazil still produces millions of tonnes of steel annually using charcoal, and thanks largely to the enthusiasm of the former President, they're being required to produce a lot more – and no, the extra charcoal is not to come from Amazon rainforests, but from eucalyptus plantations. The explicit aim is to cut emissions, cut coking coal imports, and use greener steel production to differentiate Brazilian steel.^{xiv} Beyond Brazil, there's increasing interest in biomass as a replacement for a large amounts of coal used in blast-furnaces.^{xv}

Much of the world's steel today is made in electric arc furnaces rather than blast furnaces. Here, scrap metal is the main feedstock and the process can be powered with renewable energy. It's also possible to feed electric arc furnaces with 'direct reduced iron', nearly 50 million tonnes of which is now being produced annually with natural gas rather than coal.^{xvi} Direct reduced iron can be produced with gasified biomass too—from things like forestry and agricultural waste.^{xvii} So, contrary to what's widely assumed, it's possible to make steel without coal, but perhaps more importantly, steel isn't the only way to make many things for which it is currently used.

In many applications – most notably in transport – aluminum and other lightweight metals are replacing steel, and they can be made without coal.^{xviii} Just look at the rush to produce aluminum from hydro and geothermal power in Iceland. Even more significantly, composite materials – mostly thermoplastics – actually perform better than steel in many applications—in transport, aviation, and construction—including some types of reinforced concrete.^{xix} As the steel price rises, composites materials are

increasingly cost-competitive. So, if the world takes the CO₂ in coking coal seriously, civilization won't rush back to the caves—it'll see a rapid switch to green steel production and alternatives to steel. What's stopping that is the lack of any CO₂ caps in the developing countries where most new blast furnaces are being built, and the availability of cheap iron ore and coking coal—and who's the biggest exporter of both—you guessed it – Australia.^{xx}

The next great excuse for ignoring Australia's coal exports is that they're not so significant and that if we stopped, someone else would step in and take our place. This suggests that countries are lining up to replace Australia in coal mining—that the biggest coal users have lots of options, and that the biggest producers can rapidly up production. The truth is different. While Australia accounts for only 5.6% of total world coal production, some 70% of the world's coal is consumed by the three countries mining it—China, India and the US.^{xxi} What makes Australia so important is how integral we are to enabling India and China to turbo-charge their coal addictions, and to hooking up other developing nations to the habit.

Australia is the undisputed king of the global seaborne coal trade, providing just under 30% of the world's exports, including more than half of coking coal exports.^{xxii} But we're more important than that suggests because our companies are at the heart of coal mining in the other big coal exporting nations. Indonesia, for example, is our nearest rival as a coal trader, and Australian companies mine at least 1/3rd of *their* exports. It's a similar story in other fast-growing export nations like Mongolia and Mozambique. Even excluding companies that many people consider Australian – like Rio Tinto and Xstrata, Australian firms will within the next 5 years be mining close to 350mt of coal annually in other countries—more than we currently export. So when the industry says – 'if Australia didn't export coal someone else would' what they really mean is that 'If Aussies couldn't mine coal here, Aussies would go off and mine someone else's coal.'

Other coal exporters, however, can't dramatically up production with the flick of a switch. In South Africa, rail infrastructure obstacles make it very hard to increase exports at anything like the same pace as we're seeing in Australia. In Indonesia, in Mozambique and elsewhere, the need to ferry huge quantities of coal down rivers is a major obstacle.^{xxiv} In Russia and in Mongolia, freezing temperatures are among a host of problems. There's a coal rush in these countries, but nothing like ours. And while the US is diverting large amounts of coal to the export market because of, among other things, recession and rising opposition to coal, they're not in our league as an exporter yet.^{xxv}

Meanwhile, Chinese coal demand is projected by UBS to go from 3 billion tonnes a year to 5.5 billion tonnes a year in 2020, and if China can't grow its own production by the 6% a year needed to meet that demand, it may import nearly all the coal that the seaborne

trade currently provides.^{xxvi} India also looks set to rely heavily on imports as its own annual coal use more than doubles to perhaps 1.4 billion tonnes by 2020. The likely consequence is a more than doubling of the global seaborne coal trade in the next 10 years. That's why the Australian coal industry is anticipating a bonanza irrespective of what happens domestically, and it's why companies like Peabody are banking on a 53% increase in global coal demand by 2030. It hinges on two things above all else: Chinese demand, and Australian supply—not because Australia is such a big producer, but because it's the crucial exporter. Take Australia out of the equation over the next decade and other countries cannot pick up the slack. They may pick up some, but there's no filling the hole that Australia could leave in the global coal trade, not in the current Chinese and Indian demand timeframe anyway.

The final, and perhaps greatest bit of wool over our eyes is 'clean coal'—the apparently permanent alibi that carbon capture and storage seems to have won the industry. The oil and gas industry has been capturing and storing CO₂ for years—not with the aim of saving us from climate change mind you, but to 'enhance' oil and gas recovery. In the decades since CCS was first used, a grand total of 49 million tonnes of CO₂ has been captured and stored underground.^{xxix} That sounds pretty impressive until you learn that almost none of this captured CO₂ has come from coal; and that conventional coal use without CCS currently emits about 44 million tonnes every 24 hours.^{xxx}

Right now, there's not one commercial scale coal fired power station capturing and storing its emissions anywhere in the world. As the World Coal Institute recently lamented, 'We've been talking about demonstration CCS plants for quite a long time...but when people actually say "does it apply to a full scale power plant?" at the moment we just don't have the evidence to back that up.'^{xxxi} The industry cites the International Energy Agency to argue that you can't deal with climate change without CCS—yet according to the IEA, perhaps 3000 CCS plants would need to be built between now and 2050 to clean up coal's act – that's more than one every 5 days for the next 40 years! More realistically, the G8 has targeted 20 commercial scale CCS plants by 2020 (some but not all of which would relate to coal use). That might save 150 million tonnes of CO₂ a year by 2020 – which again sounds impressive 'til you realize that over 99% of coal fired power stations and steel mills would still not be using CCS a decade from now, and they would be generating at least 20 billion tonnes of CO₂ annually.^{xxxv}

In the time remaining, I want to speak briefly about the equation facing Australia. Having already decided on the path of doubling coal exports, it will take enormous political will to get back to the 'fork in the road' in order to take an alternative path. The Australian coal industry cannot be closed down overnight, but we can as a nation decide now how to prepare for coal phase-down over a 10-15 year timeframe in the very likely event that coal emissions can't be captured and stored safely on scale or on time. That sort of

transition timeline gives coal-addicted governments and investors who have dived into coal knowing the risks, fair notice. It gives industries and communities in Australia, and coal export customers, time to prepare. As politically charged as that course would be, it's realistic, affordable, and when compared with the current plan to allow our coal export emissions to double in size without any Plan B, it's clearly in the national interest.

Australian coal phase-down wouldn't magically stop China, India and the US, continuing to use lots of coal. They wouldn't suddenly follow our lead, and other countries may well try to increase coal output to take advantage of the space left by Australia in the international trade. So, coal-based electricity and steel production wouldn't vanish overnight, any more than developing countries would keep going without electricity. If Australia exited coal, therefore, it wouldn't prevent economic development, let alone condemn millions of people in the developing world to poverty, as some would have us believe. That said, we shouldn't underestimate the impact domestically, or the ripple effects around the world, from what would be--anything but a futile gesture.

Rather than waiting for a climate agreement that may never arrive to constrain coal global demand, we would be placing a very significant constraint on supply. The loss of half a billion tonnes of anticipated annual export supply would increase the traded coal price and make investment in coal a riskier proposition. Countries like the United States and Russia – both of which are looking to cash in on coal exports—would suddenly be more conspicuous. Most significantly though, by making coal less affordable and available, Australia can help change the equation for countries deciding right now on the extent to which their industrialization will be coal-based or something different.

Without all that Australian coal on the international market helping to keep it relatively cheap, China and India would be unable to import enough cheap coal to stay on their current course--in electricity production, steel manufacturing and all of the associated industries. The magnitude of economic development in these countries would hardly be effected by Australia's action, but many more coal-based investments would be less competitive against cleaner alternatives than they are today. That's why I refer to Australia's precious place in the coal industry's world—it's the jewel in King Coal's crown, and coal phase down by Australia could be the biggest blow the industry has ever experienced.

The industry of course banks on us leaving this sort of scenario in the 'unthinkable' basket—believing as the Institute of Public Affairs puts it that replacing coal with renewables involves 'returning the nation to some nineteenth century pastoralist past and hoping that we will all prosper in such an economy'.^{xxxvi} When we stop swallowing that sort of nonsense, the really exciting thing is that Australia can deal with its biggest contribution to climate change and its domestic emissions without wrecking the

economy. When you look at the consequences of phasing down coal—which by extension means replacing all coal fired power stations in Australia with mostly renewable alternatives—it’s hard not to conclude we can transform the economy for the better. Staged over a 10 year period, even if we assume the worst—with almost no coal industry left and half of the most coal-dependent industry gone—by 2020 Australia’s GDP is nearly a third larger than today. Our export basket would recover from the loss of coal and other coal-dependent commodities—partly because the removal of coal reduces our exchange rate and makes other export industries more competitive. Our economy doubles in size in around 2037 instead of 2034.^{xxxvii}

I don’t mean to suggest that coal phase down doesn’t cause economic and political pain—or that it’s not a very big deal for regional communities and people whose livelihoods are tied to coal’s fortunes. Clearly it is. But the question for communities, families and governments now hooked up to coal is this: how much harder will the transition be if in ten years time, in the face of climate change, the world won’t turn a blind eye, and our coal industry is twice its current size? Right now we export relatively little coal to China and India—how much harder would coal phase down be politically, diplomatically, and strategically for Australia in 10 years time when we export a lot?^{xxxviii}

Climate campaigners face a similar question: if campaigning against Australia’s biggest contribution to climate change is ‘too hard’ now, how much harder will it be when the coal industry is twice its current size? If coal phase down dramatically cuts our carbon footprint abroad and makes our domestic efforts count, if it transforms the economy for the better, if it’s affordable, and has a positive environmental benefit internationally right as the world is on the brink of leaving any chance of a safe climate behind—then surely that’s something for which Australians concerned about climate change ought to be campaigning.

ⁱ The average Queensland household produces 13.77t per year—so a million such households would produce 13.77mt of CO₂ per year. Currently Australia exports 5.2mt of coal per week or 14.07mt of CO₂ per week.

ⁱⁱ 74,246 tonnes of new coal exports are added daily to double coal exports by 2020. At that rate, a million tonnes of new coal exports would be added every 13.5 days. 74,246 tonnes of extra coal daily equates to 200,465t of CO₂ being added. With the average car in Queensland emitting 4.13t of CO₂ per year, a doubling of coal exports involves the CO₂ equivalent of adding 48,538 cars every day between now and 2020.

ⁱⁱⁱ At the rate it would take to double Australian coal exports by 2020, coal exports are rising by around 2.25mt per month. A 1GW power station might use 1-1.5t of coal annually. So this is a conservative estimate.

^{iv} For more on the abatement tasks associated with different emission targets for 2020, see: *Tracking to Kyoto and 2020*, Department of Climate Change, Canberra 2009, p.7

^v The Carmichael Coal Project, proposed by Indian company, Adani would produce 60 million tonnes of coal annually by 2020; The Waratah Coal Project would produce 40mt of coal annually. The coal produced by the two projects would generate roughly 270 million tonnes of CO₂ annually from 2020. This is significantly more than the estimated

'abatement task' facing Australia if it adopted a 25% emissions reduction target for the year 2020. Sources: Carmichael Coal Mine and Rail Project, Factsheet, Queensland Government. <http://www.dip.qld.gov.au/projects/mining-and-mineral-processing/coal/carmichael-coal-mine-and-rail-project.html>; See: 'Carmichael Coal Mine and Rail Project' Initial Advice Statement by Adani Mining Pty Ltd, 22 October 2010; <http://www.dip.qld.gov.au/resources/project/carmichael/initial-advice-statement.pdf>; 'China First—Developing the Galilee Basin', Bowen Business Information Forum Presentation by Peter Lynch, Waratah Coal, 8 October 2009; <http://www.belyando.com.au/Portals/21/China%20first%20-%20Waratah%20Coal%20-%20Peter%20Lynch%2008-10-09.pdf> See also: 'Galilee Coal (Northern Export facility)' Fact Sheet, Queensland Government, <http://www.dip.qld.gov.au/projects/mining-and-mineral-processing/coal/galilee-coal-project-northern-export-facility.html> and http://www.dme.qld.gov.au/media_centre.cfm?item=811.00.

^{vi} For details on the emissions associated with the Energy Efficient Homes package, see Prime Minister and Minister for the Environment, 'Energy Efficient Homes: Ceiling Insulation in 2.7 Million Homes,' joint media release, 3 February 2009. According to the department of the environment, the package will 'help up to 420,000 households install a solar hot-water system.' See Energy Efficient Homes Package, home page www.environment.gov.au/energyefficiency (accessed 21 September 2009).

^{vii} Saudi net oil exports are currently around 8.7 million barrels a day (CIA World Factbook). This amounts to 3.175 billion barrels a year which equates to around 1.36 billion tonnes of CO₂ exported annually. (Conversion factor: 430 kilograms of CO₂ per barrel of crude oil; Source: USEPA). If Australia doubled its current coal exports between now and 2020—to 542mt annually, coal export emissions would rise to 1.46 billion tonnes annually. Add in a 50mt a year coal seam gas export industry in Queensland generating another 140mt of CO₂ and you have fossil fuel export emissions from Australia of over 1.6b tonnes annually (excluding other LNG sources in WA).

^{viii} <http://www.worldcoal.org/coal-the-environment/climate-change/>

^{ix} Total hard coal production in 2008-9 is estimated by the World Coal Institute as 5.99 billion tonnes. <http://www.worldcoal.org/resources/coal-statistics/> Australia produced 334.5mt of salable black coal in that year, or 5.6 percent of global hard coal production. <http://www.australiancoal.com.au/the-australian-coal-industry-coal-production.aspx> nb this excludes brown coal which is less than a billion tonnes a year globally.

^x Coal industry is safe says Greg Combet, The Australian, 13 September 2010 <http://www.theaustralian.com.au/national-affairs/coal-industry-is-safe-says-greg-combet/story-fn59niix-1225919936683>

^{xi} As James Hansen notes "The amount of CO₂ already emitted to the atmosphere...is about 50% from coal, 35% from oil and 15% from gas... On the long run, coal will be even much more important... The coal reservoir is larger than either oil or gas... there is enough CO₂ in coal to take the Earth far into the 'dangerous' zone of climate change, to doubled atmospheric CO₂ and even beyond." 'Testimony of James E Hansen before the Iowa Utilities Board re: Interstate Power and Light Company', November 2007, www.columbia.edu/~jeh1/2007/IowaCoal_20071105.pdf pp.25-6; The Global Carbon Project noted in 2009 that 'Emissions from coal are now the dominant fossil fuel emission source, surpassing 40 years of oil emission prevalence.' See: Fossil fuel CO₂ emissions up by 29 per cent since 2000, Media Release by the University of East Anglia, 19 November 2009

http://www.globalcarbonproject.org/carbonbudget/08/files/UniversityEastAnglia_UK.pdf See also: http://cdiac.ornl.gov/ftp/ndp030/global.1751_2007.ems For more on coal as fastest growing fuel source in the world, see: <http://www.theage.com.au/national/old-king-coal-20091107-i2w7.html> and See also: Green Coal: Limitless Energy for our Future, Presentation by Fred Palmer Senior Vice President of Government Relations--Peabody Energy, World Coal Conference, Amsterdam Oct. 18, 2010, p.9; and BP Statistical Review of World Energy, June 2009 http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2009_downloads/statistical_review_of_world_energy_full_report_2009.pdf Hydro ousted coal in the BP report in 2010 for the first time since 2002.

<https://uctcriminology.wordpress.com/2010/06/10/hydropower-ousts-coal-as-fastest-growing-fuel-source/>

^{xii} See 'Greenhouse-gas emission targets for limiting global warming to 2 degrees c' Letters, Nature, Volume 458, Number 30, April 2009, p.1158-1162

^{xiii} Source: Energy Strategies Ltd – private correspondence with the Author.

^{xiv} <http://www.cop15brasil.gov.br/en-US/?page=noticias/green-steel-for-the-brazilian-steel-industry> <http://www.gwm-tv.com/news/article/brazil-turns-to-eucalyptus-for-green-steel-production-163692.html>

<http://www.forestry-invest.com/2010/eucalyptus-charcoal-brazils-choice-for-the-steel-industry/268>
<http://sbbnews.wordpress.com/2010/08/23/arcelormittal%E2%80%99s-charcoal-production-to-double/>

^{xv} See, for example, in Canada: 'Biomass in Ironmaking Expected to Reduce Emissions' Natural Elements, NRCan's Monthly Newsletter—Issue 31, Natural Resources Canada

<http://www.nrcan-rncan.gc.ca/com/elements/issues/31/biomass-eng.php> '

^{xvi} For more information on the more than 45 million or so tonnes of direct reduced iron (DRI) produced annually without coal from gas based processes, see 'World Direct Reduction Statistics', Presentation by Midrex, <http://www.midrex.com/uploads/documents/MIDREXStatsBook2009rev4.pdf> For more info on the alternative steelmaking processes, see: Steel and Energy Fact Sheet, World Steel Association, http://www.worldsteel.org/pictures/programfiles/Fact%20sheet_Energy.pdf See also: The scope for fuel rate reduction in iron-making, Technical Note 16, Cooperative Research Centre for Coal in Sustainable Development, January 2005

^{xvii} 'Biomass gasification for DRI production' paper by Thomas Buerger¹ and Antonello Di Donato², Proceedings of the 4th Ulcos seminar, 1-2 October 2008; See: http://www.ulcos.org/en/docs/seminars/Ref23%20-%20SP12_DiDonato.pdf

^{xviii} <http://aluminumtransportation.org/main/growth/did-you-know> ; <http://www.csiro.au/science/ps1jb.html>

http://www.motoraauthority.com/blog/1032636_aluminum-use-in-cars-hits-all-time-high

<http://www.aluminiumleader.com/en/around/transport/aircraft>

^{xix} http://wardsauto.com/ar/composite_replace_steel_080922/

http://www.linearcomposites.com/ap_reinforce_soil.htm

<http://scienceblog.com/community/older/2001/D/200114560.html>

^{xx} <http://www.mbironoreindex.com/Article/2124630/Australia-dethrones-Brazil-as-biggest-iron-ore-exporter.html>

^{xxi} <http://www.worldcoal.org/coal/coal-mining/> & <http://www.worldcoal.org/resources/coal-statistics/>

^{xxii} 259-(270)/951mt (more recent figs) = at least 27.5% of total seaborne trade; 135/232mt of the trade in coking coal. <http://www.worldcoal.org/resources/coal-statistics/>

^{xxiii} As of mid 2010, Australian companies were involved in coal mining projects (either under way or planned in the next few years) that account for around 95mt of coal production annually. Include BHP Billiton's Adaro (Murawi) project and the tally may rise to 110 mt. Almost all of the projects involve export coal, and total Indonesia exports are around 228 million short tons about 205 metric tonnes. So 1/3 is a conservative estimate. See also: 'Land of the Long Black Cloud' by Guy Pearse, The Monthly, September 2010

^{xxiv} See for example, <http://hello.news352.lu/edito-54866-mozambique-to-ship-coal-on-zambezi-minister.html>

^{xxv} US coal exports have more than doubled since 2002 whereas Australia's have increased by around ¼. So US exports are increasing relatively much faster in percentage terms. However, they are about 1/3rd of Australia's total exports. See: World Total Coal Exports (spreadsheet), US EIA. For an example of Appalachian coal going to China see: <http://www.coaltransinternational.com/htm/w20100113.186336.htm> Nations That Debate Coal Use Export It to Feed China's Need, New York Times, 21/11/10 ; 'Mining companies aim to export coal to China through Northwest ports', *The Oregonian*, 9 September 2010.

^{xxvi} 'Enough coking coal for the next 30 years?' Presentation by Peter Hickson, Head of Global Materials, Mining & Commodities Research—UBS Ltd, Coaltrans World Coal Conference, 18 October 2010, slide 6 & 8

^{xxvii} Overview - Long term prospects for Indian coal requirements, Presentation by Sudhir Nair -- Head, Energy & Infrastructure CRISIL Research, 10 March 2010 www.coaltrans.com/EventDocument.aspx?eventID=1130...2928... ; Facilitating Queensland's Export Growth (2010 –2025), Presentation by Leo Zussino-- Chief Executive Officer Gladstone Ports Corporation, World Coal Conference, Amsterdam, October 2010, Slide 8 ; See also <http://www.thejakartaglobe.com/business/indonesian-coal-mines-in-sumatra-kalimantan-draw-interest-from-indias-ntpc/393658>

^{xxviii} Green Coal: Limitless Energy for our Future, Presentation by Fred Palmer Senior Vice President of Government Relations--Peabody Energy, World Coal Conference, Amsterdam Oct. 18, 2010, p.17

^{xxix} <http://www.worldcoal.org/> (Accessed 23/11/10)

^{xxx} Globally, around 6 billion tonnes of hard coal is consumed annually. This excludes close to a billion tonnes of lignite. (<http://www.worldcoal.org/coal/coal-mining/> & Coal Industry Advisory Board – International Coal Market and Policy Developments 2009, Feb 2010, pp.12,19). This equates to 16.2 billion tonnes of CO₂ annually or 44.4 million tonnes of CO₂ a day. Including lignite would take that figure closer to the 49m cited by the WCI CCS counter.

^{xxxix} Carbon capture and storage: Industry in the making –a coal perspective, Speech by Benjamin Sporton--Policy Manager, World Coal Institute, World Coal Conference, Amsterdam, 19 October 2010

^{xxxix} http://www.iea.org/roadmaps/ccs_roadmap.asp

^{xxxix} Approximately 14,600 days between now and 2050 – 3000 CCS plants between now and then means one every 4.86 days.

^{xxxix} Assuming these facilities were large 1-gigawatt scale (which is very unlikely – they'd probably be smaller demonstration projects), and assuming that carbon capture and storage (CCS) saves 80–90 per cent of emissions, they might save around 6.5 metric tonnes of CO₂ annually each, or about 130 metric tonnes in total. This is without incorporating the extra energy required by the CCS process – between a quarter and a third more than conventional coal-fired power generation.

^{xxxix} Current global hard coal consumption is around 6 billion tonnes per annum. Notwithstanding efficiency improvements (According to the World Coal Institute, 21st century coal fired plants emit 40% less than the 20th century average. <http://www.worldcoal.org/>), Peabody Energy projects global coal demand to increase by 53% to 11-12mt per annum by 2030, driven in large part by a doubling in demand for metallurgical (coking) coal. On that basis, by 2020, it is entirely conceivable that global coal demand may be over 8 billion tonnes per annum. Even if 150 million tonnes of CO₂ were saved annually by 2020 should the G8 meet its CCS target through coal projects, emissions from coal burning would still be well over 20 billion tonnes of CO₂ per annum. For Peabody's projections, see (Slide 12) 'Energizing the world one BTU at a time' Presentation by Greg Boyce—Chairman and CEO of Peabody Energy, Barclays CEO Energy Power Conference, 15 September 2010. http://www.faqs.org/sec-filings/100915/PEABODY-ENERGY-CORP_8-K/c60242exv99w1.htm; and Green Coal: Limitless Energy for our Future, Presentation by Fred Palmer Senior Vice President of Government Relations--Peabody Energy, World Coal Conference, Amsterdam Oct. 18, 2010, p.17

^{xxxix} 'DCC briefing: a farrago of spin, obfuscation and exaggeration', Opinion piece by Alan Moran Director, Deregulation at the Institute of Public Affairs *ABC Online – The Drum*, 4/11/10
<http://www.abc.net.au/unleashed/40764.html>

^{xxxix} Sources: *Australia's Low Pollution Future: The Economics of Climate Change Mitigation* (Canberra: Commonwealth Treasury, 2008), 145, 164; Australian Bureau of Agriculture and Research Economics (ABARE), Department of Innovation, Industry, Science and Research. This assumes a GDP of around \$1.5 trillion by 2020 under business as usual. Losing coal would cost around 3 per cent of projected GDP; and the cost of losing half the steel, aluminium and other EITEs would be similar. Together, this cost would equate to about \$100 billion a year, leaving a GDP of around \$1.4 trillion or about 30 per cent more than today's GDP of \$1.1 trillion.

^{xxxix} In 2008-09 Australia exported 25mt of coal to China and 24.7mt to India – 49.7mt combined which 18.8% of the 263.4mt of coal exported that year according to the Australian Coal Association.
http://www.australiancoal.com.au/the-australian-coal-industry_coal-exports_coal-export-details.aspx Our exports account for less than 1.25% of the combined coal use of China and India.